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MOST DYNAMIC MICROPOLITANS: 2022

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ABOUT HEARTLAND FORWARD

Heartland Forward's mission is to improve economic performance in the center of the United States by advocating for fact-based solutions to foster job creation, knowledge-based and inclusive growth and improved health outcomes. We conduct independent, data-driven research to facilitate action-oriented discussion and impactful policy recommendations.

The views expressed in this report are solely those of Heartland Forward.

EXECUTIVE SUMMARY

COVID-19 created unique challenges and opportunities for America's micropolitan areas—towns with 10,000 to 50,000 residents and the outlying areas with close economic ties to those communities. In some ways, these challenges and opportunities rewrote the guide to micropolitan economic success, while in other ways they simply reordered the bullet points on that guide. "Most Dynamic Micropolitans: 2022" tells the story of trends that were subverted during the pandemic and those that remained.

We ranked the economic dynamism of 536 micropolitan areas across the United States by studying changes in key economic conditions from 2015 through 2020. We also examined one indicator—the change in employment from September 2020 through September 2021—that reflects communities' ability to rebound from the early months of the pandemic. (Appendix 1 provides details on the methodology.)

The Most Dynamic Micropolitan

Our top-ranked micropolitan—Los Alamos, New Mexico—benefited from the expansion of the Los Alamos National Laboratory. While the laboratory has long contributed the area's economic strength, a $2.5 billion contract with startup Triad National Security, LLC, during the reporting period accounts for this rank. But pandemic-related factors were the primary economic drivers in other micropolitan areas, and these associated patterns are the focus of this report.

Outdoor Recreation

Our third index of micropolitans indicates that natural amenities remain a key characteristic of success. Areas offering a mix of broadband connectivity and access to the outdoors became a respite from the difficulties of pandemic-era city life.

When COVID-19 shuttered the urban amenities that draw many residents to large metropolitans and forced desk-based employees to work from home, the intrigue of an outdoor-centric small town with sufficient internet quality only increased. Communities such as Cedar City, Utah, and Bozeman, Montana, maintained or improved their position near the top of the rankings in 2022. Additionally, Brevard, North Carolina, nestled in the Blue Ridge Mountains of Southern Appalachia, is the 12th-ranked micropolitan, and heartland lake-area communities Spirit Lake, Iowa, and Albertville, Alabama, each vaulted 50-plus positions to place in the top 150.

Food Production and Processing

While those communities built upon a trend that began prior to the pandemic, food-producing communities emerged as a new micropolitan archetype at the top of the rankings.

Micropolitans driven by food production and processing found success, in part, because such operations remained open throughout the pandemic to prevent food shortages. As a result, micropolitans such as Dodge City, Kansas, made significant jumps in our rankings. Dodge City's largest employer, the National Beef Packing Company, helped stabilize that area's labor market and propel it 336 spots to No. 22 in our rankings.

Oil and Gas

Oil-producing micropolitans reversed course. For example, Pecos, Texas, relinquished the top spot in our index for the first time, largely because oil drilling, its primary industry, was unprofitable for much of 2020. Still, its pre-pandemic economic growth was so strong that Pecos remains No. 4 in our 2022 rankings. Additionally, its highly productive oil fields were among the nation's first to reopen, which helped it rebound quickly from its 2020 trough.

Overall, the changes in fortunes for micropolitans dependent on a single industry provide a reminder of the stabilizing benefits of a diversified economy. Liberal, Kansas, for instance, relies heavily on oil extraction, but the presence of ethanol and helium processing, along with food production and processing, helped it navigate the early months of the pandemic better than most micropolitans.

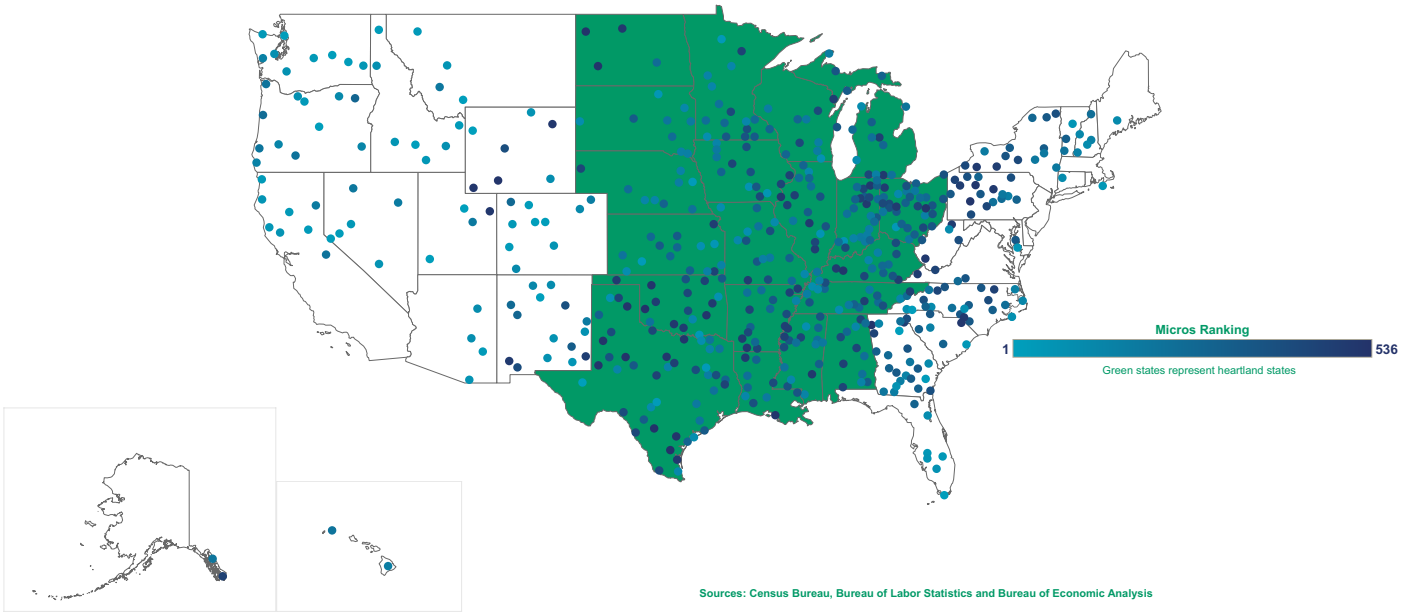
The Heartland

The 335 micropolitans in the heartland region of America delivered mixed results in this year's national rankings. While 94 of the top 200 are in the heartland, only 30 of those are among the top 100. Agriculture-dependent micropolitans found success during the pandemic, but that trend could dissipate quickly, as it did for oil-reliant micropolitans. More must be done to diversify heartland micropolitan economies if they are to weather the volatility of individual industries.

ES 1 - TOP 25 MICROPOLITAN AREAS

1. Los Alamos, New Mexico
2. Jackson, Wyoming - Idaho
3. Heber, Utah
4. Pecos, Texas
5. Jefferson, Georgia
6. Bozeman, Montana
7. Hailey, Idaho
8. Cedar City, Utah
9. Prineville, Oregon
10. Edwards, Colorado
11. Moses Lake, Washington
12. Brevard, North Carolina
13. Key West, Florida
14. Oak Harbor, Washington
15. Breckenridge, Colorado
16. Steamboat Springs, Colorado
17. Sandpoint, Idaho
18. Othello, Washington
19. Gardnerville Ranchos, Nevada
20. Fernley, Nevada
21. Fredericksburg, Texas
22. Dodge City, Kansas
23. Fremont, Nebraska
24. Jesup, Georgia
25. Montrose, Colorado

ES 2- COLOR-CODED MAP OF ALL MICROS ACROSS THE COUNTRY



Sources: Census Bureau, Bureau of Labor Statistics and Bureau of Economic Analysis

INTRODUCTION

The data collected for the 2022 edition of the Most Dynamic Micropolitans reveals how the pandemic influenced each micropolitan, how each fared relative to its peers, and the various characteristics that helped some smoothly navigate the crisis and hindered others. Thus, while previous editions of this report focused on the top-performing communities, this one looks at the most compelling patterns provided by the data.

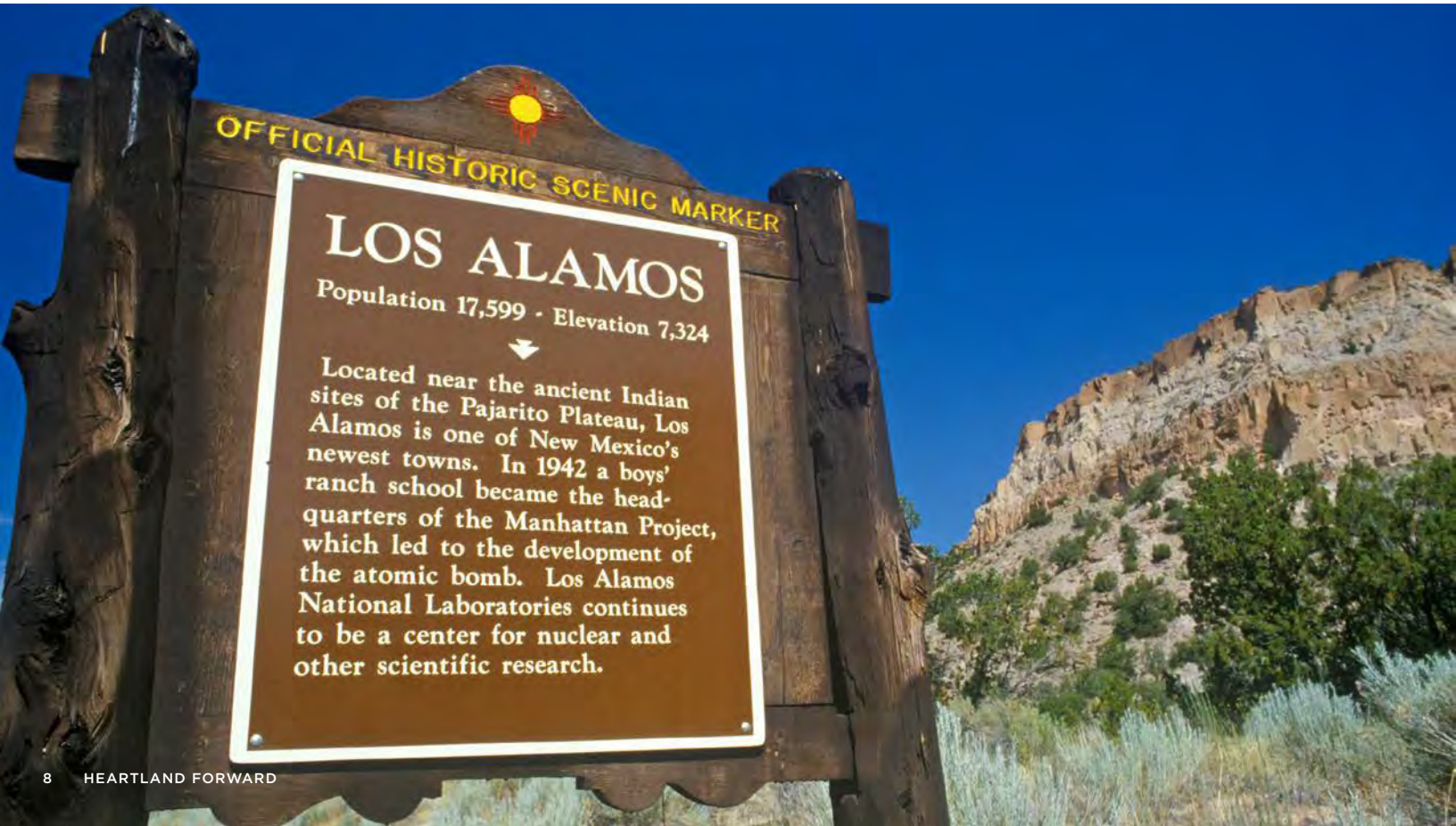
COVID-19 brought an unprecedented shock to the overall economy, but the challenges have been unique to micropolitans, where resident populations number 10,000 to 50,000. These areas are at a comparative disadvantage versus metropolitan areas because smaller workforces result in a less-diversified economy.

The bulk of the labor force generally focuses on a specialized industry to benefit from economies of scale. Micros heavily dependent on severely COVID-impacted industries have suffered, at least in the short term. Others have benefited from a combination of luck and foresight and have thrived.

While the rankings in this report help illustrate the patterns by showing which micropolitan areas benefited and which ones struggled, the top spot represents a bit of an outlier. Los Alamos, already a strong micropolitan area, rose to No. 1 on the wings of the $2.5 billion contract that made Triad National Security, LLC the management firm of Los Alamos National Laboratory.

This government research institution began as a nuclear weapons development lab during World War II but now serves as a hub for fields ranging from renewable energy to oncology. The lab's highly paid scientists support a vibrant town of about 13,000 residents nestled in the Jemez Mountains.

We will address the impact of the new contract and other factors that played into the top ranking for Los Alamos, but first we will cover the industry patterns that had a more widespread effect on micropolitan areas – food production and processing, outdoor recreation, and oil and gas.



FOOD PRODUCTION AND PROCESSING

Micros that specialize in food production and processing acted as the sustenance safety net for everyone during 2020; therefore, their economies were relatively stable, while many of their nonagricultural counterparts struggled.

Several heartland micros gained significant ground in the rankings on the strength of food manufacturing. Dodge City, Kansas, experienced strong GDP growth rates in both medium-term (2015-2020 at 27.9%) and short-term (2019-2020 at 3.2%) periods, placing it at No. 18 and No. 32, respectively, in those categories. National Beef contributed substantially to local GDP growth even before the pandemic. The company, headquartered in Kansas City, announced a $30 million expansion plan for its Dodge City[1] operations in summer 2016. The project, completed by the end of 2017, included additional cranes and pelletizers to more efficiently handle its products.

When the pandemic struck, the manufacturing industry was presented with unprecedented challenges that disrupted businesses that were vital to local economies. Job losses were widespread, and Dodge City was no exception, although it registered only a short-term employment decline of 1.9%.

As the national economy recovered slowly from COVID-19, Dodge City's manufacturing sector experienced a small bounce-back, including employment growth of 3.8%. Since the pandemic, food manufacturing sectors tightened employee health and safety policies, as well as sanitation procedures.

Moses Lake, Washington, is another micropolitan that demonstrated the stabilizing influence of food manufacturing, in addition to high-tech manufacturing. The tourist town is famous for its 120 miles of freshwater shorelines and is in Grant County, the 10th-largest agriculture producer in the United States. The area includes more than 1 million acres of farmland that generated almost $2 billion in market value of products in 2017.[2]

In addition to its ranching, crop production and other food-related operations, Moses Lake, ranked No. 11 overall, benefited from being a high-tech manufacturing hub that is dependent on nearby large bodies of water. Manufacturers with roots there include aerospace giant Boeing, automobile legend BMW, Moses Lake Industries (which makes chemical products for semiconductors and flat-panel companies) and REC Silicon (a producer of polysilicon for solar-energy purposes).

BMW in 2014 pledged $100 million to expand its manufacturing plant with a goal of tripling its carbon-fiber production capacity to 9,000 tons per year.[3] As a result, from 2015 onward, this micro area's economy has been naturally impressive.

With a healthy medium-term GDP growth of 8.6% and an impressive performance in short-term GDP growth of 12.8% (second-best among all micros), Moses Lake is remarkably diversified in the manufacturing sectors, especially considering the small economic base that defines micropolitans. Average pay growth is 33% for medium term and 13.7% for short term due to the large, highly skilled workforce that is required by its high-tech employers. COVID-19 caused a job growth loss of 1.9%, but the trend had already reversed to growth of 0.49% by the reporting period of September 2020-September 2021.

Moses Lake and other micropolitans with a diversified economy performed well because they have the resources to support tourism, as well as multiple manufacturing operations. The importance of food manufacturing to micropolitan economies should not be underestimated. Many micro communities depend on this sector for their livelihood, which creates an important link between rural and urban areas in the U.S. Transforming agricultural products into shelf-stable foods provides nutrition and energy for households.

OUTDOOR RECREATION

The Mountain West region again dominates the upper echelon of the Most Dynamic Micropolitans. Twelve of the top 25 micros are in Colorado, Idaho, Montana, Nevada, Utah or Wyoming.

Similar to its metro areas, which generally performed well in our 2021 Most Dynamic Metropolitan rankings, Mountain West micros offered an outdoor-centric respite from the stresses of COVID-19. When travel restrictions were relaxed in the latter half of 2020, tourists flocked to Jackson Hole, Wyoming; Heber, Utah; Bozeman, Montana; and other small towns at the doorstep to the Mountain West's vast wilderness. Some stayed for weeks at a time, while others who had transitioned to remote work at the start of the pandemic, stayed even longer.

The result was a surge in economic activity and population. Cedar City, Utah, our eighth-ranked micro, experienced the fastest population growth of any micropolitan area from July 2020 to July 2021.[4]

A few Mountain West communities have successfully parlayed the influx of tourists and remote workers into vibrant startup ecosystems. In Edwards, Colorado, for instance, REVER developed a motorcycle ride-planning application that provides in-depth guidance for popular on-road and off-road motorcycle routes in Colorado and beyond. Motorcycle e-commerce company Comoto Holdings acquired REVER at the end of 2020.[5]

Several micropolitans in the southern Appalachians have also benefited from the nation's increased interest in the outdoors. Brevard, North Carolina, known as the Land of Waterfalls, ranks 12th on our list, due partly to its uniquely easy access to world-class mountain biking, fly fishing, hiking and whitewater rafting. The community was named one of the top 10 mountain biking destinations in North America by prominent cycling news outlet Singletracks and was the only top-10 community east of the Mississippi River.[6]

Brevard's performance in the Most Dynamic Micropolitans Index is the result of strong medium-term growth in jobs, GDP and wages, as well as a respectable level of entrepreneurship activity. Brevard and the broader Western North Carolina area have been remarkably successful in translating their residents' passion for the outdoors into a development powerhouse for outdoor recreation products. For example, camping trailer manufacturer SylvanSport has become a camping industry darling for its innovative small-camper designs. National Geographic Adventure Magazine declared the popular SylvanSport Go to be the "Coolest. Camper. Ever."[7]

In keeping with the outdoors trend, lakeside communities such as Albertville, Alabama, and Spirit Lake, Iowa, also have seen economic boosts.

While neither micro made the top 25, both rose significantly from the previous iteration of Most Dynamic Micropolitans. Albertville, near Lake Guntersville, improved from 174 to 124, while Spirit Lake, home to the Iowa Great Lakes, climbed from 235 to 134.

Lake Guntersville is one of the nation's preeminent spots for bass fishing, hosting major tournaments and thousands of recreational anglers each year. In 2019, it was named the second-best bass lake in the U.S. by Bassmaster Magazine.[8] The lake's fishing prowess, in addition to the other watersport opportunities it provides, resulted in a $1.2 billion impact on the Albertville micropolitan area and neighboring Jackson County in 2020.[9]

The Iowa Great Lakes are similarly important to Spirit Lake, driving $300 million in tourism spending each year. According to a recent report, one key to Spirit Lake's success is the decades-long effort to keep the Iowa Great Lakes clean and clear, leading tourists to bypass less-pristine lakes nearer to home.[10]

Overall, the pandemic has increased the impact of natural amenities upon micropolitans, and their value is even greater for areas that encourage their outdoor-loving residents to create products to better enjoy their surroundings. Thus, communities such as Edwards and Brevard are thriving. The lingering question for outdoor-centric micropolitans is how long Americans' newfound love for the outdoors will last. However, more than two years after the pandemic's onset, this love has shown no signs of waning.

OIL AND GAS

Micropolitan areas that specialize in oil and gas are still looking for ways to navigate the influences of COVID-19. While striking oil in the late 1800s to early 1900s brought growth and prosperity to many communities, recent data shows that the pandemic has been devasting. Pecos, Texas, is the only notable oil-and-gas micro in the top 25 overall; the rest bank on tourism and manufacturing.

Liberal, Kansas, near the Kansas-Oklahoma border, landed at No. 91 overall on our list. Its roots go back to 1888 when a resident of a nearby town put up a general store and a post office. In 1920, the city found natural gas, which later would become part of the Hugoton Gas Field.[11] In 1951, the discovery of oil southwest of Liberal helped preserve the area's longevity.

The gas industry not only contributed to Liberal's population growth, but also helped farmers grow crops more efficiently by using gas-powered machinery. However, as it did across the oil and gas industry, the arrival of COVID-19 rocked Liberal. Its workforce declined as medium-term employment growth plummeted to –7.9% and remained stagnant throughout our study period (evidenced by –0.4% in short-term employment growth and –1.15% in short-term momentum employment growth between September 2020 and September 2021). The noticeable drop in medium-term employment growth also contributed to a worsening level of GDP growth, recorded as –14.8% over our five-year study period. The redeeming quality of this micro's overall ranking is that both medium- and short-term average annual pay growth rates are among the highest of all micros studied.

Overall, Liberal has fared better than many other oil-and-gas-centric micropolitans, and thanks may be due to its other industries. Just as in Dodge City, National Beef also found a home in Liberal. The city's economic-development website lists the meat packer among its major employers, with 3,500 workers. Continuous operation at the National Beef plant in Liberal throughout the pandemic helped slow the speed of economic deterioration. Beyond beef, Liberal is home to processing plants for pork, ethanol and helium, reflecting a degree of economic diversity that can only help during a global pandemic.[12]

Pecos is in the natural gas-rich Permian Basin of Texas, from which it drew great economic strength. The city's founders struck oil in the early 1900s after drilling near a local source of gas that was used for medicinal purposes. Little did residents know this site would only be used briefly before drillers struck oil in the "Miracle Well" that brought about the Yates oil field in 1912.[13]

Until later in the 1950s, natural gas was considered a nonvaluable byproduct of oil; therefore, much of Peco's resources went unused for many years. Later came the key discoveries of the Santa Rosa and Gomez oil fields. These assets help Pecos land the No. 1 spot in the Most Dynamic Micropolitans of 2020, and the area slipped only three spots to No. 4 in the current ratings. Its medium-term GDP growth of 218.2% continues to impress, although the pandemic took a toll on its short-term GDP, which dipped to –16.6%.

Certainly, the oil-and-gas industry is important to many American micropolitans. Cities like Pecos and Liberal relied on it through the 1900s and still do. The flip side is that their lack of a diversified economic sector appears to have made them vulnerable to ambushers like COVID-19. These two micros only remained high in the overall rankings due to strong performances prior to the pandemic. From early 2020 forward, they could only wait and hope for a rebound in the oil-and-gas industry. Without a diversified economy, oil-and-gas-dependent micros will be vulnerable.

NO. 1-RANKED LOS ALAMOS, NEW MEXICO

The top-ranked micropolitan in our 2022 index – Los Alamos – rose to that spot thanks to some unusual circumstances. So, while it doesn't fit neatly into the patterns of other micropolitans, it still merits our attention.

The Los Alamos National Laboratory created the first atomic bomb during World War II. Ever since the Manhattan Project was handed to Robert Oppenheimer, director of the lab, this micro area has been a nuclear-engineering hub that has employed many physicists, engineers and other highly skilled workers. This trend continues and, as a result, Los Alamos had our rankings' eighth-highest income per capita for 2020 ($87,078) after adjusting for regional price parity.

A U.S. leader in nuclear science, most of Los Alamos' economic growth comes from the national lab. And on June 8, 2018, the U.S. Department of Energy (DoE) awarded a $2.5 billion contract to Triad National Security, a new management firm that partnered with the University of California, Texas A&M, and Battelle Memorial Institute to manage the Los Alamos laboratory's operations.[14] This transaction contributed to the highest young-firm employment share (73.5%), as well as the highest young-firm knowledge intensity (37.2%), ever recorded since the inception of this annual report.

Los Alamos National Laboratory was already a multidisciplined research hub before Triad took over. Currently, according to its website, the company engages in research areas such as nuclear energy, nuclear nonproliferation, national security, nanotechnology, renewable energy, magnetic field research, genomics, supercomputing and other projects for the Department of Energy.

This diversification is reflected in growth numbers such as medium-term GDP growth at 20% and short-term GDP growth at 3.9%. The strong GDP growth also triggered medium-term job growth of 13.9% and short-term job growth of 4.3% as demand for highly skilled labor increased. This chain of economic activities also sparked medium-term and short-term average annual pay growth of 28.3% and 9.7%, respectively.

It was this vigorous growth that put Los Alamos at the top of our overall rankings.

We have categorized this micro area as an outlier due to its unprecedented young-firm data. We predict the young-firm employment share and young-firm knowledge intensity will recede eventually in this community that is predominantly dependent on a single employer.

CONCLUSION

Distinct types of communities reacted differently to COVID-19. Some have navigated well, while others have not.

Communities that exclusively depend on oil and gas have seen sharp declines in short-term GDP and employment growth. The decrease in GDP growth is a major factor of concern, as it lowers the standards of living for residents.

Micros that rely on food manufacturing fared well because these industries were exempted from COVID-19-related shutdowns. Other communities leveraged their natural amenities to attract remote workers and specialized manufacturing associated with those amenities.

Micros that relied heavily upon tourism even before COVID-19 saw growth because of how people reacted to policy changes that affected their work-life balance. The adaptation of remote work gave numerous workers a chance to experience a fresh breath of work-life balance—trading confinement inside an office for the refreshment of nature. However, most U.S. manufacturing activity was curtailed by pandemic-related shutdowns.

Relative to data trends, the principal factor of sustainable economic development has always been industry diversification. However, few micros have the luxury of a diversified economy that is common within large metro areas. Evidently, micros that do provide natural amenities—or multiple industry sectors—breed growth stability and thus avoided economic ruin during the pandemic.

Overall, sustainable growth requires a solid foundation of economic diversity as an insurance policy against unforeseen events, and communities can catalyze new manufacturing by encouraging innovation and entrepreneurship, which will create jobs that likely will pay well and provide a high quality of life.

APPENDIX 1: METHODOLOGY

The 2022 Most Dynamic Micropolitan rankings are derived from the following economic measures: growth in average annual pay, employment numbers and gross domestic product (GDP); level of per capita personal income; share of total employment at firms aged 5 years or fewer (young-firm employment share); and the share of employment at those young firms with a bachelor's degree or higher (young-firm knowledge intensity).

In addition, we use a few time-sensitive categories to measure economic performances: short-term economic development is defined by 2019-2020 real GDP growth, 2019-2020 employment growth, 2019-2020 average annual pay growth, and employment growth over a 12-month period from September 2020 to September 2021.

The medium-term economic development measurements are defined as 2020 per capita personal income, 2015-2020 employment growth, 2015-2020 average annual pay growth, and the 2020 young-firm employment share and young-firm knowledge intensity. The 2020 level of per capita personal income is an indicator of medium-term economic development because it represents the stock of all previous welfare improvements. We incorporate the latest available regional price parity (RPP) to adjust for per capita personal income and average annual pay. RPP measures price-level differences across states and metropolitans.

Since our report focuses on micropolitan areas, we employ RPP by state from the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) to reflect whether goods and services are generally more or less expensive than the national average. Therefore, the indexes can be used to adjust income measures for differing inflation rates and varying levels of purchasing power across regions.

To be qualified as a micropolitan statistical area, an urban cluster should contain a population of more than 10,000 but fewer than 50,000 people. The adjacent counties along with the urban cluster must be linked with community ties as determined by the federal Office of Management and Budget (OMB).
The 2020 rankings contained 515 micropolitan areas with data available for all measures. The 2022 rankings use the most recent definition (Bulletin No. 20-01) by OMB, which was released in March 2020. As a result of the definition change, we analyzed 536 micropolitan areas for the 2022 rankings.

The following micropolitan areas were excluded from this year's ranking due to the lack of young-firm data from the Census Bureau: Quincy, Illinois-Missouri; Wahpeton, North Dakota-Minnesota; Zapata, Texas; Fort Madison-Keokuk, Iowa-Illinois-Missouri; Union, South Carolina; Iron Mountain, Michigan-Wisconsin; and Eufaula, Alabama-Georgia.

It is essential to include the young-firm employment share and young-firm knowledge intensity, as they are strong indicators for future economic growth. Young firm employment share allows us to understand an entrepreneur's ability to start new firms and scale them, while young-firm knowledge intensity provides insights into potential innovations driven by educational attainment within these young firms.

We standardize all metrics via z-scores. That is, we calculate the mean and standard deviation of a metric across all micropolitan areas, subtract the mean of the metric from each micropolitan area's metric value, and divide that difference by the standard deviation of the metric. The resulting number tells us how many standard deviations above the mean (positive z-score) or below the mean (negative z-score) a micropolitan area's metric value is. A micropolitan area's index value is its average z-score across all economic-development metrics. If an area has a positive average z-score, then, on average, it performs better than the mean micropolitan area for each metric.

TABLE 1 - MEASUREMENTS DERIVED FOR EACH RANKING

MEASURE	TIME PERIOD	SOURCE
Young firm employment ratio	2020	Census Bureau
Young firm knowledge intensity	2020	Census Bureau
Per capita personal income	2020	Bureau of Economic Analysis
Medium-term job growth	2015-2020	Bureau of Labor Statistics
Short-term job growth	2019-2020	Bureau of Labor Statistics
Short-term job growth momentum	Sep. 2020-Sep. 2021	Bureau of Labor Statistics
Medium-term average annual pay growth	2015-2020	Bureau of Labor Statistics
Short-term average annual pay growth	2019-2020	Bureau of Labor Statistics
Medium-term GDP growth	2015-2020	Bureau of Economic Analysis
Short-term GDP growth	2019-2020	Bureau of Economic Analysis

TABLE 2 - OVERALL TABLE

	OVERALL RANKING	2021 POPULATION	YOUNG FIRM EMPLOYMENT SHARE	YOUNG FIRM KNOWLEDGE INTENSITY	2020 PER CAPITA PERSONAL INCOME	2015-2020 EMPLOYMENT GROWTH	2019-2020 EMPLOYMENT GROWTH	SEP.2020-SEP.2021 EMPLOYMENT GROWTH	2015-2020 AVERAGE ANNUAL PAY GROWTH	2019-2020 AVERAGE ANNUAL PAY GROWTH	2015-2020 GDP GROWTH	2019-2020 GDP GROWTH
Los Alamos, NM	1	19,330	73.5%	37.2%	$87,078	13.9%	1.4%	4.3%	28.3%	9.7%	20.0%	3.9%
Jackson, WY-ID	2	35,842	15.9%	21.0%	$172,693	0.7%	-9.4%	9.7%	47.6%	16.2%	7.2%	-3.4%
Heber, UT	3	79,266	19.1%	22.6%	$129,161	7.8%	-6.8%	8.1%	40.4%	10.7%	13.8%	-6.7%
Pecos, TX	4	14,544	21.9%	10.5%	$48,501	59.7%	-26.1%	13.5%	54.6%	-6.2%	218.2%	-16.6%
Jefferson, GA	5	80,286	9.5%	20.8%	$52,779	46.8%	12.3%	10.6%	6.7%	3.1%	27.4%	2.2%
Bozeman, MT	6	122,713	16.9%	19.0%	$68,568	13.4%	-2.6%	6.6%	35.5%	13.4%	22.7%	-0.4%
Hailey, ID	7	25,905	16.6%	20.3%	$129,571	-1.7%	-5.6%	5.0%	27.7%	12.9%	9.0%	-3.1%
Cedar City, UT	8	60,519	18.8%	13.7%	$41,442	27.2%	2.0%	7.5%	31.6%	10.7%	35.8%	1.3%
Prineville, OR	9	25,739	12.4%	15.7%	$47,964	9.2%	4.2%	6.2%	24.2%	17.1%	28.4%	2.0%
Edwards, CO	10	55,727	14.8%	23.1%	$91,914	-2.5%	-10.9%	9.4%	31.1%	13.5%	2.3%	-6.9%
Moses Lake, WA	11	100,297	14.8%	17.4%	$49,968	0.7%	-1.9%	0.5%	33.0%	13.7%	8.6%	12.8%
Brevard, NC	12	33,165	13.0%	20.0%	$51,771	4.8%	-5.1%	0.9%	21.7%	9.8%	89.5%	1.0%
Key West, FL	13	82,170	18.2%	20.0%	$115,472	-7.0%	-9.5%	10.3%	20.4%	8.2%	6.6%	-5.7%
Oak Harbor, WA	14	87,432	18.7%	19.4%	$61,032	6.3%	-3.9%	4.4%	27.4%	9.5%	16.2%	0.5%
Breckenridge, CO	15	30,941	15.5%	23.6%	$81,331	-4.0%	-11.9%	4.6%	34.9%	15.7%	7.0%	-5.4%
Steamboat Springs, CO	16	25,091	19.0%	21.7%	$89,785	1.9%	-7.9%	3.4%	20.6%	12.5%	2.6%	-4.1%
Sandpoint, ID	17	49,491	14.2%	16.8%	$50,543	9.8%	-1.2%	5.1%	27.9%	10.9%	15.4%	0.7%
Othello, WA	18	20,621	13.2%	18.6%	$51,154	7.7%	-4.8%	9.3%	19.9%	9.7%	6.3%	6.0%
Gardnerville Ranchos, NV	19	49,870	11.7%	21.1%	$84,563	-4.2%	-9.1%	2.3%	35.7%	14.6%	-0.5%	-2.0%
Fernley, NV	20	60,903	12.8%	16.0%	$47,555	7.9%	-3.4%	10.3%	26.5%	8.6%	20.3%	-0.3%
Fredericksburg, TX	21	27,297	17.9%	17.3%	$75,442	4.8%	-3.7%	7.5%	17.4%	5.2%	12.6%	-0.2%
Dodge City, KS	22	34,159	5.8%	14.1%	$51,555	-5.4%	-1.9%	3.8%	37.4%	15.5%	27.9%	3.2%
Fremont, NE	23	37,103	17.6%	17.9%	$59,030	3.4%	0.9%	-1.3%	24.7%	9.8%	12.0%	0.5%
Jesup, GA	24	30,380	18.4%	15.5%	$40,816	0.7%	-0.9%	4.0%	20.7%	6.4%	39.9%	4.5%
Montrose, CO	25	48,203	17.1%	15.9%	$49,726	6.4%	-3.8%	6.3%	25.8%	10.7%	7.2%	-0.7%
Truckee-Grass Valley, CA	26	103,487	16.4%	21.2%	$64,922	0.1%	-7.3%	5.6%	22.8%	13.1%	0.3%	-4.5%
Rexburg, ID	27	67,473	16.6%	12.3%	$37,609	14.2%	0.6%	6.8%	20.2%	7.9%	20.6%	0.8%

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	OVERALL RANKING	2021 POPULATION	YOUNG FIRM EMPLOYMENT SHARE	YOUNG FIRM KNOWLEDGE INTENSITY	2020 PER CAPITA PERSONAL INCOME	2015-2020 EMPLOYMENT GROWTH	2019-2020 EMPLOYMENT GROWTH	SEP.2020-SEP.2021 EMPLOYMENT GROWTH	2015-2020 AVERAGE ANNUAL PAY GROWTH	2019-2020 AVERAGE ANNUAL PAY GROWTH	2015-2020 GDP GROWTH	2019-2020 GDP GROWTH
Crescent City, CA	28	28,100	14.6%	15.3%	$40,221	-1.6%	-5.0%	2.2%	24.0%	13.3%	15.2%	12.3%
Safford, AZ	29	39,050	12.5%	11.1%	$43,793	11.5%	1.7%	-0.2%	29.3%	7.6%	37.3%	3.7%
Athens, TX	30	83,667	14.9%	16.9%	$47,483	8.5%	0.5%	4.5%	17.0%	4.8%	16.8%	3.7%
The Dalles, OR	31	26,726	15.1%	14.7%	$50,523	-1.0%	-5.0%	1.6%	24.0%	11.7%	2.9%	13.4%
Kalispell, MT	32	108,454	12.8%	17.3%	$57,010	5.7%	-2.5%	6.6%	24.3%	9.6%	1.1%	-2.9%
Bemidji, MN	33	46,380	23.5%	20.5%	$51,208	2.2%	-4.0%	-0.2%	21.3%	8.8%	7.5%	-1.6%
Red Bluff, CA	34	65,498	14.7%	14.8%	$46,040	8.6%	-2.1%	2.3%	21.9%	10.1%	23.9%	1.6%
Ellensburg, WA	35	45,499	20.1%	17.3%	$46,668	5.5%	-4.2%	3.5%	23.7%	7.8%	16.2%	-2.0%
Durant, OK	36	47,105	13.8%	12.3%	$43,144	26.7%	2.2%	-4.0%	18.8%	6.3%	26.3%	5.6%
Port Angeles, WA	37	78,209	16.9%	18.7%	$51,257	0.5%	-4.6%	4.3%	24.2%	9.4%	6.2%	-1.7%
Wilmington, OH	38	42,004	4.8%	16.5%	$55,312	7.2%	-4.9%	5.9%	26.9%	10.4%	9.5%	2.0%
Okeechobee, FL	39	40,266	12.7%	15.6%	$37,917	2.6%	-3.6%	1.6%	14.1%	9.4%	44.8%	9.3%
Glenwood Springs, CO	40	79,509	14.5%	20.7%	$87,580	-3.7%	-7.4%	4.1%	21.3%	8.7%	-4.5%	-6.2%
Fallon, NV	41	25,723	8.7%	16.5%	$54,007	8.3%	-0.5%	1.0%	23.2%	8.3%	19.2%	0.2%
Georgetown, SC	42	63,921	13.7%	18.6%	$61,749	2.0%	-3.3%	3.4%	19.3%	7.1%	1.9%	1.2%
Wauchula, FL	43	25,425	18.4%	15.8%	$34,425	-8.3%	0.1%	7.9%	17.2%	5.2%	7.6%	8.5%
Burley, ID	44	47,119	13.6%	13.2%	$55,448	8.9%	0.0%	3.4%	23.8%	7.3%	8.1%	-1.4%
Vineyard Haven, MA	45	21,097	14.3%	24.5%	$82,566	-10.8%	-14.3%	7.2%	22.4%	12.2%	-2.8%	-8.0%
Cambridge, MD	46	32,489	7.6%	16.0%	$54,758	6.1%	2.1%	5.3%	19.6%	9.6%	-2.7%	-1.4%
Pullman, WA	47	47,873	11.1%	18.0%	$46,009	-1.6%	-5.8%	7.0%	26.3%	9.4%	15.5%	-1.4%
Aberdeen, SD	48	42,134	10.0%	16.4%	$70,414	-6.0%	-3.7%	0.2%	19.3%	10.8%	3.2%	7.8%
Ukiah, CA	49	91,305	15.5%	17.0%	$54,834	-5.5%	-8.1%	5.5%	28.2%	13.5%	2.6%	-3.3%
Ottawa, KS	50	25,986	14.3%	18.8%	$53,105	-3.0%	-2.5%	5.8%	16.9%	8.5%	1.0%	-1.2%
Carlsbad-Artesia, NM	51	60,911	12.7%	12.0%	$71,312	6.6%	-9.7%	2.6%	25.3%	3.5%	31.9%	4.6%
Barre, VT	52	59,969	10.7%	22.8%	$66,602	-5.0%	-7.2%	0.8%	24.4%	10.3%	1.0%	-2.0%
Fairfield, IA	53	15,647	7.3%	30.3%	$48,832	-3.4%	-6.9%	2.3%	18.0%	9.5%	3.8%	-3.3%
Mountain Home, ID	54	28,827	10.6%	15.4%	$47,473	9.5%	-0.2%	0.6%	24.0%	9.0%	11.1%	-1.7%
Effingham, IL	55	34,430	6.9%	15.8%	$63,459	6.7%	-2.6%	3.2%	20.8%	10.1%	7.0%	-2.1%
Helena, MT	56	84,693	11.8%	17.1%	$58,210	-0.5%	-2.3%	2.6%	23.5%	8.6%	2.4%	-1.7%
Washington, IN	57	33,397	11.1%	13.2%	$54,428	6.7%	-1.8%	0.0%	22.0%	11.1%	7.9%	1.8%
Eureka-Arcata, CA	58	136,310	16.6%	17.0%	$50,218	0.8%	-7.6%	3.2%	24.2%	13.2%	3.1%	-4.1%
Arcadia, FL	59	34,408	16.7%	15.7%	$30,187	11.4%	0.1%	1.9%	16.7%	7.7%	11.7%	0.3%
Cañon City, CO	60	49,661	12.6%	15.6%	$40,744	2.3%	-1.1%	2.2%	26.8%	9.3%	5.1%	0.1%
Sheridan, WY	61	31,646	13.1%	14.3%	$66,786	-1.6%	-1.6%	2.9%	24.8%	6.2%	1.0%	-0.4%
Clearlake, CA	62	68,766	19.6%	14.8%	$47,177	0.9%	-6.3%	1.3%	23.8%	10.6%	7.9%	0.4%
Pahrump, NV	63	53,450	12.8%	17.6%	$44,610	12.7%	-0.6%	0.5%	14.9%	6.1%	16.5%	-0.7%
Nogales, AZ	64	47,883	13.4%	12.1%	$52,698	-3.8%	-3.8%	3.0%	33.1%	11.2%	11.3%	-1.9%
Whitewater, WI	65	106,799	12.3%	22.0%	$60,260	-0.9%	-6.3%	3.6%	17.0%	9.2%	-0.6%	-2.9%
Moultrie, GA	66	45,812	12.9%	14.8%	$43,790	2.0%	-1.0%	0.6%	27.7%	9.3%	8.7%	0.4%
Ruidoso, NM	67	20,436	14.5%	13.4%	$51,157	-5.8%	-8.8%	3.9%	34.5%	17.0%	-4.1%	-2.0%
Pella, IA	68	33,380	5.2%	19.8%	$61,389	3.3%	-3.6%	5.8%	17.5%	5.4%	20.6%	-3.9%
Dumas, TX	69	21,118	11.9%	15.9%	$56,376	3.6%	-2.5%	4.0%	12.4%	4.7%	62.0%	-8.2%
Clewiston, FL	70	40,313	13.6%	14.9%	$38,511	3.7%	-1.0%	5.8%	12.6%	7.2%	12.3%	3.9%
Tahlequah, OK	71	47,627	11.3%	12.2%	$41,080	0.9%	1.5%	0.2%	20.8%	10.0%	9.5%	6.9%
Centralia, WA	72	84,398	16.1%	16.5%	$49,230	8.3%	-3.4%	0.3%	25.3%	8.9%	5.5%	-6.5%
Alamogordo, NM	73	68,537	10.2%	14.9%	$44,349	-4.1%	-3.3%	5.1%	30.6%	11.5%	-0.5%	-1.1%
Portales, NM	74	19,019	14.6%	14.8%	$53,749	-2.4%	-1.2%	1.2%	24.8%	6.9%	13.2%	-1.7%
Hood River, OR	75	24,057	10.7%	19.6%	$62,553	2.1%	-7.8%	1.3%	24.1%	8.8%	10.3%	-4.0%

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Blackfoot, ID	76	48,876	10.2%	12.2%	$48,047	4.1%	-3.4%	4.6%	22.1%	7.3%	14.0%	3.9%
Cullowhee, NC	77	57,546	14.6%	15.3%	$46,014	3.0%	-4.8%	3.2%	20.9%	9.1%	13.2%	-1.3%
Emporia, KS	78	34,596	7.6%	13.9%	$50,362	-0.8%	-4.7%	4.3%	23.3%	11.8%	19.1%	0.0%
Morehead City, NC	79	68,541	15.0%	17.1%	$61,638	-0.4%	-4.3%	2.2%	24.0%	6.4%	9.3%	-5.7%
Pinehurst-Southern Pines, NC	80	102,763	9.1%	18.8%	$63,071	4.2%	-6.6%	2.3%	22.3%	10.9%	2.2%	-5.5%
Shelton, WA	81	67,615	16.9%	18.2%	$47,322	0.6%	-4.8%	1.6%	24.2%	8.6%	1.4%	-3.7%
Oxford, MS	82	56,884	13.7%	14.9%	$54,344	6.3%	-6.9%	7.3%	13.5%	9.9%	7.0%	-3.0%
Moscow, ID	83	40,313	12.8%	17.8%	$49,632	-2.0%	-5.5%	3.1%	24.8%	9.5%	6.1%	-3.2%
Marshall, MO	84	23,289	6.0%	15.7%	$50,140	-4.0%	-2.6%	1.2%	23.0%	13.3%	8.0%	2.5%
Payson, AZ	85	53,589	9.9%	15.8%	$55,192	-4.0%	-4.4%	2.0%	29.2%	10.7%	-2.1%	-0.2%
Worthington, MN	86	21,991	8.2%	15.9%	$60,817	-0.2%	-2.0%	0.3%	22.9%	11.6%	1.4%	-1.7%
Bonham, TX	87	36,569	16.9%	14.7%	$46,613	11.9%	-6.6%	1.7%	14.3%	2.3%	29.7%	2.9%
Union City, TN	88	30,466	11.7%	13.4%	$52,501	10.5%	-2.7%	3.4%	16.5%	7.3%	4.5%	0.6%
Port Lavaca, TX	89	19,727	7.6%	16.9%	$57,147	0.3%	-3.5%	1.2%	18.6%	6.5%	46.4%	-4.3%
Laramie, WY	90	37,608	13.6%	17.1%	$46,824	-2.0%	-1.9%	4.1%	23.1%	7.8%	-8.3%	-1.5%
Liberal, KS	91	21,747	5.1%	13.0%	$49,868	-7.9%	-0.4%	-1.1%	38.2%	16.0%	-14.8%	2.8%
Spearfish, SD	92	26,165	12.4%	13.5%	$62,294	0.0%	-3.7%	3.5%	20.7%	10.2%	-0.1%	-2.9%
Lawrenceburg, TN	93	44,828	11.3%	15.8%	$44,090	6.6%	-1.6%	4.9%	17.3%	6.6%	-0.3%	-0.7%
Maryville, MO	94	21,160	8.3%	13.9%	$42,270	-1.4%	-2.9%	4.8%	17.0%	9.1%	3.5%	8.3%
Taos, NM	95	34,623	16.3%	16.1%	$49,136	-6.0%	-10.0%	7.0%	26.0%	13.0%	-2.2%	-5.6%
Palatka, FL	96	74,167	12.4%	15.3%	$39,386	-2.1%	-3.1%	4.3%	19.3%	10.3%	4.8%	1.2%
Holland, MI	97	120,950	9.3%	16.7%	$56,970	0.1%	-6.2%	2.8%	18.9%	10.3%	9.0%	-1.0%
Show Low, AZ	98	108,147	16.8%	13.4%	$45,163	-2.5%	-2.9%	2.0%	26.9%	11.5%	-1.6%	-4.0%
Martin, TN	99	33,036	13.2%	17.2%	$47,858	0.3%	-2.5%	1.5%	19.9%	5.3%	15.3%	-1.5%
Clarksburg, WV	100	89,385	9.2%	16.5%	$57,435	-2.9%	-7.2%	3.5%	22.2%	4.5%	16.3%	3.4%
Traverse City, MI	101	154,685	11.0%	16.8%	$64,421	-4.2%	-9.1%	3.4%	22.1%	12.5%	2.6%	-3.8%
Kerrville, TX	102	53,161	14.0%	14.5%	$61,432	1.3%	-4.7%	3.3%	14.1%	5.8%	12.9%	-0.5%
Concord, NH	103	155,238	7.1%	23.3%	$63,381	-3.4%	-6.1%	-0.1%	20.4%	8.4%	2.4%	-3.6%
Torrington, CT	104	185,000	9.5%	22.5%	$65,533	-7.4%	-7.4%	3.3%	20.7%	9.3%	-4.7%	-5.6%
Shelby, NC	105	100,359	9.2%	21.3%	$48,148	2.0%	-3.8%	1.9%	19.5%	5.1%	15.8%	-4.5%
Augusta-Waterville, ME	106	124,486	7.3%	17.9%	$54,594	-1.3%	-3.6%	0.9%	22.2%	8.6%	6.5%	-0.3%
Hannibal, MO	107	38,879	7.3%	16.7%	$51,531	-4.5%	-3.7%	0.1%	20.4%	7.7%	19.4%	4.8%
Statesboro, GA	108	82,442	12.6%	15.2%	$41,400	0.5%	-4.1%	3.4%	22.4%	9.6%	9.4%	-2.2%
Findlay, OH	109	74,656	5.8%	21.9%	$61,971	-2.2%	-5.5%	-0.7%	22.9%	12.6%	-14.5%	-2.7%
Rochelle, IL	110	51,449	8.4%	17.3%	$57,988	-8.7%	-4.3%	0.4%	17.9%	11.7%	-1.1%	4.9%
Hermiston-Pendleton, OR	111	92,291	9.3%	14.5%	$49,671	3.1%	-3.6%	2.1%	21.0%	10.6%	12.4%	-2.7%
Durango, CO	112	56,250	13.4%	21.0%	$64,124	-4.7%	-7.2%	3.4%	19.8%	9.4%	-15.0%	-6.1%
Fort Morgan, CO	113	29,008	12.0%	14.5%	$50,941	1.1%	-4.2%	1.2%	29.5%	8.1%	0.1%	-2.4%
Warrensburg, MO	114	54,150	11.1%	14.0%	$46,801	0.9%	-1.8%	0.2%	18.7%	9.0%	6.8%	3.2%
Raymondville, TX	115	20,316	11.1%	10.1%	$34,728	1.6%	-2.7%	12.0%	18.5%	6.2%	7.8%	1.1%
Ada, OK	116	38,163	13.6%	12.9%	$54,846	3.5%	-1.8%	-1.0%	24.4%	5.2%	14.4%	-1.7%
Sikeston, MO	117	37,840	8.7%	14.7%	$51,388	-1.1%	-2.3%	3.4%	19.2%	8.5%	4.9%	0.6%
Watertown, SD	118	34,682	9.6%	12.1%	$61,075	-0.7%	-3.3%	5.4%	12.9%	6.2%	3.2%	5.2%
Lebanon, NH-VT	119	223,471	7.4%	19.9%	$62,429	-5.4%	-7.0%	3.6%	19.7%	9.3%	0.3%	-2.7%
Faribault-Northfield, MN	120	67,262	7.2%	18.2%	$53,997	2.0%	-5.4%	2.2%	17.5%	9.8%	7.5%	-2.2%
Bardstown, KY	121	47,098	9.4%	14.7%	$55,550	4.2%	-5.6%	5.3%	21.8%	9.3%	-10.9%	-2.3%
Española, NM	122	40,179	10.8%	12.9%	$46,627	-5.6%	-5.8%	-1.1%	35.9%	11.5%	-2.1%	3.8%
Brookhaven, MS	123	34,943	9.4%	13.9%	$49,721	2.5%	-1.3%	6.5%	17.4%	5.1%	5.1%	-1.8%

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Albertville, AL	124	98,228	13.7%	13.9%	$47,902	7.0%	-2.1%	0.7%	19.4%	6.9%	5.0%	-2.3%
DeRidder, LA	125	36,584	7.7%	14.3%	$54,765	-5.6%	-0.9%	9.8%	14.2%	4.2%	6.1%	-0.8%
Sevierville, TN	126	99,517	14.7%	16.1%	$51,405	2.9%	-8.4%	6.1%	23.4%	9.7%	1.9%	-10.1%
Brainerd, MN	127	97,909	10.6%	13.4%	$56,206	-3.9%	-8.2%	8.9%	22.1%	11.5%	-5.2%	-3.7%
Kill Devil Hills, NC	128	37,826	12.2%	18.4%	$68,539	-6.8%	-7.6%	1.1%	25.1%	9.5%	4.0%	-8.2%
Alexandria, MN	129	39,238	10.9%	14.5%	$63,252	1.2%	-4.9%	1.5%	17.8%	10.0%	-1.8%	-1.7%
Ontario, OR-ID	130	58,043	12.4%	15.2%	$42,361	3.9%	-0.6%	1.0%	17.5%	7.0%	4.1%	-0.6%
Kearney, NE	131	57,013	10.9%	16.2%	$67,970	-2.9%	-3.9%	1.6%	15.5%	7.6%	3.2%	-2.7%
Roseburg, OR	132	111,978	11.9%	14.7%	$48,134	3.3%	-3.8%	2.0%	17.3%	8.7%	7.8%	-1.4%
Lexington, NE	133	25,722	7.2%	14.5%	$56,133	-0.8%	-0.7%	1.7%	24.0%	7.7%	-1.7%	-1.6%
Spirit Lake, IA	134	17,851	9.6%	16.1%	$72,456	-5.5%	-5.1%	7.7%	8.0%	7.6%	3.3%	-4.1%
Big Spring, TX	135	34,128	12.9%	12.3%	$49,398	-2.6%	-8.6%	3.7%	13.7%	-0.6%	128.3%	-10.8%
Calhoun, GA	136	58,237	5.7%	16.6%	$44,189	5.7%	-3.5%	2.8%	26.4%	6.8%	8.7%	-4.0%
Blytheville, AR	137	39,661	12.9%	13.9%	$44,154	-5.4%	-5.1%	0.0%	31.0%	1.9%	32.6%	1.9%
Sulphur Springs, TX	138	37,211	12.3%	15.9%	$49,523	2.2%	-1.5%	2.9%	13.0%	4.5%	15.7%	-2.7%
Stephenville, TX	139	43,378	13.2%	15.3%	$48,079	0.9%	-6.0%	4.5%	16.5%	4.6%	13.7%	0.1%
Bedford, IN	140	45,070	10.0%	14.0%	$52,131	1.5%	-5.5%	2.8%	19.5%	8.2%	5.3%	1.1%
Enterprise, AL	141	54,174	14.5%	13.9%	$54,142	4.5%	-3.1%	3.9%	16.5%	7.5%	-3.9%	-5.0%
Fergus Falls, MN	142	60,046	8.8%	15.8%	$59,491	-2.8%	-5.1%	1.6%	18.7%	9.6%	-1.7%	1.0%
Picayune, MS	143	56,503	16.2%	15.5%	$47,455	2.9%	-3.0%	0.8%	11.6%	6.2%	10.6%	-0.7%
Fitzgerald, GA	144	17,158	4.1%	18.6%	$42,404	0.5%	0.3%	2.0%	18.2%	7.8%	1.0%	-0.2%
Frankfort, KY	145	75,717	10.0%	20.6%	$53,572	-3.4%	-4.9%	2.5%	16.2%	7.9%	-3.9%	-2.7%
Brookings, OR	146	23,683	16.0%	14.3%	$49,903	0.4%	-5.1%	1.8%	14.3%	9.0%	7.3%	-1.0%
Pittsburg, KS	147	39,110	8.6%	13.6%	$49,133	-1.7%	-3.2%	2.4%	18.2%	9.6%	13.6%	0.5%
Norfolk, NE	148	48,466	7.2%	14.5%	$62,926	-2.0%	-3.2%	0.7%	18.1%	7.1%	10.3%	1.4%
Keene, NH	149	77,329	8.4%	20.1%	$55,685	-7.1%	-6.1%	2.3%	19.0%	8.9%	1.7%	-2.2%
Coffeyville, KS	150	31,156	14.1%	12.9%	$46,489	-12.5%	-5.3%	4.7%	11.8%	7.0%	38.8%	3.0%
Zanesville, OH	151	86,408	6.7%	15.5%	$52,495	1.0%	-2.3%	1.7%	18.4%	10.3%	0.5%	-1.7%
Laconia, NH	152	64,460	8.0%	17.6%	$66,439	-6.6%	-8.4%	3.8%	20.9%	10.6%	0.2%	-4.3%
Aberdeen, WA	153	76,841	14.1%	17.8%	$45,063	-0.2%	-6.2%	4.1%	22.8%	8.2%	-5.0%	-6.3%
Yankton, SD	154	23,297	7.1%	13.2%	$62,137	-3.0%	-5.1%	2.2%	17.4%	7.9%	16.1%	2.2%
Newberry, SC	155	37,996	8.8%	15.1%	$49,984	1.3%	-2.0%	2.9%	15.3%	5.4%	10.5%	0.5%
Coldwater, MI	156	44,985	6.4%	16.0%	$48,173	5.8%	-4.3%	1.6%	17.1%	8.2%	9.8%	-0.2%
Elizabeth City, NC	157	53,951	9.8%	16.4%	$49,752	-4.9%	-2.8%	2.4%	17.9%	7.8%	4.7%	-0.5%
Mayfield, KY	158	36,615	9.5%	15.6%	$49,133	2.8%	-3.7%	3.4%	19.6%	7.0%	1.7%	-2.7%
Vermillion, SD	159	15,150	13.1%	13.9%	$48,618	-0.2%	-7.5%	6.7%	15.6%	10.6%	11.7%	-5.9%
Fort Leonard Wood, MO	160	53,816	8.9%	15.3%	$52,068	-3.5%	-3.0%	2.9%	16.6%	7.6%	-0.2%	2.2%
Sunbury, PA	161	91,266	6.9%	18.0%	$52,933	-6.7%	-7.4%	1.0%	25.2%	10.8%	2.3%	-0.2%
Beaver Dam, WI	162	89,313	8.5%	16.9%	$54,634	-0.3%	-3.1%	1.8%	15.7%	7.9%	-1.7%	-0.8%
Greensburg, IN	163	26,320	3.2%	17.0%	$54,558	0.7%	-8.3%	1.5%	16.7%	8.3%	32.1%	0.4%
Dyersburg, TN	164	36,615	7.8%	15.2%	$52,046	-5.5%	-4.7%	5.5%	20.9%	8.0%	6.0%	-2.5%
North Vernon, IN	165	27,409	7.3%	14.8%	$51,544	0.9%	-3.6%	1.9%	16.0%	7.4%	10.9%	1.4%
Hilo, HI	166	202,906	10.6%	21.3%	$43,172	-6.8%	-13.7%	15.1%	15.6%	8.2%	1.4%	-8.2%
Tifton, GA	167	41,212	6.8%	17.0%	$49,479	7.5%	-1.5%	4.4%	2.4%	8.3%	-3.7%	0.5%
Palestine, TX	168	58,402	11.9%	17.2%	$42,501	-0.3%	-3.9%	3.7%	15.2%	4.2%	11.9%	-1.4%
Menomonie, WI	169	45,547	6.8%	16.6%	$50,221	1.5%	-3.7%	2.4%	15.3%	8.1%	1.1%	0.3%
New Castle, IN	170	48,935	7.9%	14.9%	$48,859	-2.9%	-4.6%	0.8%	19.9%	7.7%	18.4%	1.3%
Columbus, NE	171	34,241	6.5%	13.6%	$58,885	0.6%	-2.5%	3.3%	14.9%	6.1%	6.1%	0.7%
Sterling, CO	172	21,487	18.0%	13.7%	$48,343	-7.6%	-2.5%	-1.4%	27.3%	8.0%	-15.5%	0.6%

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Starkville, MS	173	61,825	11.8%	13.8%	$45,683	-0.2%	-4.6%	1.6%	19.0%	7.7%	8.6%	0.7%
Watertown-Fort Atkinson, WI	174	84,943	7.8%	16.1%	$55,809	-2.3%	-3.9%	2.7%	18.9%	11.5%	-6.0%	-4.7%
Thomasville, GA	175	45,842	9.8%	15.7%	$57,863	-4.3%	-1.9%	5.3%	14.0%	6.3%	-3.2%	-3.5%
Houghton, MI	176	39,420	12.6%	14.3%	$49,361	-5.0%	-5.1%	3.9%	18.7%	9.4%	0.5%	-2.0%
Seymour, IN	177	46,067	4.1%	16.8%	$54,149	4.5%	-2.7%	2.0%	16.1%	3.7%	8.0%	0.7%
Cookeville, TN	178	115,777	8.5%	15.1%	$47,433	7.0%	-1.0%	2.6%	15.0%	4.3%	7.1%	-2.4%
Elko, NV	179	55,818	8.3%	14.9%	$54,235	-1.1%	-4.9%	-2.2%	24.7%	7.6%	16.8%	-0.8%
Clovis, NM	180	47,999	7.3%	13.0%	$55,917	-2.3%	-1.1%	2.2%	18.5%	7.5%	4.9%	-0.9%
Scottsburg, IN	181	24,355	5.2%	18.2%	$47,683	5.2%	-4.5%	-1.9%	18.8%	8.5%	13.2%	-1.6%
Susanville, CA	182	33,159	13.4%	15.3%	$40,519	-9.2%	-7.1%	-0.6%	25.8%	14.5%	-6.1%	1.1%
Rolla, MO	183	44,937	10.1%	14.7%	$48,923	1.7%	-1.9%	1.9%	16.6%	7.2%	-1.8%	-1.3%
Batavia, NY	184	57,853	7.9%	17.2%	$53,689	-8.0%	-8.7%	4.7%	26.4%	10.3%	-2.9%	-4.3%
Brookings, SD	185	34,639	8.1%	17.5%	$55,034	-3.1%	-6.0%	3.2%	14.3%	8.5%	-3.1%	0.3%
Lewisburg, TN	186	34,984	10.8%	15.6%	$49,333	6.9%	-8.2%	1.1%	18.5%	4.0%	28.5%	-3.2%
Stevens Point, WI	187	70,468	7.4%	17.5%	$56,061	-4.7%	-5.4%	2.2%	18.9%	9.6%	4.5%	-4.4%
Price, UT	188	20,372	11.1%	12.6%	$48,324	0.5%	-1.5%	0.2%	20.9%	5.9%	4.3%	0.3%
Opelousas, LA	189	82,071	9.3%	17.8%	$53,749	-4.5%	-3.0%	1.2%	13.0%	4.8%	5.3%	1.3%
Spencer, IA	190	16,440	7.2%	16.5%	$62,244	-5.7%	-2.6%	2.9%	11.8%	7.5%	6.5%	-2.9%
Hudson, NY	191	61,778	13.2%	22.4%	$66,052	-7.7%	-9.4%	1.2%	19.2%	8.5%	-14.4%	-7.6%
Brenham, TX	192	35,891	9.8%	15.4%	$63,987	-0.6%	-0.9%	-1.4%	12.1%	6.1%	6.0%	-2.0%
Amsterdam, NY	193	49,558	6.3%	17.7%	$50,285	-4.1%	-8.1%	3.7%	27.4%	10.0%	0.6%	-6.1%
Norwalk, OH	194	58,367	8.9%	16.5%	$52,238	-2.4%	-7.0%	3.2%	16.4%	9.0%	3.0%	-1.6%
Oneonta, NY	195	58,123	6.1%	20.8%	$53,480	-11.6%	-12.0%	4.8%	28.2%	11.5%	1.0%	-6.8%
Lewisburg, PA	196	42,568	7.4%	16.2%	$50,584	-3.1%	-6.9%	2.0%	22.7%	8.8%	1.1%	-0.6%
Paducah, KY-IL	197	98,068	13.3%	19.6%	$57,692	-6.5%	-5.0%	3.6%	12.7%	5.6%	-8.5%	-4.6%
Columbus, MS	198	58,150	8.1%	13.6%	$52,119	-2.9%	-6.2%	2.3%	20.2%	7.1%	10.9%	1.5%
Butte-Silver Bow, MT	199	35,411	10.3%	14.1%	$54,775	-4.6%	-4.4%	2.5%	18.8%	9.4%	-0.5%	-2.9%
Jacksonville, IL	200	37,442	9.8%	13.6%	$51,149	-6.7%	-5.1%	-0.2%	22.9%	10.8%	8.1%	-0.8%
Tiffin, OH	201	54,906	8.6%	16.8%	$51,268	-3.6%	-6.4%	-0.3%	19.3%	10.8%	4.8%	-1.8%
Winnemucca, NV	202	17,648	8.2%	12.7%	$55,830	-2.9%	-1.9%	-1.8%	19.5%	8.8%	10.3%	-0.1%
Boone, NC	203	54,234	13.7%	15.4%	$46,460	-0.4%	-8.2%	5.6%	18.9%	8.4%	4.5%	-7.2%
Greenville, OH	204	51,597	7.4%	14.0%	$54,795	-4.8%	-4.5%	2.5%	17.7%	10.1%	-1.0%	0.0%
Dublin, GA	205	65,013	7.8%	15.5%	$45,108	0.6%	-4.2%	2.0%	20.2%	7.3%	5.5%	-1.9%
Storm Lake, IA	206	20,771	6.3%	17.1%	$55,014	-0.7%	-1.6%	0.7%	23.1%	8.5%	-35.6%	-0.1%
Portsmouth, OH	207	73,346	10.0%	16.2%	$49,932	-2.4%	-2.4%	3.5%	16.2%	8.3%	-16.6%	-2.6%
Coos Bay, OR	208	64,999	10.4%	14.7%	$52,536	0.3%	-5.0%	0.5%	19.7%	7.5%	7.5%	-3.4%
Huron, SD	209	20,757	7.4%	14.4%	$60,372	-1.6%	-2.8%	1.4%	14.1%	6.6%	-1.9%	1.0%
Bainbridge, GA	210	29,038	10.9%	12.4%	$47,840	-0.6%	-5.6%	2.4%	17.2%	7.8%	6.1%	1.4%
Mount Pleasant, TX	211	43,799	10.3%	13.1%	$44,839	2.9%	0.3%	4.2%	10.8%	8.4%	-14.6%	-1.2%
Juneau, AK	212	31,973	8.4%	14.9%	$73,420	-11.2%	-11.7%	6.6%	17.7%	12.6%	-4.3%	-5.2%
Kapaa, HI	213	73,454	11.3%	21.6%	$50,455	-12.0%	-20.9%	22.9%	18.1%	10.0%	-7.7%	-16.9%
El Campo, TX	214	41,721	12.6%	13.9%	$52,989	0.4%	-4.0%	0.4%	16.4%	3.4%	14.8%	-1.2%
Campbellsville, KY	215	37,526	7.8%	16.7%	$46,043	5.4%	-1.1%	-3.2%	13.7%	7.1%	4.0%	0.3%
Vicksburg, MS	216	43,579	7.4%	17.1%	$52,438	-7.7%	-4.5%	1.0%	19.5%	6.6%	10.8%	-1.4%
Astoria, OR	217	41,810	11.5%	16.0%	$50,663	-1.2%	-9.4%	3.1%	20.5%	10.6%	1.0%	-6.1%
Moberly, MO	218	24,760	11.3%	14.3%	$49,604	-4.2%	-4.4%	4.0%	16.6%	8.4%	-1.6%	-2.9%
Garden City, KS	219	41,998	8.2%	12.7%	$55,258	2.8%	-3.2%	-1.8%	21.1%	9.5%	0.5%	-1.9%
Sonora, CA	220	55,810	12.1%	16.4%	$49,743	-5.9%	-9.6%	4.7%	22.3%	10.2%	7.1%	-8.8%
Alpena, MI	221	28,893	12.4%	13.8%	$51,959	-5.2%	-4.7%	4.2%	15.5%	9.5%	-5.4%	-3.3%

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Klamath Falls, OR	222	70,164	9.9%	14.9%	$46,234	0.3%	-4.6%	2.0%	16.6%	8.5%	5.9%	-3.3%
Altus, OK	223	24,777	8.5%	12.8%	$53,327	-2.0%	-2.7%	-0.2%	22.2%	6.0%	6.6%	-0.2%
Paris, TX	224	50,098	10.6%	14.4%	$50,968	5.2%	-4.0%	3.4%	8.8%	3.1%	15.5%	-1.8%
Bennington, VT	225	37,312	9.3%	20.9%	$60,591	-8.9%	-11.3%	2.9%	21.9%	7.9%	-1.5%	-6.0%
Adrian, MI	226	98,956	8.6%	18.2%	$50,976	-13.3%	-9.5%	5.2%	15.8%	11.8%	1.1%	-1.7%
Willmar, MN	227	43,767	7.0%	15.6%	$64,475	1.3%	-3.4%	-4.0%	19.1%	9.0%	-6.1%	-2.0%
Crawfordsville, IN	228	38,063	4.8%	18.5%	$50,448	-6.2%	-2.8%	0.7%	16.0%	5.0%	1.5%	2.6%
Huntsville, TX	229	77,977	13.8%	15.0%	$35,412	3.5%	-2.2%	-0.6%	14.7%	4.2%	10.2%	0.1%
Beatrice, NE	230	21,616	10.8%	15.2%	$59,478	-6.2%	-4.8%	1.0%	17.3%	6.8%	2.7%	-2.8%
Harrison, AR	231	45,034	10.9%	13.5%	$43,539	-1.4%	-4.3%	3.6%	18.4%	5.8%	4.5%	-1.2%
Albemarle, NC	232	63,425	9.9%	15.3%	$49,302	-1.8%	-4.8%	2.1%	21.9%	7.2%	-0.4%	-5.0%
Lewistown, PA	233	46,136	7.5%	15.0%	$49,473	-0.7%	-4.6%	-1.1%	19.9%	7.0%	3.3%	2.1%
Troy, AL	234	32,991	6.9%	13.0%	$48,257	4.5%	0.0%	5.0%	10.9%	6.4%	-1.1%	-3.9%
Big Rapids, MI	235	40,031	13.3%	13.1%	$42,740	-9.4%	-7.4%	3.5%	22.2%	13.0%	-0.8%	-3.5%
Greenwood, MS	236	37,436	7.0%	13.2%	$51,107	-0.8%	-4.1%	5.0%	15.0%	6.9%	0.4%	-0.7%
Ottawa, IL	237	147,414	6.2%	17.0%	$57,271	-9.3%	-6.9%	3.1%	16.2%	8.4%	-1.5%	0.7%
Natchitoches, LA	238	37,026	8.3%	14.8%	$50,919	-0.3%	-3.5%	4.3%	16.4%	6.7%	1.9%	-5.7%
West Point, MS	239	18,535	6.5%	14.2%	$49,799	-2.5%	-4.0%	8.6%	16.0%	2.3%	2.0%	-1.3%
Mountain Home, AR	240	42,144	11.1%	13.2%	$46,752	1.1%	-0.5%	1.4%	16.1%	3.9%	7.9%	-3.0%
Alexander City, AL	241	51,473	8.7%	16.9%	$51,295	-6.9%	-7.8%	2.6%	18.6%	9.2%	3.1%	-2.5%
Cornelia, GA	242	46,774	10.8%	17.8%	$42,939	-8.1%	-7.0%	1.1%	26.8%	7.7%	2.2%	-4.3%
Marshall, MN	243	25,231	4.6%	18.4%	$61,616	-10.1%	-6.2%	3.6%	18.9%	12.8%	-8.1%	-8.1%
Berlin, NH	244	31,289	9.0%	15.0%	$49,208	-9.3%	-10.0%	4.6%	22.0%	11.0%	-1.6%	-1.0%
Washington, NC	245	44,468	10.2%	14.9%	$53,640	-1.9%	-0.8%	2.8%	13.9%	5.8%	-10.7%	-3.5%
Ashland, OH	246	52,316	7.1%	15.6%	$49,044	0.6%	-4.4%	-0.7%	13.3%	9.6%	2.5%	0.5%
Connersville, IN	247	23,360	6.5%	16.0%	$51,538	-9.5%	-7.1%	1.5%	20.9%	11.6%	-1.5%	-0.4%
Angola, IN	248	34,632	9.4%	13.7%	$54,556	-4.0%	-7.6%	2.5%	19.8%	9.0%	5.9%	-3.0%
North Platte, NE	249	35,199	10.5%	15.7%	$61,069	-4.8%	-2.5%	0.5%	15.9%	7.4%	-10.2%	-4.4%
Vincennes, IN	250	35,956	8.8%	14.0%	$55,833	-5.1%	-3.5%	1.6%	16.3%	7.1%	0.3%	-0.9%
Sterling, IL	251	55,305	7.7%	14.3%	$56,422	-3.7%	-6.7%	1.6%	21.3%	9.5%	-3.4%	-2.4%
Poplar Bluff, MO	252	52,718	12.1%	12.4%	$45,194	-6.1%	-1.2%	1.7%	13.9%	6.7%	-3.0%	2.9%
Ludington, MI	253	29,383	14.2%	13.6%	$51,551	-10.8%	-8.9%	4.7%	21.8%	10.3%	-6.5%	-3.7%
Fort Payne, AL	254	71,813	9.3%	14.2%	$41,987	3.2%	-3.9%	3.2%	19.8%	6.8%	-2.5%	-4.3%
Newport, OR	255	50,862	13.9%	17.2%	$49,057	-5.4%	-10.8%	4.6%	21.3%	8.5%	-2.3%	-7.6%
Mitchell, SD	256	23,383	8.3%	13.4%	$65,179	-6.4%	-3.9%	1.0%	15.1%	7.7%	5.0%	-2.6%
Selinsgrove, PA	257	39,621	12.6%	13.5%	$52,557	-6.4%	-6.7%	1.2%	21.4%	7.2%	9.7%	-3.4%
Jamestown, ND	258	21,576	7.8%	16.0%	$69,674	-8.0%	-3.2%	-1.4%	15.8%	5.8%	4.1%	-2.8%
Richmond-Berea, KY	259	108,758	10.8%	19.2%	$45,064	-6.9%	-7.6%	4.6%	18.1%	6.1%	-3.9%	-4.5%
Red Wing, MN	260	47,968	8.1%	17.2%	$65,808	-8.7%	-9.4%	2.3%	11.8%	7.8%	0.2%	0.5%
Newport, TN	261	36,418	5.3%	18.1%	$42,184	-4.9%	-6.4%	5.8%	20.1%	7.8%	-9.0%	-2.9%
Gallup, NM	262	71,780	9.8%	11.4%	$37,516	-5.4%	-7.2%	2.3%	33.0%	11.0%	-1.4%	-2.7%
Decatur, IN	263	35,961	11.9%	11.5%	$48,218	-3.4%	-5.9%	0.5%	20.1%	7.5%	15.8%	-1.4%
Dayton, TN	264	33,136	12.3%	15.1%	$44,659	-4.1%	-4.9%	10.2%	12.6%	9.4%	-2.5%	-13.3%
Martinsville, VA	265	63,765	10.9%	13.2%	$50,201	-3.4%	-4.9%	1.6%	16.1%	7.0%	5.0%	-1.0%
Plymouth, IN	266	46,121	9.2%	16.1%	$51,427	-9.7%	-5.1%	2.1%	16.6%	7.6%	0.6%	-1.0%
Thomaston, GA	267	27,720	7.0%	17.0%	$46,099	-2.8%	-3.3%	5.4%	14.9%	3.1%	0.8%	-3.0%
Wooster, OH	268	116,710	6.9%	16.1%	$56,861	-0.6%	-7.5%	1.1%	19.4%	6.7%	8.2%	-4.3%
Danville, KY	269	54,990	7.8%	18.4%	$47,048	-1.5%	-5.0%	2.2%	15.3%	6.9%	0.8%	-5.0%
Craig, CO	270	13,185	10.9%	14.1%	$49,651	-5.0%	-4.1%	-1.5%	22.9%	7.9%	-6.4%	-0.5%

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Madison, IN	271	33,141	6.2%	15.6%	$54,597	-6.1%	-4.9%	3.4%	13.1%	6.7%	7.4%	-1.4%
Searcy, AR	272	77,207	9.3%	14.7%	$46,341	-3.1%	-1.1%	4.1%	12.9%	5.0%	-6.4%	-1.8%
Tullahoma-Manchester, TN	273	108,891	5.5%	17.2%	$50,017	-1.6%	-3.1%	-1.8%	16.0%	5.8%	15.9%	-2.1%
New Ulm, MN	274	25,819	7.2%	14.4%	$67,456	-5.4%	-6.6%	0.1%	19.6%	10.2%	0.1%	-5.5%
Hays, KS	275	28,790	8.9%	13.4%	$58,078	-4.1%	-3.5%	2.9%	10.3%	7.1%	-0.9%	-0.8%
Van Wert, OH	276	28,732	5.2%	15.1%	$53,941	1.4%	-7.1%	2.1%	20.6%	9.1%	-1.6%	-4.5%
Hutchinson, KS	277	61,414	6.3%	13.3%	$50,923	-6.2%	-4.6%	4.1%	17.3%	8.1%	4.7%	-1.6%
Frankfort, IN	278	33,065	5.3%	13.6%	$48,872	-3.2%	-4.0%	0.4%	17.5%	9.3%	8.2%	-0.1%
Dixon, IL	279	34,049	5.8%	16.7%	$54,677	-3.6%	-4.1%	-1.0%	16.2%	4.3%	9.7%	0.9%
Camden, AR	280	27,047	5.8%	12.4%	$48,295	1.0%	-0.6%	3.5%	22.7%	5.5%	-9.9%	-3.7%
Ogdensburg-Massena, NY	281	108,051	7.8%	15.7%	$46,706	-4.6%	-6.5%	1.0%	26.1%	6.7%	-0.4%	-2.1%
Cullman, AL	282	89,496	7.2%	13.9%	$51,029	1.6%	-2.9%	2.1%	16.0%	6.5%	-1.3%	-3.1%
Paris, TN	283	32,239	9.1%	13.5%	$51,249	-2.0%	-4.5%	7.7%	15.1%	4.2%	1.0%	-5.7%
Alma, MI	284	41,544	7.2%	14.2%	$47,844	-5.8%	-6.9%	-2.5%	23.5%	8.8%	5.4%	4.0%
Grants, NM	285	27,184	7.2%	14.8%	$37,460	-6.9%	-3.0%	-5.0%	22.6%	15.4%	-6.8%	2.2%
La Grande, OR	286	26,212	8.9%	14.5%	$46,991	0.0%	-4.2%	1.6%	15.5%	6.1%	5.0%	-2.0%
Platteville, WI	287	52,110	10.7%	12.9%	$55,605	-2.0%	-3.0%	0.0%	14.1%	8.0%	4.0%	-3.8%
Wisconsin Rapids-Marshfield, WI	288	74,070	5.5%	16.4%	$57,314	-1.3%	-5.8%	0.0%	15.8%	7.9%	3.4%	-2.6%
McPherson, KS	289	30,146	5.7%	13.6%	$66,830	-1.5%	-4.1%	1.2%	10.8%	3.1%	27.0%	-3.3%
Fort Polk South, LA	290	48,027	7.7%	15.9%	$52,804	-9.8%	-3.6%	5.3%	19.6%	2.7%	-4.9%	-1.9%
Freeport, IL	291	44,021	7.2%	16.0%	$53,849	-0.9%	-5.2%	0.3%	14.3%	10.2%	-17.1%	-0.2%
Rockport, TX	292	24,510	17.6%	12.3%	$59,549	-14.8%	-2.6%	9.7%	8.1%	1.2%	-9.7%	-2.6%
Tupelo, MS	293	163,162	8.7%	14.2%	$49,273	-0.3%	-4.2%	1.2%	17.6%	5.7%	0.2%	-1.5%
Bradford, PA	294	39,941	5.1%	16.5%	$52,961	-13.3%	-7.2%	0.2%	10.3%	5.0%	16.0%	10.8%
Winona, MN	295	49,630	4.9%	18.0%	$58,917	-8.7%	-7.4%	1.3%	17.4%	8.9%	-1.8%	-1.9%
Nacogdoches, TX	296	64,668	10.3%	13.7%	$45,108	-1.5%	-3.1%	1.8%	14.2%	6.1%	-0.9%	-0.8%
Carroll, IA	297	20,692	6.7%	17.6%	$64,360	-7.3%	-5.7%	1.8%	14.2%	7.3%	-2.6%	-5.3%
Forest City, NC	298	64,586	12.3%	16.7%	$42,477	-4.1%	-7.1%	1.0%	21.7%	6.8%	4.1%	-5.7%
Lake City, FL	299	70,385	12.1%	15.8%	$41,432	2.4%	-2.5%	-2.1%	14.2%	5.3%	6.7%	-3.3%
Pottsville, PA	300	143,264	7.6%	16.5%	$53,033	-5.6%	-5.8%	0.9%	22.3%	6.7%	-4.8%	-3.7%
Ruston, LA	301	48,152	12.3%	15.8%	$52,366	0.1%	-6.2%	3.1%	8.4%	5.4%	5.8%	-5.1%
Kirksville, MO	302	29,210	7.4%	17.6%	$40,352	-3.3%	-5.1%	-0.8%	17.4%	8.8%	-0.4%	-0.7%
Orangeburg, SC	303	82,962	9.8%	15.1%	$46,191	-5.8%	-5.7%	2.5%	17.4%	8.8%	-4.2%	-3.0%
Hastings, NE	304	31,027	7.7%	17.5%	$59,916	-2.6%	-2.8%	-2.3%	16.9%	5.7%	-4.2%	-5.0%
Sault Ste. Marie, MI	305	36,816	10.9%	13.8%	$45,144	-8.3%	-5.4%	3.0%	18.5%	7.9%	0.2%	-2.3%
Winfield, KS	306	34,496	6.7%	14.2%	$48,413	-5.3%	-1.8%	2.2%	16.6%	6.9%	-3.9%	-1.9%
Washington Court House, OH	307	28,906	5.9%	12.9%	$52,713	-6.4%	-4.7%	-1.1%	25.0%	11.2%	-3.1%	-2.5%
Malvern, AR	308	33,148	9.9%	13.4%	$39,918	-3.7%	-0.3%	0.6%	16.9%	6.4%	1.0%	-2.0%
Americus, GA	309	33,761	8.3%	19.1%	$46,418	-4.9%	-5.6%	-1.6%	19.3%	7.0%	-2.6%	-2.6%
Hereford, TX	310	18,329	5.4%	11.7%	$60,180	4.1%	1.7%	3.8%	11.5%	6.7%	-16.4%	-6.8%
Logansport, IN	311	37,563	5.0%	14.4%	$50,323	-3.4%	-5.3%	-1.5%	18.4%	10.4%	2.6%	0.1%
Farmington, MO	312	67,541	10.3%	14.9%	$43,507	-2.6%	-4.6%	0.1%	16.4%	8.5%	0.3%	-2.9%
Marion, OH	313	65,291	5.3%	17.6%	$47,230	-3.0%	-6.4%	0.7%	18.4%	9.3%	-5.0%	-3.0%
Shelbyville, TN	314	51,119	7.4%	15.2%	$48,598	-15.1%	-3.2%	3.5%	14.5%	6.8%	6.5%	-0.5%
Waycross, GA	315	56,009	11.9%	13.9%	$44,762	1.9%	-4.0%	0.5%	12.4%	6.8%	0.8%	-3.0%
Somerset, KY	316	65,423	8.9%	17.3%	$48,813	-3.9%	-6.8%	3.3%	14.5%	5.5%	1.3%	-4.2%

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Meridian, MS	317	96,338	7.9%	16.7%	$49,281	-8.1%	-5.1%	-0.8%	17.5%	8.8%	0.7%	-2.0%
Greenwood, SC	318	69,241	7.7%	15.2%	$48,643	-3.9%	-5.4%	-2.3%	20.4%	8.4%	1.8%	-1.1%
Jackson, OH	319	32,511	9.8%	12.3%	$46,334	-2.2%	-0.5%	-3.8%	15.7%	11.4%	-4.2%	-1.6%
Kinston, NC	320	54,706	4.0%	14.5%	$51,324	0.1%	-3.1%	-0.6%	22.5%	7.8%	-4.7%	-4.2%
Sandusky, OH	321	74,852	9.0%	15.7%	$64,644	-10.6%	-10.1%	7.8%	20.0%	10.7%	-21.4%	-10.0%
LaGrange, GA-AL	322	104,261	9.8%	16.7%	$46,988	-0.5%	-5.9%	1.5%	14.7%	4.6%	0.3%	-3.2%
Chillicothe, OH	323	76,891	8.3%	14.7%	$48,254	0.8%	-5.2%	0.8%	12.2%	7.5%	0.8%	-1.7%
Rutland, VT	324	60,591	6.4%	18.3%	$58,698	-12.6%	-10.2%	3.0%	26.3%	8.0%	-6.9%	-6.0%
Sanford, NC	325	64,138	6.1%	17.6%	$51,913	-1.6%	-3.3%	2.3%	15.8%	4.5%	-10.3%	-4.7%
Roswell, NM	326	64,629	9.7%	10.5%	$49,879	-5.2%	-3.4%	2.0%	23.7%	7.8%	-3.4%	-4.2%
Ozark, AL	327	49,342	7.0%	14.8%	$47,981	2.8%	-1.8%	2.4%	12.4%	5.5%	-9.1%	-3.8%
Lincoln, IL	328	27,992	5.5%	15.8%	$48,235	-5.9%	-5.5%	-3.9%	20.1%	8.5%	6.4%	2.1%
Cadillac, MI	329	49,031	10.9%	13.0%	$46,810	-2.0%	-8.9%	4.4%	18.3%	9.6%	1.3%	-6.5%
Gloversville, NY	330	53,116	5.0%	17.3%	$53,134	-9.0%	-7.4%	0.7%	25.3%	8.3%	2.8%	-6.1%
Douglas, GA	331	51,777	11.8%	13.9%	$40,874	8.2%	-5.3%	-1.0%	19.5%	3.5%	7.0%	-4.6%
Uvalde, TX	332	24,729	17.5%	9.5%	$49,562	-4.3%	-3.1%	0.4%	15.1%	7.6%	-14.4%	-0.5%
Auburn, NY	333	75,880	7.9%	16.5%	$52,731	-9.7%	-7.8%	-0.1%	24.1%	9.5%	-4.3%	-4.3%
Auburn, IN	334	43,333	5.7%	14.6%	$55,584	-2.0%	-6.4%	2.2%	15.4%	6.5%	2.7%	-2.7%
Crossville, TN	335	62,451	8.3%	16.4%	$46,612	-1.1%	-3.7%	1.4%	12.0%	5.6%	2.7%	-4.1%
Wabash, IN	336	30,816	4.8%	15.3%	$53,210	-7.7%	-6.4%	1.5%	19.4%	9.2%	-5.0%	-1.4%
Pierre, SD	337	20,726	10.8%	14.0%	$63,249	-5.0%	-3.5%	1.1%	15.2%	7.3%	-5.4%	-8.8%
Escanaba, MI	338	36,826	7.6%	13.4%	$51,476	-4.4%	-7.2%	2.0%	16.5%	9.3%	0.1%	-2.0%
Bucyrus-Galion, OH	339	41,754	9.7%	14.4%	$50,043	-7.1%	-3.5%	-3.8%	18.8%	8.1%	-3.6%	0.9%
Vidalia, GA	340	35,564	10.5%	14.4%	$45,106	-1.3%	-0.6%	-2.2%	11.1%	5.2%	-3.1%	0.7%
Salina, KS	341	59,726	7.5%	14.8%	$60,141	-8.1%	-7.5%	1.7%	17.5%	9.3%	-4.6%	-4.1%
Austin, MN	342	40,158	5.2%	14.6%	$57,042	-3.1%	-3.2%	0.2%	9.5%	6.7%	-5.3%	1.5%
Cordele, GA	343	19,879	10.5%	13.1%	$43,593	-3.1%	-5.0%	2.9%	20.6%	4.0%	11.7%	-5.8%
Bay City, TX	344	36,344	12.1%	13.1%	$52,733	-8.4%	-5.5%	4.3%	8.9%	2.5%	6.6%	1.3%
Miami, OK	345	30,340	10.6%	12.4%	$46,952	-1.3%	-3.2%	4.6%	14.4%	3.8%	-2.2%	-4.0%
Urbana, OH	346	38,699	5.8%	15.8%	$53,105	-4.6%	-6.6%	-2.2%	14.2%	5.9%	6.5%	3.8%
New Castle, PA	347	85,497	6.8%	17.3%	$54,860	-7.6%	-7.4%	0.1%	19.3%	5.3%	-2.1%	-1.0%
Great Bend, KS	348	25,216	10.6%	16.5%	$56,535	-7.6%	-4.0%	1.1%	12.0%	4.5%	-5.7%	-3.3%
Richmond, IN	349	66,456	7.1%	15.2%	$51,679	-3.9%	-5.8%	0.3%	15.7%	7.1%	3.4%	-2.7%
Rockingham, NC	350	42,724	5.4%	15.9%	$44,606	-2.5%	-2.9%	2.3%	16.6%	6.8%	-5.6%	-4.6%
Sweetwater, TX	351	14,597	5.8%	12.1%	$52,587	2.7%	-1.1%	-0.3%	12.5%	2.4%	5.4%	1.1%
Lumberton, NC	352	116,328	6.4%	12.3%	$38,252	-2.6%	-3.5%	-0.2%	21.8%	7.7%	13.3%	-2.6%
DuBois, PA	353	80,082	6.6%	14.3%	$56,637	-4.8%	-6.1%	1.3%	21.3%	6.2%	-1.9%	-4.4%
Malone, NY	354	47,456	6.1%	17.9%	$46,154	-7.5%	-8.6%	1.4%	27.9%	8.3%	-3.2%	-7.2%
Lebanon, MO	355	36,133	5.9%	11.7%	$44,701	1.8%	-6.0%	2.2%	17.4%	8.5%	6.9%	-3.1%
Point Pleasant, WV-OH	356	54,315	8.8%	15.3%	$48,306	-4.1%	-3.6%	3.0%	17.2%	4.3%	-4.8%	-5.5%
Batesville, AR	357	55,345	11.7%	13.2%	$43,801	4.2%	-1.5%	1.9%	19.1%	3.5%	-6.9%	-9.1%
Fairmont, MN	358	19,915	7.2%	15.2%	$65,415	-8.1%	-6.2%	1.0%	21.8%	8.8%	-1.4%	-11.1%
Easton, MD	359	37,626	8.6%	20.1%	$83,944	-13.2%	-11.9%	0.4%	18.3%	7.2%	-11.1%	-9.8%
Henderson, NC	360	42,185	6.4%	15.1%	$43,703	-9.6%	-6.1%	2.7%	20.0%	9.1%	-6.1%	-1.8%
Salem, OH	361	101,310	9.6%	14.8%	$48,736	-8.5%	-5.7%	-2.5%	20.2%	11.3%	-6.3%	-2.8%
Manitowoc, WI	362	81,505	7.3%	16.3%	$57,202	-4.6%	-5.2%	2.1%	9.0%	7.2%	-7.0%	-3.7%
Gaffney, SC	363	56,052	6.0%	15.3%	$43,612	3.5%	-7.6%	1.5%	11.1%	8.6%	3.6%	-2.1%
Oskaloosa, IA	364	21,984	5.8%	14.8%	$53,082	-2.8%	-2.5%	-0.9%	20.7%	4.9%	5.1%	-6.5%
Indianola, MS	365	25,402	8.4%	10.6%	$41,851	-7.0%	-2.0%	1.8%	16.4%	4.2%	4.1%	3.8%

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Danville, VA	366	102,187	8.5%	15.0%	$48,744	-8.1%	-4.9%	0.7%	21.1%	5.2%	-0.7%	-2.9%
Marquette, MI	367	66,103	9.2%	18.0%	$50,549	-8.5%	-8.1%	1.8%	16.6%	9.2%	-10.9%	-5.4%
Marietta, OH	368	59,423	7.3%	15.8%	$53,971	-5.8%	-6.7%	2.8%	15.2%	5.8%	-6.9%	-2.5%
New Philadelphia-Dover, OH	369	92,500	9.3%	13.8%	$54,623	-4.9%	-5.5%	1.6%	13.5%	7.0%	-3.4%	-3.2%
Seneca Falls, NY	370	33,688	18.1%	17.8%	$47,825	-8.2%	-14.2%	1.3%	26.1%	5.7%	0.5%	-9.4%
Milledgeville, GA	371	52,411	15.2%	13.4%	$42,070	-1.2%	-3.7%	2.6%	11.3%	5.1%	-5.6%	-5.3%
Brownsville, TN	372	17,694	11.5%	13.5%	$43,800	1.9%	0.8%	0.2%	16.9%	6.0%	-18.8%	-8.2%
Bogalusa, LA	373	45,133	9.4%	15.3%	$44,875	-2.9%	-4.2%	4.5%	7.7%	4.6%	-3.2%	-2.9%
Mount Airy, NC	374	71,152	8.7%	13.0%	$48,746	-4.8%	-7.2%	2.0%	23.8%	7.6%	-2.1%	-5.8%
Charleston-Mattoon, IL	375	57,110	11.4%	13.9%	$60,088	-3.6%	-5.3%	0.7%	10.2%	7.3%	14.8%	-11.0%
Bluffton, IN	376	28,197	5.5%	17.6%	$51,912	-3.0%	-3.1%	-1.8%	14.8%	5.4%	-5.4%	-3.2%
Albert Lea, MN	377	30,749	8.0%	15.4%	$56,847	-5.4%	-5.7%	-2.0%	13.3%	8.0%	-1.1%	-2.3%
London, KY	378	149,615	7.4%	16.7%	$42,742	0.4%	-2.6%	1.3%	12.0%	4.1%	-5.4%	-3.9%
Ponca City, OK	379	43,732	10.5%	13.7%	$51,365	-6.1%	-3.6%	1.8%	12.1%	3.4%	0.5%	-2.0%
Pontiac, IL	380	35,664	6.5%	15.2%	$60,290	-6.4%	-5.4%	-2.2%	11.8%	5.9%	12.3%	-1.6%
Corinth, MS	381	34,349	7.1%	18.2%	$45,985	-3.2%	-6.5%	0.2%	15.8%	5.2%	-3.1%	-3.0%
Sedalia, MO	382	43,188	7.3%	15.1%	$47,690	-4.8%	-6.0%	0.8%	18.6%	6.2%	-5.5%	-2.1%
McComb, MS	383	39,973	7.7%	16.1%	$40,983	-2.2%	-1.6%	-0.1%	15.0%	4.2%	-10.1%	-1.7%
Lamesa, TX	384	12,413	19.8%	10.6%	$46,649	-7.2%	-5.8%	1.3%	12.3%	2.0%	11.1%	-1.7%
Cambridge, OH	385	38,287	8.7%	16.6%	$51,525	-10.4%	-7.7%	-0.5%	13.1%	7.5%	8.1%	-1.8%
Marshalltown, IA	386	39,853	5.5%	15.5%	$54,578	-11.6%	-4.7%	-1.6%	12.8%	8.2%	2.0%	1.1%
Sidney, OH	387	47,977	3.8%	15.4%	$56,923	-5.1%	-6.4%	1.4%	11.5%	5.7%	2.7%	-0.3%
Ashtabula, OH	388	97,337	9.7%	15.3%	$49,678	-5.3%	-7.0%	0.6%	13.8%	8.3%	-1.2%	-4.6%
Las Vegas, NM	389	31,346	12.4%	9.1%	$47,266	-9.9%	-6.5%	1.4%	23.9%	10.0%	-10.2%	-1.5%
Fremont, OH	390	58,715	4.1%	16.6%	$52,544	-8.6%	-6.7%	2.3%	15.9%	8.5%	-6.7%	-3.4%
Marion, NC	391	44,717	6.7%	16.4%	$43,800	-6.1%	-3.4%	-0.9%	21.1%	6.0%	-7.3%	-3.9%
Mount Sterling, KY	392	47,191	5.9%	16.8%	$44,028	-9.4%	-5.8%	4.2%	15.8%	4.7%	3.2%	-3.9%
Warren, PA	393	38,134	6.0%	15.6%	$52,326	-10.8%	-7.4%	-2.9%	21.2%	6.2%	-0.6%	3.2%
St. Marys, GA	394	55,664	11.7%	15.4%	$45,948	-11.7%	-1.7%	0.6%	7.0%	7.0%	-4.5%	-2.1%
Mason City, IA	395	50,091	5.4%	16.4%	$60,008	-1.0%	-4.5%	-2.6%	10.8%	8.0%	-13.8%	-2.0%
Jennings, LA	396	32,345	11.2%	15.3%	$53,153	-9.0%	-5.6%	3.1%	8.7%	2.0%	-2.5%	0.1%
Athens, TN	397	54,059	4.8%	16.7%	$46,494	3.5%	-4.8%	-3.4%	13.7%	4.7%	5.2%	-1.3%
Plattsburgh, NY	398	79,596	8.4%	17.9%	$52,413	-4.9%	-9.3%	0.8%	21.7%	6.6%	-11.0%	-7.6%
Sayre, PA	399	59,892	7.5%	17.3%	$51,416	-12.5%	-7.4%	-0.3%	20.2%	4.1%	0.6%	-1.4%
Owatonna, MN	400	37,349	5.0%	15.2%	$58,358	-7.5%	-8.9%	-0.7%	21.7%	7.1%	3.0%	-3.7%
Jacksonville, TX	401	51,097	10.4%	12.7%	$41,825	-0.8%	-2.8%	-0.4%	9.4%	1.6%	1.9%	3.5%
Mexico, MO	402	24,982	9.5%	13.2%	$48,922	-13.5%	-7.3%	1.4%	18.1%	7.8%	-12.6%	2.5%
Riverton, WY	403	39,336	11.3%	14.1%	$52,469	-9.9%	-3.8%	2.2%	15.9%	4.9%	-14.9%	-4.3%
Seneca, SC	404	79,203	8.0%	16.8%	$56,664	0.3%	-3.5%	-0.8%	4.6%	2.5%	-6.2%	-1.2%
Elkins, WV	405	27,806	6.0%	16.0%	$48,557	-8.1%	-5.9%	-0.6%	24.3%	6.7%	-3.0%	-5.7%
Murray, KY	406	37,560	10.6%	14.2%	$44,907	-8.7%	-8.1%	1.8%	18.5%	7.2%	1.1%	-4.2%
Corsicana, TX	407	53,591	9.1%	14.3%	$46,949	-2.0%	-6.2%	2.6%	13.0%	4.1%	-4.1%	-2.6%
West Plains, MO	408	39,975	8.7%	11.8%	$43,550	-2.4%	-5.0%	2.6%	12.2%	7.5%	-3.3%	-2.2%
Greenville, MS	409	43,687	8.0%	14.5%	$51,677	-9.9%	-3.7%	-2.5%	14.7%	6.2%	-9.8%	2.5%
Deming, NM	410	25,532	9.6%	7.7%	$43,483	-5.8%	-4.3%	-4.1%	26.0%	9.2%	2.6%	1.4%
Shawnee, OK	411	73,019	11.8%	14.7%	$45,995	-5.7%	-3.8%	2.6%	13.7%	5.7%	-7.7%	-8.3%
Maysville, KY	412	16,931	8.2%	16.3%	$52,881	-12.9%	-7.2%	-1.3%	10.2%	4.3%	3.1%	4.9%
Forrest City, AR	413	22,739	8.0%	14.1%	$36,165	-13.6%	-5.5%	-0.2%	21.9%	7.9%	-0.1%	0.7%
Del Rio, TX	414	47,564	11.7%	9.5%	$44,989	2.0%	-6.0%	4.0%	9.4%	4.7%	-0.6%	-1.5%

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Plainview, TX	415	32,220	7.8%	11.5%	$42,355	-6.5%	-5.2%	1.9%	17.7%	6.1%	5.4%	-1.9%
Wilson, NC	416	78,369	7.1%	16.0%	$49,878	-5.4%	-3.3%	-0.2%	17.9%	3.3%	-11.1%	-3.8%
Jasper, AL	417	64,818	9.5%	16.4%	$52,746	-5.3%	-5.9%	2.0%	15.4%	4.1%	-11.3%	-6.9%
Somerset, PA	418	73,627	9.5%	14.0%	$52,597	-6.6%	-7.5%	2.1%	20.3%	4.0%	-3.4%	-5.6%
Natchez, MS-LA	419	47,118	11.9%	14.0%	$45,501	-10.7%	-8.0%	2.8%	16.1%	6.5%	-2.9%	-3.5%
Huntington, IN	420	36,717	6.1%	13.8%	$52,213	-8.7%	-4.2%	0.3%	15.8%	5.7%	-2.6%	-1.8%
Rio Grande City-Roma, TX	421	66,049	9.0%	9.9%	$35,206	-2.9%	-4.0%	-1.3%	13.4%	8.2%	2.9%	4.0%
Shawano, WI	422	45,148	11.7%	11.0%	$51,615	-6.6%	-7.1%	1.0%	17.3%	8.8%	-0.7%	-6.2%
Wapakoneta, OH	423	46,141	7.9%	14.2%	$59,629	-2.7%	-7.7%	1.7%	14.6%	4.9%	-1.8%	-6.5%
Athens, OH	424	62,056	10.1%	16.0%	$41,753	-4.3%	-5.8%	0.8%	12.8%	7.2%	-3.6%	-6.1%
Jamestown-Dunkirk-Fredonia, NY	425	126,807	7.3%	17.0%	$49,227	-12.7%	-10.3%	1.5%	26.0%	8.3%	-8.1%	-7.0%
Hutchinson, MN	426	36,735	5.9%	15.4%	$61,119	-12.4%	-5.8%	1.7%	12.7%	6.3%	-2.8%	-4.5%
Jasper, IN	427	55,693	4.4%	15.8%	$63,790	-1.7%	-3.6%	-2.3%	10.3%	4.8%	-4.9%	-4.1%
Celina, OH	428	42,309	7.3%	12.7%	$62,132	0.1%	-3.9%	-1.9%	13.3%	6.6%	-12.6%	-5.0%
Cortland, NY	429	46,311	7.7%	17.3%	$49,682	-9.1%	-9.5%	1.6%	11.9%	8.9%	-11.3%	-2.4%
Arkadelphia, AR	430	21,321	10.2%	13.4%	$46,167	-5.4%	-7.4%	-2.7%	21.2%	9.1%	-1.7%	-4.8%
Ottumwa, IA	431	35,256	4.6%	14.2%	$49,078	-4.7%	-4.9%	-1.1%	17.0%	11.4%	-12.2%	-4.9%
Baraboo, WI	432	65,697	6.1%	17.3%	$62,083	-9.9%	-11.2%	3.0%	17.6%	8.6%	-2.5%	-10.6%
Huntingdon, PA	433	43,889	6.4%	15.6%	$48,705	-4.1%	-7.2%	0.9%	19.6%	6.9%	-7.1%	-6.7%
Sturgis, MI	434	60,758	10.2%	13.4%	$49,836	-13.3%	-15.0%	0.1%	10.5%	15.8%	2.7%	1.7%
Stillwater, OK	435	81,989	11.6%	13.3%	$46,505	-4.6%	-4.8%	3.7%	9.8%	1.9%	0.1%	-4.3%
Scottsboro, AL	436	52,773	5.8%	15.4%	$47,954	-10.4%	-6.4%	1.5%	17.3%	8.6%	-7.7%	-4.9%
Eagle Pass, TX	437	58,056	13.1%	8.9%	$38,477	-2.0%	-4.6%	3.0%	14.0%	3.8%	10.9%	-4.4%
Glasgow, KY	438	54,893	7.3%	16.7%	$46,600	-8.9%	-8.4%	1.4%	13.7%	6.9%	-5.4%	-2.5%
Centralia, IL	439	37,390	7.1%	14.7%	$54,349	-7.9%	-7.1%	1.7%	12.6%	7.9%	-5.6%	-5.3%
Warsaw, IN	440	80,106	6.0%	15.9%	$58,708	-1.2%	-5.9%	-0.4%	-5.7%	5.9%	8.0%	0.0%
Vernon, TX	441	12,731	14.2%	12.8%	$54,252	-4.5%	-2.0%	-1.7%	9.2%	4.9%	5.3%	-10.0%
Scottsbluff, NE	442	37,580	10.1%	14.3%	$56,002	-6.8%	-3.0%	-3.4%	11.6%	5.5%	-8.2%	-3.1%
North Wilkesboro, NC	443	65,806	8.4%	15.8%	$45,721	-5.8%	-5.7%	-1.2%	18.3%	5.8%	-6.2%	-5.3%
Grenada, MS	444	21,365	4.6%	13.9%	$47,567	-4.6%	-5.7%	-0.7%	18.7%	5.8%	-1.6%	-2.4%
Talladega-Sylacauga, AL	445	81,524	7.4%	15.0%	$45,814	-2.1%	-3.7%	1.4%	8.7%	3.1%	-0.8%	-3.8%
Muscatine, IA	446	42,688	4.4%	15.6%	$58,514	-5.6%	-5.3%	-0.9%	10.0%	6.8%	-6.7%	-3.2%
Mount Vernon, OH	447	62,897	7.8%	15.9%	$54,654	-6.1%	-5.8%	0.6%	12.2%	4.0%	-4.7%	-5.5%
Fort Dodge, IA	448	37,147	6.5%	18.0%	$55,913	-9.8%	-6.2%	-0.5%	14.0%	6.6%	-15.5%	-5.4%
El Dorado, AR	449	38,340	10.9%	12.0%	$56,956	-11.2%	-4.8%	0.7%	12.6%	4.2%	-4.8%	-2.6%
Russellville, AR	450	83,944	8.6%	15.0%	$41,951	-8.5%	-6.5%	2.1%	15.3%	2.7%	-2.8%	-1.1%
Atmore, AL	451	36,699	8.6%	15.0%	$44,423	-3.9%	-4.7%	-1.7%	14.4%	6.1%	-5.4%	-4.4%
Borger, TX	452	20,495	6.8%	12.1%	$51,320	-15.6%	-3.9%	-0.2%	9.2%	2.2%	14.6%	5.3%
Bluefield, WV-VA	453	105,195	7.6%	17.1%	$47,925	-10.7%	-5.7%	0.3%	18.7%	4.0%	-10.8%	-5.0%
Parsons, KS	454	19,912	4.3%	20.5%	$53,880	-12.1%	-8.2%	-1.0%	14.1%	5.0%	-1.2%	-4.5%
Cedartown, GA	455	43,496	10.9%	13.8%	$42,353	-2.2%	-3.5%	-0.4%	15.3%	4.0%	0.9%	-8.6%
Meadville, PA	456	83,351	6.4%	16.1%	$51,837	-9.8%	-6.4%	0.5%	17.8%	4.2%	-5.4%	-4.9%
Lufkin, TX	457	86,506	8.8%	13.2%	$46,585	-7.2%	-3.8%	3.3%	8.0%	4.3%	-2.5%	-4.0%
Paragould, AR	458	46,317	5.6%	11.9%	$45,126	-5.3%	-6.0%	3.3%	13.2%	4.4%	1.6%	-1.2%
Bartlesville, OK	459	52,772	7.0%	14.8%	$66,633	-13.6%	-3.9%	1.2%	7.8%	2.5%	4.8%	-5.5%
Grand Rapids, MN	460	45,070	8.6%	15.1%	$55,163	-6.6%	-5.7%	0.9%	8.9%	6.0%	-3.4%	-7.3%
Macomb, IL	461	26,828	8.1%	16.7%	$48,238	-15.6%	-9.8%	3.9%	12.3%	8.5%	-14.2%	-2.9%

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Brownwood, TX	462	38,192	7.2%	13.6%	$46,842	-5.5%	-4.6%	0.6%	11.6%	2.7%	3.4%	-1.7%
Peru, IN	463	36,081	6.5%	13.2%	$42,786	-7.7%	-6.1%	-0.6%	14.9%	9.5%	0.3%	-3.6%
Roanoke Rapids, NC	464	65,401	6.2%	13.5%	$45,497	-4.4%	-5.1%	-2.5%	17.5%	8.1%	-1.0%	-5.1%
Cleveland, MS	465	30,308	7.0%	16.3%	$50,484	-13.9%	-6.6%	0.7%	13.8%	4.2%	-8.4%	-0.5%
Ketchikan, AK	466	13,754	4.4%	13.2%	$69,868	-15.5%	-15.2%	11.8%	17.9%	8.7%	-11.9%	-11.1%
Clinton, IA	467	46,463	5.3%	14.3%	$55,302	-13.4%	-6.4%	1.4%	15.4%	7.3%	-14.0%	-2.5%
Helena-West Helena, AR	468	15,906	11.3%	12.3%	$44,652	-9.9%	-4.3%	-3.9%	13.7%	4.7%	8.8%	-0.4%
Granbury, TX	469	64,222	17.4%	16.1%	$60,380	-4.5%	-8.7%	5.9%	0.4%	-3.1%	6.5%	-11.6%
Selma, AL	470	37,619	7.3%	15.1%	$49,277	-11.1%	-7.3%	-2.2%	20.7%	6.5%	-2.8%	-4.4%
Toccoa, GA	471	26,865	12.9%	15.2%	$46,991	-8.7%	-8.3%	1.7%	8.4%	2.2%	-3.4%	-1.9%
Greeneville, TN	472	70,621	5.6%	15.0%	$45,708	-6.4%	-5.9%	2.0%	13.3%	4.6%	-1.6%	-5.3%
Galesburg, IL	473	49,268	10.6%	12.3%	$51,983	-13.6%	-5.4%	-2.7%	15.4%	6.9%	-9.7%	-0.1%
Mount Pleasant, MI	474	64,813	6.3%	14.6%	$45,517	-13.2%	-11.2%	1.9%	20.2%	11.1%	-7.1%	-5.2%
Clarksdale, MS	475	20,810	8.4%	14.3%	$48,140	-13.3%	-6.5%	-1.3%	16.2%	8.5%	-5.4%	-4.1%
McMinnville, TN	476	41,523	6.8%	14.3%	$44,019	-9.3%	-1.3%	-0.2%	12.3%	0.2%	-0.9%	-0.6%
Hobbs, NM	477	73,004	9.6%	11.4%	$53,996	-10.6%	-14.9%	6.7%	8.9%	-3.5%	30.2%	4.2%
Branson, MO	478	56,387	15.6%	14.0%	$45,232	-11.9%	-14.2%	6.8%	18.2%	9.6%	-8.7%	-13.9%
Corning, NY	479	92,948	5.7%	16.6%	$54,626	-7.5%	-8.1%	0.2%	21.2%	2.6%	-6.1%	-7.9%
Kennett, MO	480	27,717	14.6%	12.0%	$45,187	-13.7%	-2.9%	-0.5%	15.9%	6.1%	-7.5%	-7.9%
Oil City, PA	481	49,938	5.8%	14.5%	$52,697	-12.5%	-6.9%	-0.5%	18.9%	3.7%	-1.7%	-2.7%
Mount Vernon, IL	482	36,877	6.3%	13.6%	$51,106	-3.5%	-7.7%	0.4%	12.3%	7.2%	-0.2%	-6.9%
Weatherford, OK	483	28,163	11.2%	14.7%	$49,820	-5.4%	-7.8%	2.4%	11.8%	1.0%	-3.4%	-6.4%
Atchison, KS	484	16,239	7.5%	16.3%	$49,145	-10.8%	-6.7%	-2.4%	18.8%	0.6%	12.4%	-5.2%
Marinette, WI-MI	485	65,174	6.0%	12.3%	$54,976	-8.1%	-5.8%	0.4%	11.8%	6.3%	-2.1%	-4.8%
Middlesborough, KY	486	23,858	10.1%	14.9%	$40,244	-8.5%	-4.7%	0.0%	9.8%	4.1%	-4.9%	-3.3%
Defiance, OH	487	38,144	5.9%	15.5%	$51,715	-8.7%	-6.7%	0.4%	8.1%	6.6%	-6.4%	-4.6%
Big Stone Gap, VA	488	39,313	7.4%	16.4%	$41,578	-11.0%	-5.9%	1.9%	12.3%	6.1%	-15.1%	-5.2%
Ardmore, OK	489	58,507	9.5%	13.4%	$51,586	-5.0%	-3.6%	-2.7%	10.4%	2.2%	2.0%	-5.0%
Fairmont, WV	490	56,001	10.2%	16.4%	$53,849	-16.2%	-9.6%	3.3%	12.5%	4.3%	-4.8%	-7.7%
Hope, AR	491	27,881	6.4%	11.0%	$40,170	-3.4%	-4.9%	-1.7%	18.0%	5.8%	-0.7%	-3.3%
Bellefontaine, OH	492	46,035	5.4%	14.1%	$55,231	-7.6%	-7.4%	0.2%	11.3%	4.5%	-0.2%	-4.8%
Guymon, OK	493	20,865	5.7%	13.6%	$63,674	-4.7%	-2.3%	-5.2%	11.4%	2.0%	4.9%	-6.8%
Olean, NY	494	76,426	9.1%	13.6%	$49,057	-11.1%	-10.0%	0.3%	18.1%	9.4%	-12.4%	-7.3%
Madisonville, KY	495	45,138	7.2%	15.3%	$49,893	-10.3%	-5.6%	0.5%	10.7%	5.6%	-14.3%	-5.5%
Muskogee, OK	496	66,146	10.1%	12.8%	$45,824	-3.4%	-4.9%	-2.3%	12.5%	2.6%	-14.1%	-1.6%
Minden, LA	497	36,184	6.8%	15.9%	$52,534	-8.1%	-4.8%	-2.3%	10.8%	3.3%	-10.8%	-3.9%
Lock Haven, PA	498	37,465	9.0%	14.3%	$51,817	-4.7%	-7.6%	-1.2%	14.9%	2.6%	-1.7%	-7.5%
Marion, IN	499	66,263	5.0%	15.7%	$49,973	-4.7%	-3.4%	-0.6%	11.3%	4.6%	-33.6%	-3.2%
Taylorville, IL	500	33,662	5.2%	16.3%	$54,242	-13.7%	-10.2%	-1.6%	20.6%	11.8%	-13.3%	-10.5%
Silver City, NM	501	27,889	7.8%	17.2%	$52,105	-8.3%	-6.8%	5.0%	14.1%	3.8%	-22.8%	-14.7%
Kendallville, IN	502	47,227	6.6%	14.7%	$50,472	-10.3%	-10.0%	-1.2%	14.5%	6.1%	-3.6%	-4.2%
Mount Gay-Shamrock, WV	503	31,909	10.9%	16.8%	$48,458	-10.9%	-10.3%	7.6%	9.6%	-2.2%	-0.4%	-10.7%
Kingsville, TX	504	30,975	12.7%	8.8%	$47,743	-10.6%	-5.9%	2.2%	15.4%	3.4%	-5.8%	-7.1%
Hillsdale, MI	505	45,546	6.4%	13.3%	$44,815	-12.5%	-11.3%	3.5%	12.3%	5.2%	0.3%	-2.9%
Burlington, IA-IL	506	44,803	6.2%	13.8%	$58,685	-12.6%	-7.0%	-0.9%	11.6%	6.8%	-12.6%	-6.3%
Minot, ND	507	76,586	10.5%	14.0%	$64,806	-15.0%	-6.7%	2.2%	9.1%	2.3%	-20.3%	-7.6%
Duncan, OK	508	43,129	10.7%	12.2%	$52,869	-12.1%	-5.3%	6.9%	4.7%	1.0%	-17.5%	-7.2%
Laurinburg, NC	509	34,227	5.4%	12.2%	$41,937	-6.0%	-7.6%	3.8%	17.0%	7.8%	-34.0%	-5.9%

Shaded rows represent heartland micropolitans

	OVERALL RANKING	2021 POPULATION	YOUNG FIRM EMPLOYMENT SHARE	YOUNG FIRM KNOWLEDGE INTENSITY	2020 PER CAPITA PERSONAL INCOME	2015-2020 EMPLOYMENT GROWTH	2019-2020 EMPLOYMENT GROWTH	SEP.2020-SEP.2021 EMPLOYMENT GROWTH	2015-2020 AVERAGE ANNUAL PAY GROWTH	2019-2020 AVERAGE ANNUAL PAY GROWTH	2015-2020 GDP GROWTH	2019-2020 GDP GROWTH
Magnolia, AR	510	22,672	9.5%	13.7%	$45,414	-6.7%	-4.7%	1.4%	8.1%	2.3%	-10.8%	-7.6%
Laurel, MS	511	83,035	6.8%	15.3%	$48,050	-5.5%	-5.1%	-1.4%	9.9%	3.0%	-15.5%	-6.2%
Mineral Wells, TX	512	28,686	13.6%	15.2%	$49,387	-3.2%	-7.6%	-1.6%	7.9%	-1.3%	-6.1%	-7.4%
St. Marys, PA	513	30,783	5.9%	15.4%	$59,929	-13.6%	-11.6%	2.2%	15.7%	1.8%	-3.6%	-9.6%
Vernal, UT	514	36,204	14.6%	14.1%	$37,496	-14.0%	-8.1%	8.8%	6.0%	1.3%	-21.4%	-10.2%
Bennettsville, SC	515	26,382	10.6%	12.7%	$42,635	-4.2%	-5.0%	-3.3%	7.6%	2.1%	-4.9%	-6.5%
Gillette, WY	516	60,461	13.3%	13.5%	$56,933	-13.6%	-6.2%	0.6%	9.8%	0.2%	-25.6%	-8.4%
Gainesville, TX	517	42,244	12.3%	15.2%	$59,971	-12.7%	-8.3%	3.7%	4.9%	-1.1%	-34.5%	-7.0%
Evanston, WY	518	20,635	11.4%	14.8%	$46,505	-10.0%	-5.4%	-2.3%	10.5%	2.8%	-18.2%	-10.3%
Indiana, PA	519	82,886	6.7%	17.2%	$49,731	-13.7%	-9.4%	-0.7%	16.4%	4.5%	-18.1%	-12.7%
Central City, KY	520	30,694	19.4%	12.8%	$43,395	-17.1%	-8.4%	2.3%	0.3%	0.5%	-26.8%	-8.8%
McAlester, OK	521	43,633	12.9%	13.0%	$46,849	-7.4%	-8.1%	-1.0%	8.9%	-3.3%	-11.2%	-10.8%
Woodward, OK	522	23,967	11.6%	14.2%	$49,531	-15.9%	-6.2%	-0.2%	5.8%	-4.5%	-11.4%	-7.8%
Coshocton, OH	523	36,618	7.0%	11.2%	$45,169	-15.1%	-7.5%	-0.7%	-3.8%	11.0%	-23.0%	-5.4%
Rock Springs, WY	524	41,614	9.1%	13.4%	$58,601	-14.7%	-9.7%	-0.6%	8.5%	-0.5%	-16.3%	-10.9%
Pampa, TX	525	21,827	10.0%	14.7%	$49,688	-17.7%	-6.9%	2.6%	4.9%	-0.1%	-37.3%	-9.5%
Morgan City, LA	526	48,232	7.2%	12.9%	$53,317	-22.7%	-7.5%	3.0%	2.0%	2.1%	-22.1%	-8.2%
Andrews, TX	527	18,440	12.4%	12.1%	$55,031	-6.2%	-13.0%	2.9%	11.1%	-4.0%	-14.9%	-17.8%
Dickinson, ND	528	34,001	12.6%	15.6%	$71,301	-19.6%	-11.2%	1.6%	-1.3%	-3.6%	-25.0%	-14.5%
Beeville, TX	529	30,924	8.7%	12.1%	$34,864	-8.9%	-5.1%	-3.9%	-4.0%	-0.9%	-14.2%	-4.6%
Levelland, TX	530	21,363	7.1%	10.8%	$50,434	-16.2%	-12.3%	6.8%	14.8%	-6.9%	-12.2%	-17.1%
Summerville, GA	531	24,932	8.7%	15.1%	$39,620	-18.9%	-14.8%	-1.3%	10.1%	0.8%	-18.1%	-12.6%
Snyder, TX	532	16,824	14.9%	11.4%	$51,771	-28.4%	-11.5%	1.4%	6.2%	-2.7%	-22.3%	-13.5%
Pearsall, TX	533	18,436	10.0%	9.6%	$36,587	-4.4%	-11.6%	1.1%	3.7%	-2.8%	-19.2%	-13.8%
Elk City, OK	534	22,046	10.9%	14.1%	$47,142	-22.4%	-11.1%	-1.5%	1.5%	-6.5%	-27.1%	-13.8%
Williston, ND	535	38,484	14.5%	14.2%	$72,070	-32.6%	-18.2%	1.2%	-3.7%	-7.1%	-30.0%	-21.7%
Alice, TX	536	48,603	7.5%	9.0%	$49,949	-20.8%	-12.8%	10.8%	-6.2%	-12.0%	-28.0%	-21.3%

Shaded rows represent heartland micropolitans

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An Economic Development Toolbox:

Strategies and Methods

Terry Moore, Stuart Meck, and James Ebenhoh

American Planning Association

Planning Advisory Service
Report Number 541

This report was originally prepared for Envision Utah, a public/private partnership dedicated to studying the long-term effects of growth for the Great Wasatch Area around Salt Lake City, Utah. The report grows out of Envision Utah's 2000 Quality Growth Strategy, intended to preserve the area's quality of life, natural resources, and economic vitality. Envision Utah commissioned this report in 2003 to round out its other publications on quality growth and to provide local governments in the region with an economic development toolbox that would help them implement the economic development aspects of the Quality Growth Strategy. (See www.envisionutah.org/resources.phtml; accessed October 2006). The purpose of the report is to be a basic and practical guide for local governments; more detailed and advanced information is referenced in the bibliography.

This report was written by Terry Moore, FAICP, managing director of ECONorthwest, a consulting firm based in Portland and Eugene, Oregon, specializing in economic development policy formulation and specialized economic analysis; Stuart Meck, FAICP, formerly a senior research fellow with the Research Department of the American Planning Association in Chicago, and now Director of the Center for Government Services, Edward J. Bloustein School of Planning and Public Policy, Rutgers, The State University of New Jersey, New Brunswick; and James Ebenhoh, AICP, a former employee and current associate at ECONorthwest, now senior strategic advisor for Wellington City Council, New Zealand. The authors have revised and recast the original report for a national audience, although some Utah-specific references have been retained where relevant.

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CHAPTER 1

The Purpose and Organization of This Report

This report is a practical guide for local governments planning for economic development. Because of its practical (as opposed to theoretical) nature, we refer to it as an economic development *toolbox.* It aims to help local governments:

- incorporate economic development planning into local comprehensive plans (especially planning efforts for land use, transportation, and environmental protection);
- provide a framework for self-evaluation to determine whether they are competitively positioned for economic development;
- assist in maintaining the integrity of the "jobs" aspect of local comprehensive plans and development regulations under fiscal pressure;
- encourage the development of infrastructure (utilities, transportation, communications) for job sites so that the infrastructure has been planned and is available when needed in the site-selection process; and
- encourage increased cooperation and limited territoriality between local governments in the effort to plan for and create jobs.

There is a huge professional literature on economic development and related topics. Items covered in one page of this report are the sole subjects of numerous journal articles or entire books. We obviously cannot provide that detail and do not want to try. Our purpose is different. We are trying to consolidate ideas into a useable guidebook—something that a local planner in a small city or metropolitan region can turn to for practical advice when the assignment comes down: "we need to do an economic development plan." This report will get you started and help you finish.

This PAS Report has four chapters, supported by five appendices:

Chapter 2 provides a framework for thinking about local economic development. It describes what businesses look for when they make location and expansion decisions, and what local government can do to provide those things and, thus, make themselves more attractive to businesses and private investment.

Chapter 3 describes a series of analytical techniques for evaluating a local or regional economy, and the specifics of how local governments can conduct such an evaluation.

This toolbox is for local government, including cities, counties, and regional planning or economic development agencies. Sometimes, however, we have contrasted the "local" economy to that of the wider region. This has two purposes: (1) to show how certain analytical tools treat city and county economies differently from a wider regional economy; and (2) to illustrate the difference in roles between, on one hand, city and county jurisdictions, and on the other, regional planning or economic development agencies. Most of the time, however, we use the term "local government" to include regional agencies as well as city and county governments. We also tend to use the term "region" when describing characteristics most easily measured at the regional level, but these characteristics may also apply across the city and county jurisdictions within that region. We have organized our description of these analytical techniques as follows.

Economic overviews. Techniques that look at the current and past composition of an economy:

- Economic base analysis
- Shift-share analysis
- Retail market analysis
- Market-share analysis

Evaluations of comparative advantages. Techniques that explain why an economy is what it is, and why it has changed over time. Specifically, we consider the following elements:

- Natural resources and supplies
- Building and land supply and markets
- Labor market
- Location relative to market and supplies
- Infrastructure and utilities
- Business clusters
- Amenity and other quality-of-life factors
- Housing costs
- Government policies

Chapter 4 describes and evaluates strategies and measures that local governments could employ to encourage economic development in the context of quality growth. It describes a process for selecting strategies for coordinated regional economic development, and provides guidance in how to monitor strategies. These strategies include the following:

- Coordinate economic development programs and support services
- Engage in business development
- Provide development incentives and financing
- Engage in business attraction and retention
- Educate the workforce
- Ensure an adequate land supply
- Provide adequate infrastructure
- Provide a quality of life conducive to business innovation

Appendices provide more detail about many of the topics covered in Chapters 2 through 4, as well as additional resources that local governments may want to employ.

- Appendix A. Using Economic Base and Shift-Share Analyses To Analyze the Regional Economy
- Appendix B. Model Economic Development Element From the American Planning Association's *Growing Smart℠ Legislative Guidebook*
- Appendix C. Economic Development Readiness Evaluation Tool and Feedback
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CHAPTER 2

A Definition of Economic Development, Important Factors, and the Role of Government

What is economic development? The definition of economic development, as used in this PAS Report, is:

> Economic development is the process of improving a community's well-being through job creation, business growth, and income growth (factors that are the typical and reasonable focus of economic development policy), as well as through improvements to the wider social and natural environment that strengthen the economy.

This is a broader view of economic development than was common as recently as 10 years ago, when the focus was almost exclusively on job growth and business development. Nonetheless, job and business development should still be the primary objective of local government economic development efforts, just as the performance of the transportation system (not land use or social equity) should be the primary focus of transportation planning. The broader definition of economic development simply acknowledges that (1) economic development can have effects on other desired public purposes (in the areas, for example, of land use, environmental quality, and social justice), and (2) economic development planning must pay attention to those effects and deal with the tradeoffs among competing public objectives.

FACTORS THAT MATTER TO FIRMS

Direct inputs

- Natural resources and supplies
- Built space (and land to put it on)
- Labor

Factors directly affecting the cost of inputs and the revenues from outputs

- Location relative to supplies and markets
- Infrastructure and utilities (including transportation and telecommunications)
- Business clusters

Factors indirectly affecting the cost of inputs

- Amenity and other quality of life factors
- Government policies

THE MOST IMPORTANT FACTORS TO ECONOMIC DEVELOPMENT

This report proceeds from the assumption that the key objective of an economic development strategy is business development and job growth, which comes from the creation of new firms, the expansion of existing firms, and the attraction or retention of existing firms. Thus, a key question for public policy is, *What are the factors that influence business and job growth, and what is their relative importance?*

Some simple assumptions, grounded in basic economic principles, provide a point of departure for answering that question:

- Businesses want to be profitable.
- Profitability is the excess of revenues over costs. Thus, profitability can be achieved and increased by increasing revenues or reducing costs.
- In the jargon of economics, increasing revenues is primarily a function of the market for the goods and services a firm produces (the *demand* side of the equation), and deceasing costs is primarily a function of reducing the costs of producing and delivering goods and services (the *supply* side of the equation).
- Every good or service produced has multiple inputs. Thus, if one wants to influence the costs of production, one should focus on the costs of individual inputs. Some inputs are more important (as a percentage of total production costs) than others, and some are more amenable to the influence of public policy than others (e.g., the costs of infrastructure).
- There are a few things that local governments can do to influence the demand side of the equation (e.g., marketing of regional products, buying locally, assisting local producers in finding local supplier (import substitution)), but the majority and most significant ways that the public sector can influence business profitability are on the supply (cost) side of the equation.

The rest of this section focus on the supply (cost) side. It looks at three broad categories of the ways local government policies can influence cost factors (see sidebar).

Direct Inputs to the Production Process

Economic theory says that firms locate where they can reduce the costs of their factors of production (assuming demand for products and any other factors are held constant). Certain factors are direct inputs to the production process:

Natural resources and supplies. Firms producing goods, and even firms producing services, need various materials to develop products that they can sell. Some firms need natural resources: a manufacturing sector (e.g., lumber) needs trees. Farther down the line, other firms need intermediate materials (e.g., dimensioned lumber). The quality, quantity, and cost of the locally available natural resources and supplies are all relevant.

Land and buildings. Land is obviously important to businesses; it provides the physical foundation upon which buildings are constructed and the production process occurs. To be effective, communities must have an available supply of development-ready land—appropriately zoned and supplied with utilities and services—to accommodate the needs of business. Buildings are also important; the demand for land is essentially derived from the demand for the functional built space businesses actually inhabit. Existing buildings are useful for businesses that do not have the time or funding to pay for a purpose-built structure on previously vacant land. The use of older, historical buildings preserves a community's architectural and visual character and is

often popular with firms in creative industries (e.g., graphic design, computer software). Service firms and small start-up firms also may be able to adapt to older buildings that have become outmoded for their previous tenants. Speculative office, retail, or manufacturing space also plays an important role in providing space ready for move-in, often with the modern facilities and suburban locations that suit some firms.

Labor. The relative productivity and cost of labor is often the single most important factor for businesses (especially service businesses). Other things being equal, firms want higher productivity—in other words, more labor output per dollar. This depends not only on the cost of labor but also on the skills of the workforce.

The importance of location with respect to supplies and markets clearly diminished in the last quarter of the twentieth century.

Factors Directly Affecting the Cost of Inputs and the Revenues from Outputs

Of the direct inputs above, land is usually the only factor provided on site. Labor and supplies have to be brought in from elsewhere. Therefore, the location relative to these factors is important, as is the transportation and communication infrastructure that allows these supplies to bridge the distance. In other words, these factors help businesses get what they need at lower prices. They also help get the finished product to market at lower cost (allowing higher net revenues).

Location relative to supplies and markets. Firms need to bring their supplies (including labor) from other locations. The closer the supplying markets, generally the less expensive this transfer is. The final stage of the production process is getting the product (either goods or services) to market. As with supplies, the closer the receiving markets, the less expensive this transfer is. The location factor is often most important for firms that either have supplies shipped to them or that produce heavy products, such as heavy machinery or transportation equipment. Even service firms or manufacturers of lightweight products or services, however, often require proximity to their customer base for sales and service, and proximity to a labor pool is important for all labor-intensive firms.

The importance of location with respect to supplies and markets clearly diminished in the last quarter of the twentieth century. The move to a knowledge-based economy with high-speed communication infrastructure and improved transportation links has allowed firms to locate at a greater distance from their markets. An example is the software industry in Utah, which managed to build a software cluster despite its distance from major markets. In the new knowledge-based economy, transportation of ideas (communication) can substitute for some of the transportation of inputs and outputs (because ideas can be both).

Infrastructure and utilities. An important role of government is to increase economic capacity by improving the quality and efficiency of infrastructure (e.g., roads, bridges, water and sewer systems, airport and cargo facilities, energy systems, and telecommunications). In some cases, where the product is information that can be provided electronically, the telecommunications infrastructure actually brings the product to market.

Business clusters. Another way for businesses to reduce their input costs is to choose a location where there are other similar businesses, constituting an emerging or established "cluster" (Porter 2004; Cortright 2006). Firms in a cluster can reduce their direct input costs by sharing a large labor pool and suppliers that have emerged to service the cluster. Clusters also have advantages beyond direct inputs. The interchange of ideas that occurs through proximity can benefit business innovation, creativity, and efficiency.

Well-known national examples of a cluster are the high-technology cluster in California's Silicon Valley and the Salt Lake City area's bioscience cluster,

which includes many medical device manufacturers as well as pharmaceutical companies and biotechnology firms. The success of the University of Utah's Huntsman Cancer Institute in mapping more than 30 genes related to cancer with the help of the genealogical databases of the locally based Church of Jesus Christ of Latter-day Saints is a perfect example of an advantage made possible by clustering.

Factors Indirectly Affecting the Cost of Inputs

Firms locate in a city or region in part because of the presence of factors that can have indirect but important effects on the cost and, thus, the profitability of doing business.

Government must provide quality basic services and an efficient regulatory environment if it wishes to create economic development. Providing further incentives to businesses is optional.

Amenity and other quality-of-life factors. A local jurisdiction with a high level of amenity and other quality-of-life factors (e.g., good schools, a clean environment, affordable and appropriate housing, and a diverse and exciting culture) attracts people simply because it is a nice place to be. In particular, it attracts skilled workers, decreasing labor costs for businesses.

Government policies. The supply, cost, and quality of all the factors above depend greatly on market factors—conditions of supply and demand locally, nationally, and even globally. But they also depend on public policy. In addition to direct public provision of infrastructure and services, public policy can affect the costs of doing business through regulation, taxes, and incentives.

WHAT CAN LOCAL GOVERNMENTS DO TO AFFECT THE AMOUNT AND TYPE OF ECONOMIC DEVELOPMENT?

Policies and Strategies

Even though government cannot affect all the factors important to economic development, it can have a significant impact through both its traditional role as public service provider and regulator, and its entrepreneurial role as a deal-maker and business recruiter. Of these two roles, the former is essential—government must provide quality basic services and an efficient regulatory environment if it wishes to create economic development. Providing further incentives to businesses is optional—whether it makes sense depends on what government can reasonably offer, the extent to which such offerings are necessary to attract firms, and the cost of those offerings.

Local government involvement in economic development takes a number of forms, including:

- clearing and assembling adequate land for business (zoning, urban renewal, and similar devices);
- underwriting risk (industrial development bonds, tax abatement, low-interest loan programs);
- providing amenities and infrastructure (construction of utilities, tax increment financing, urban renewal);
- promoting economic development (participation in chambers of commerce, economic development organizations, trade missions, other nonprofit groups);
- providing job training, or establishing or supporting institutions that provide job training (e.g., community colleges and technical schools);
- changing the tax structure to promote economic development; and
- modifying regulations that are seen as burdensome to business.

These are a mix of traditional and more entrepreneurial roles for local government. A local government's specific options for promoting economic development are listed in Chapter 4.

The Process for Making Decisions About What Policies and Strategies To Pursue

Chapter 4 describes the types of policies and strategies that government might pursue to further economic development. It also describes ways to evaluate and select from a range of possible policies and strategies. In this chapter, we briefly describe the *process* of economic development planning, as well as the content of a typical local economic development plan.

The local economic development planning process. The economic development planning process is similar to the standard planning model in many respects. It has direct relationships with land use, regional coordination, transportation, and other elements commonly addressed in a local comprehensive plan.

Like comprehensive planning, economic development planning typically begins by identifying a community vision, as well as goals and objectives for implementing that vision. An accurate factual base is essential and should cover broad economic trends, the local business mix, land supply, labor force, and other economic characteristics.

The steps can be summarized as follows:

Step 1. Develop a vision statement and goals

Step 2. Conduct economic baseline analysis

Step 3. Identify economic development issues

Step 4. Develop policies

Step 5. Develop strategies or "action plan"

Steps 2 and 3 are described in Chapter 3; Steps 1, 4, and 5 are described in Chapter 4.

What's in a local economic development plan? Many local governments incorporate an economic development element as part of their comprehensive plan. We describe the analysis and strategies that make up such an element in next two chapters. In brief, an economic development plan will typically address these topics:

- Assessing the local government's strengths and weaknesses with respect to attracting and retaining business and industry
- Defining the local government's role in encouraging job retention and growth and economic prosperity
- Relating the local government's initiatives to the distinct competitive advantages of its surrounding region that make it attractive for business and industrial growth and retention
- Coordinating local economic development initiatives with those of the state and regional initiatives.

CHAPTER 3

Evaluating a Local Economy

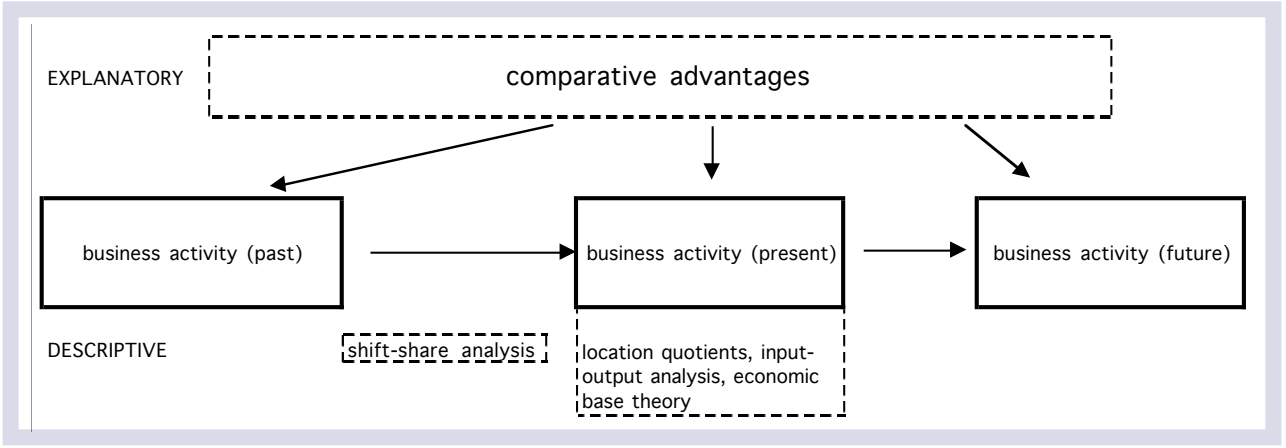
To help governments think about the future, a solid analysis of current conditions is necessary along with consideration of past trends that may continue into the future and alter current conditions.

What is assessed in such an analysis of past and current conditions may either be: (a) measurements of economic performance (typically, employment by industry, unemployment rates, income), or (b) the factors that influence economic performance (e.g., the price and quality of labor, the amount and price of land, tax rates), or (c) both. The first set of factors is *descriptive*; the second set is *explanatory* and *predictive*. This chapter organizes the techniques for describing a local economy in the following two groups:

1. **Descriptive:** Economic overviews that look at the current and past composition of an economy.
2. **Explanatory:** Evaluations of comparative advantages, which explain why an economy is what it is, and why it has changed over time. Such an evaluation *explains* the economic conditions that the first set of techniques *describes*.

FIGURE 3-1. ORGANIZATION OF THE TECHNIQUES IN THIS CHAPTER

Figure 3-1 shows how these techniques relate to one another.



Source: ECONorthwest

Before discussing these evaluative techniques, we describe the data sources that they use.

DATA SOURCES

Both sets of analysis techniques use data, sometimes from the same source. Particularly useful sources are state employment departments and federal departments that collect and publish economic information.

State departments of employment services typically have "covered employment" data that show the number of employers, employees, and wages in most industries "covered" by employment insurance. Please note, however, that a significant proportion of employment (perhaps 10 to 20 percent, depending on the area) is not covered, including sole proprietors and many agricultural workers. Thus, the data on covered employment, though good for describing the relative composition of employment in large metropolitan areas, *underestimates* the amount of total employment. The industries are usually categorized according to the North American Industrial Classification System (NAICS).

Federal agencies also provide useful economic data.

- **The Bureau of Labor Statistics,** U.S. Department of Labor (www.stats.bls.gov). The Bureau of Labor Statistics (BLS) collects information on employment levels, occupations, and wages. Quarterly data on employment and wages are available at the county level. Annual data on occupations and wages are available at the metropolitan area level. Annual data on employment in various industries are available at the national level. Also available

are the Consumer Price Index, which measures inflation as experienced by consumers in their day-to-day living expenses, and the Consumer Expenditure Survey, which measures the spending habits of U.S. consumers and includes data on their expenditures, income, and characteristics.

- **The Bureau of Economic Analysis,** U.S. Department of Commerce (www.bea.gov). The Bureau of Economic Analysis (BEA) publishes information on state and local personal income and employment by industry, as well as regional "input-output multipliers" that show how industries within a region are interrelated. These multipliers are used in input-output analysis, described below.
- **The U.S. Census Bureau** (www.census.gov). The Census Bureau conducts the comprehensive Economic Census every five years, providing detailed data on various characteristics of national, state, metropolitan, and county economies, including sales data. The Bureau also publishes annual County Business Patterns reports on the number of businesses, employees, and payroll by industry for all counties in the United States (www.census.gov/epcd/cbp/view/cbpview.html).

There are many other sources of qualitative and quantitative data about local and regional economies, including county assessors' offices, local real estate networks, and the records of other local organizations. The state and federal sources identified above, however, are a useful place to start.

TECHNIQUES FOR DESCRIBING THE STRENGTHS AND WEAKNESSES OF A LOCAL ECONOMY

The techniques described here work best at the county or regional level (both because a metropolitan region is the most logical way to describe and evaluate a local economy, and because many data sources are only available at the county level). But they can also be applied to smaller units of government. Appendix A provides some simple formulas and sample calculations for economic base and shift-share analysis. Sidebars illustrate some of the techniques and their use.

Economic overviews. Techniques that look at the current and past composition of an economy:

- Economic base analysis, including location quotients and input-output models
- Shift-share analysis
- Retail market analysis
- Market-share analysis

Evaluations of comparative advantages. Techniques that explain why an economy is what it is and why it has changed over time, looking at the following comparative advantages:

- Natural resources and supplies
- Building and land supply and markets
- Labor market
- Location relative to market and supplies
- Infrastructure and utilities
- Business clusters
- Amenity and other quality-of-life factors
- Housing costs
- Government policies

ECONOMIC OVERVIEWS

Economic Base Analysis

What: Measures the extent to which the local or regional economy is exporting goods and services to the rest of the world.

Why: The more goods and services are exported, the more the local or regional economy will grow.

The economic driver in metropolitan economies could be the services (e.g., legal, financial, management, technical support) that allow businesses to grow, enter, or adapt in changing markets as export industries wax and wane over time.

The premise of economic base theory is easy to understand and has been the basis for regional economic analysis for decades: a region should try to get more industries that produce goods for export (*basic* goods). Nonbasic industries (e.g., retailing), the theory goes, rely on the basic industries for their existence because basic industries bring new money into the region in exchange for exported goods or services. In this two-sector model, economic growth occurs when demand for a region's exports increases or when the region produces goods and services that were formerly imported, a process known as "import substitution" (Hoover and Giarratani 1984, 316-30).

The traditional view is that manufacturing is a traded, export-oriented, "basic" sector of the economy that supports the "nonbasic" service sector. In this view, a loss of manufacturing output results in a loss of income to the region—income that can no longer support the local service industry.

But other businesses besides manufacturing are equally "basic." Tourism is essentially an export, bringing nonlocal dollars into an economy. More importantly, the economic driver in metropolitan economies could be the services (e.g., legal, financial, management, technical support) that allow businesses to grow, enter, or adapt in changing markets as export industries wax and wane over time.

A related terminology that helps to widen the definition of "basic" is "traded" vs. "nontraded" sectors. Traded sectors are essentially the same as basic industries, but the name "traded" implies that the definition is based on trading activity rather than the actual business product. The traded sector is composed of businesses that compete with firms outside the local area. Those businesses bring wealth into a local economy by exporting goods and services, or they retain wealth within a local economy by substituting for goods and services that would otherwise have to be imported from elsewhere.

To identify whether an industry is basic or nonbasic (or traded or nontraded) in an area, one usually needs to look beyond broad industry classifications (manufacturing, services, etc.) to more specific industry classifications. Examples of basic industries include durable goods (e.g., fabricated metal products, electrical equipment and supplies, and transportation equipment) and nondurable goods (e.g., food products, textile mill products, and chemical products). Some services (e.g., child care or landscaping) may be nontraded inasmuch as they are not exported outside the region and are not competing with firms outside the region. Other services like investment banking, however, may be exported outside the region and provide for local needs.

In most cases, the retail sector is not a basic one because it primarily serves local residents and therefore exchanges dollars within the community rather than bringing in new dollars. The exceptions are in tourist-serving communities, and in cases of import substitution. Import substitution through retail might occur if a new retail outlet makes items available locally that people had previously traveled to other regions (or ordered by phone or Internet) to purchase.

Retail jobs are also often not high paying. Nonetheless, many communities pursue retail businesses because of incentives created by local tax structures,

notably the ability to tax sales. To that end, some local governments will offer incentives to such businesses to locate within their boundaries. While this might make some sense as a revenue-generating strategy from the standpoint of the local government's fiscal health, it is limited as a long-term economic development strategy to generate wealth-creating jobs that bring income into the region and create demand for local business services (e.g., printing, office supplies, and insurance). Local governments that attempt to attract retail businesses are likely to be competing for a limited share of an existing regional market—reallocating a portion of an existing pie rather than making the pie larger.

Technique: Location Quotients

What: Reveals concentration of specific industries in a local or regional economy.

Why: May help to identify the "traded sector" that drives economic growth.

Location quotients are a specific quantitative technique used in economic base analysis (see Appendix A for more detail)**.** Directly, location quotients measure the concentration of industry in a geographic area relative to a larger area. Indirectly, these measures of concentration can provide some indication of export-orientation—the extent to which certain industries are the "traded" or "basic" ones that are critical to economic growth (O'Sullivan 2003).

A location quotient is simply a ratio of ratios. The first ratio describes an area's employment in one industry as a share of its employment in all industries. The second ratio describes the same thing, but for a larger, reference area: the ratio of a larger area's employment in the same industry to that larger area's employment in all industries. The third ratio yields the location quotient: divide the first ratio by the second ratio (a ratio of ratios).

Location quotients greater than 1.0 indicate that an industry is more represented in the smaller area (e.g., the region) than in the larger area (e.g., the nation); location quotients less than 1.0 indicate that an industry is less represented in the smaller area than in the larger area. Putting that slightly differently, location quotients less than 1.0 indicate that the smaller area's share of a larger area's employment *in a specific industry* is less than the smaller area's share of the larger area's *total* employment. In short, the higher the location quotient, the more concentrated the employment in that industry is in the area under consideration.

The interpretation of location quotients in the context of economic development policy can be problematic, and practitioners often fail to recognize that problem. One common interpretation is that location quotients show the comparative advantage of an area in attracting and retaining various industries, and that they reflect the degree to which firms find an area advantageous. Thus, a high location quotient, which shows a relative concentration of a certain industry in an area, is interpreted as a comparative advantage to be built on.

While this interpretation is probably correct in explaining the situation in the present, it is not clear that location quotients tell much about future trends. A high location quotient for a region's industry might signal that the region has grown all it can, and employment growth in that industry might stagnate unless there is national growth in that industry. A low location quotient might, in contrast, indicate untapped potential. Recent growth rates of the industry can provide some insight into possible future trends. Table 3-1 gives an example of how location quotients and growth rates can be combined to classify industries.

EXAMPLES OF LOCATION QUOTIENTS

1. Furniture manufacturing accounts for 5 percent of employment in Region X, and also for 5 percent of employment in the nation. The location quotient is 5 percent divided by 5 percent, or 1. The region has the same amount of employment in furniture manufacturing that one would expect if the region's employment were distributed across industries in the same proportions as national employment.
2. Furniture manufacturing accounts for 10 percent of employment in Region X, but only 5 percent of employment in the nation. The location quotient is 10 percent divided by 5 percent, or 2. The region has twice the employment in furniture manufacturing that one would expect based on the national distribution of employment across industries. Region X has a relative concentration in furniture manufacturing.
3. Furniture manufacturing accounts for 2.5 percent of employment in Region X, but 5 percent of employment in the nation. The location quotient is 2.5 percent divided by 5 percent, or 0.5. The region has half the employment in furniture manufacturing that one would expect based on the national distribution of employment across industries.

TABLE 3-1. METHODS FOR CLASSIFYING INDUSTRY CLUSTERS

	Low Employment Growth	High Employment Growth
High Location Quotient	Important industries that may require attention	Important growth industries
Low Location Quotient	Industries with little promise for local economy	Potential emerging industries

Source: Carnegie–Mellon Center for Economic Development 2002.

Location quotients can be used as an indirect method of measuring export orientation. The logic is as follows. To produce enough goods or services for internal regional consumption, the sector would need to have only the same share of employment in that sector that the nation has; that is, the location quotient would be 1.0. If a location quotient is much greater than 1.0, the region is very likely to be net exporter of goods or services from that sector.

This logic rests on several big assumptions. One is that per capita consumption by sector is the same across all regions; for example, people in Region X are assumed to buy the same amount of shoes per capita as do people in Region Y. But if, for example, a region buys more shoes per capita than the national average, it could have more shoe employment per capita just to meet local needs. Another assumption is that productivity does not vary across regions; that is, the same amount of employment is assumed to be necessary to produce a pair of shoes in Region X as in Region Y.

There are other important caveats. Even if the assumptions above are generally accurate, the location quotients give only an indication of *net* importing or exporting with respect to a sector. In other words, not every business in a sector with a location quotient greater than 1.0 is exporting, and not every business in a sector with a location quotient of 1.0 or less is producing for local consumption. The degree to which the net effect is true of the entire sector depends on the amount of exporting *and* importing that is done within a business sector.

For all these reasons, we recommend using location quotients as illustrative rather than definitive: they are an indicator for prompting discussion and deeper thinking.

Technique: Input-Output Analysis

What: Shows the overall effect on a local economy of a change in one local industrial sector.

Why: To evaluate the benefits of job creation efforts and highlight the importance of revenue or employment in one sector to the overall local economy.

Input-output analysis is related to economic base theory inasmuch as it estimates the importance of exports, which bring new dollars into the local economy (see generally Isard 1960, and Krueckerberg and Silvers 1974). Rather than using location quotients, however, input-output analysis directly measures the inter-relationships among industries in a region, as well as the extent of importing and exporting. For example, it shows the effect that a dollar of new spending within one industry has on the output, employment, or income in other industries with which it trades goods and services. These "multiplier" effects are useful in estimating the overall economic effect of an initial income or employment boost to one regional industry (e.g., the creation of a new manufacturing plant). In the context of "traded-sector" evaluation, the multipliers can be interpreted as measures of how important one industry is to the rest of the regional economy, thereby helping to target economic development efforts (O'Sullivan 2003, 135-38).

Multipliers generated by input-output analysis essentially show how each dollar of additional income flows through a regional economy. Additional income has "flow-on" effects in two ways. One (the so-called "indirect" effect) occurs because the industry being studied uses some of its additional income to purchase inputs (goods and services) from other firms. These firms will then use some of their added income to purchase additional inputs from other firms, and so on. A regional multiplier captures how much of this flow-on spending occurs within a region, rather than through importing.

The other way in which an initial dollar has a flow-on effect is through the "induced" spending of households. When a person is hired or receives a pay increase as a result of the additional income received by an industry, the person's household does not usually save all the money. Like firms, the household makes additional purchases as a result of its increased income, creating additional income for other firms and households within the region if at least some of the purchases are local.

A potential use of input-output analysis is a simple one: By looking at the economic multipliers embedded in the model (for a state or region), one can get an idea of what *sectors* tend to generate more indirect effects by keeping more money in the regional economy. These might be the sectors to target to get the best return (in terms of local jobs and income) on public-sector investments.

Table 3-2 shows an example of employment multipliers from IMPLAN, a popular input-output model. The multipliers in Table 3-2 allow an estimate of the number of direct, indirect, and induced jobs generated by $1 million of expenditures in particular industries. Table 3-2 also shows multipliers for the total number of jobs generated by one job in the selected industries. Direct jobs refer to jobs in the industry in which the initial expenditures occur. Indirect jobs are jobs created by subsequent expenditures by affected businesses. Induced jobs refer to jobs created by subsequent expenditures of direct and indirect household income and wages.

TABLE 3-2. EXAMPLE OF IMPLAN EMPLOYMENT MULTIPLIERS FOR CONSTRUCTION INDUSTRIES, 2003

	Jobs per $ Million of Expenditures				Jobs per Direct Job	
Industry	Direct Effects	Indirect Effects	Induced Effects	Total	Type I Multiplier*	Type II Multiplier**
New Residential Structures	7.912	4.147	2.506	14.564	1.524	1.841
New Industrial and Commercial Buildings	8.806	3.604	3.372	15.782	1.409	1.792
New Utility Structures	10.834	3.757	4.045	18.636	1.347	1.720
New Highways and Streets	10.054	3.013	3.555	16.623	1.300	1.653
New Farm Structures	0.000	0.000	0.000	0.000	0.000	0.000
New Mineral Extraction Facilities	0.000	0.000	0.000	0.000	0.000	0.000
New Government Facilities	7.006	4.006	3.644	14.656	1.572	2.092
Maintenance and Repair, Residential	13.560	3.403	4.222	21.185	1.251	1.562
Maintenance and Repair, Other Facilities	17.871	2.277	5.717	25.865	1.127	1.447

Source: Minnesota IMPLAN Group, Inc. Extracted by ECONorthwest.

*Type I multipliers estimate the total number of direct and indirect jobs

** Type II multipliers estimate the total number of direct, indirect, and induced jobs.

Note: Multipliers for some industries are 0 because there are no businesses in these industries in the county used for this example.

The IMPLAN model reports multipliers for jobs, output (gross sales), wages, proprietors' income, and unearned income (rent, dividends, interest) for expenditures in every industry in every county in the United States. IMPLAN is structured to allow estimates for individual counties or groups of counties in which the expenditures and impacts will occur.

Practitioners need to employ some cautions when using input-output analysis. First, note that the multipliers in Table 3.2 are generally in the range of 1.5

If a region is to export, what counts is its ability to make products that people want more efficiently; that is, to increase productivity.

to 2.0. Yet, in the past, it has been easy to find economic evaluations that assert multipliers of 3.0 or higher, which are highly unlikely. Second, there are clearly political incentives to use multipliers: whoever wants to build a stadium, attract an electronics firm, and give tax breaks to an existing manufacturer will want to show that such public investments have big returns. Multipliers help make that case. We find multipliers not very useful technically (we accept that they are useful politically) in that context for a number of reasons:

- The real issue is usually (or should be) one of direct benefits and costs. If an industry is going to employ 1,000 people and generate a payroll of $30 million per year, that's a big deal even without multipliers.
- People understand the direct impacts better, both because they are direct and because the numbers are smaller. Instead of trumpeting "$2.5 billion of present value" (which the public cannot understand intuitively) a more understandable analysis would be: "500 new jobs at an average wage of $35,000 per year, in an industry that [an input-output model shows] has a relatively high level of exports."
- Many assumptions are made in translating a certain project into the initial benefits to one industry, and any errors in those assumptions are then magnified through the multipliers of input-output analysis.
- Multipliers generated through standard input-output software usually are based on wide industry categories and are not "fine-grained" enough to capture the linkages between more narrowly defined industries.

Despite these challenges in analyzing the results of input-output analysis, as well as the cost of doing the analysis for jurisdictions without the staff or software to do so, local and regional planners may find the input-output tool useful to illustrate cross-industry linkages, provided the skills are available to correctly run the models and interpret the results.

Limitations of Economic Base and Input-Output Analysis

Several limitations exist in relation to economic base analysis, including input-output analysis (this discussion draws significantly from O'Sullivan 2003, 138-41).

- *A focus on export orientation.* For a regional economy, some exporting is both desirable and inevitable. No metropolitan area in the U.S. produces all the goods and services its businesses and residents want. They buy from outside the region. Thus, they need to have something to trade for what they want: they need to export.

  But the relative balance of exports and imports can be affected in different ways. If a region is to export, what counts is its ability to make products that people want more efficiently; that is, to increase productivity. Increased productivity may be substantially enhanced by contributions from the service sector, not just the manufacturing sector.

  Productivity gains can lead to an improved trade balance not only through more exports but through import substitution, as more things can be created for local consumption with the same amount of inputs. Increased trade within the region can also lead to growth as specialization occurs and productivity increases.
- *Failure to explain the reasons for the composition of an economy.* This is true of the other economic overview techniques below. That is why evaluation of comparative advantages (described below) is also an important technique for analyzing a regional economy.

- *Inability to model structural changes in the economy.* Economic base analysis assumes a static, nondynamic model of the economy. It does not take into account the fact that a local economy can adapt to larger economic changes. For example, a loss of income and jobs in a traded, export-oriented sector of a local economy will probably be only temporary, until the economy adjusts to new opportunities and constraints.

  The importance of the flexibility of an economy was recognized by Wilbur Thompson, an economist, who stated: "The economic base of the larger metropolitan area is, then, the creativity of its universities and research parks, the sophistication of its engineering firms and financial institutions, the persuasiveness of its public relations and advertising agencies, the flexibility of its transportation networks and utility systems, and all of the other dimensions of infrastructure that facilitate the quick and orderly transfer from old dying bases to new growing ones" (Thompson 1968, 53).

- *Assumption of a constant wage.* The multipliers used in economic base theory and input-output analysis assume that wages will stay constant as employment is added through greater exporting. In fact, however, wages will increase as the demand for labor increases. This will moderate the growth in employment that occurs.

- *Neglect of labor supply.* Economic base theory and input-output analysis focus on the demand for labor resulting from the extent of the increases in new money in the local economy (exporting). But employment growth can occur through changes in the supply for labor. For example, infrastructure and environmental policy can attract more workers to a region, moderating wage increases and leading to more employment. Increases in demand for labor (an outward shift in the labor demand curve) and increases in the supply of labor (an outward shift in the labor supply curve) will have counteracting influences on wages. The net effect in equilibrium is unclear. More employment will certainly occur, but wages might be higher or lower than before. It depends on how desperate employers are for workers compared to how determined incoming workers are to live in an area regardless of wages.

These limitations are not fatal, but an analyst must be aware of them to use and interpret the results of the techniques properly.

Shift-share analysis is a technique used to identify regional departures from national growth rates.

Shift-Share Analysis

What: Shows how a local or regional economy has changed over time relative to a larger area and breaks that change into various components.

Why: Can show how the overall national economy, the mix of industries in a local or regional area, and intrinsic local or regional conditions affect certain industries.

Shift-share analysis is a technique used to identify regional departures from national growth rates. It can also be used to project economic activity. In explaining differentials among regions, shift-share analysis breaks down the total amount of change, whether positive or negative, as measured either by an industry's income or employment, into three components (Hoover and Giarratani 1984; Tiebout 1962).

- ***National share*** represents the influence the overall growth or decline of the national economy has on a region's industry. The national share component is computed by multiplying the national employment growth rate over a given period by the amount of income or employment in a

region for an industry at the outset of the analysis period (see sidebar for a general example and Appendix A for more detailed examples).

- ***The industrial mix effect,*** which is also known as the "proportionality shift," identifies the influence an industry's national growth rate has on a region's economy. For example, an analysis of a region's economy may disclose that a major portion of its growth is attributable to a concentration in industries growing rapidly at the national level. The industrial mix effect is computed by multiplying the income or employment of a region's industry at the outset of the analysis period by an adjusted growth rate that quantifies the difference between the industry's national growth rate and the national growth rate for the whole economy.
- ***Regional share***, also called "differential shift," reflects the fact that industries are generally expanding more (or less) rapidly in some regions than they are at the national level. An area's regional share may increase either from its gaining a large proportion of a nationally growing industry or because it contains the growing parts of a declining industry. For example, even though textile employment may be declining nationally, an area may increase its share of this employment if it becomes host to a new plant. An area which exhibits net gains (or losses) in its regional share for an industry does so because it has certain competitive advantages (or disadvantages) compared to other areas. These potential advantages are described below in this chapter.

Shift-share analysis is therefore helpful in showing whether employment growth rates in a region are the result of a change in the overall national economy, a change in the fortunes of specific industries that make up a significant share of a region's employment, or a change in the region's competitiveness with respect to various industries.

Looking at shares can also help in forecasting growth in a smaller area by using information about growth by sector in a larger area. Most states have long-run forecasts of employment by sector; few cities have such forecasts. But those cities can determine the current amount of employment they have by sector (using state employment information about employment by sector, and by subarea; see sidebar, "The Use of ES-202 Data" on the next page), and they can learn what the state forecasts anticipate the employment growth in different sectors to be. Those growth *rates* can then be applied to the *amount* of current local employment to forecast growth in employment. A local area with a preponderance of high-growth sectors will, thus, grow faster than the forecasted state average for all sectors. This method relies primarily on the industry mix effect (or proportionality shift) and assumes there is no change in the regional share (or differential shift).

Retail Market Analysis

What: Projects the amount and type of retail activity required to meet local demand.

Why: Informs business location decisions and planning decisions, such as zoning and downtown revitalization, with the aim of keeping retail spending within the community.

Retail market analysis is a way of estimating how much retail activity (and therefore how much retail building space and land zoned for retail) will be required by a community in the future. It can also identify which types of retail are likely to be most in demand or least in demand (see generally, England 2000; Barrett and Blair 1982; Lemmon 1981; Nelson 1958; Wiewel and Mier 1981; and Brossard 1993).

EXAMPLES OF SHIFT-SHARE ANALYSIS

Here is an example that uses all the growth components of a shift-share analysis:

- **National Share:** National employment grows 1 percent. All else being equal, the region's employment grows 1 percent as well.
- **Industry Mix:** The region's employment is completely based in the sock and shoe industries, which grow at 5 percent nationally. All else being equal, the region's employment grows at 5 percent—the result of the especially high growth of the sock and shoe industries.
- **Regional Share:** Employment in the region's sock and shoe industries does not grow as fast as those same industries do nationally; it grows at 4 percent instead of 5 percent. Modest overall national employment growth and a favorable industry mix are moderated by local factors that result in a decreased share for the region of national employment in the sock and shoe industries.

The overall effect is one of growth, primarily due to industry mix, partially due to national share, and *in spite of* negative local factors that decrease regional share.

There are many things that households need, and if they cannot find them locally they may travel elsewhere (or order through the Internet or catalogs) to purchase them. Retail market analysis is thus an important way for a local community to retain dollars that might otherwise have been spent elsewhere through import substitution. This may not be that important if the local community is part of a wide economic region that will "share the wealth" through the flow-on spending and hiring linkages identified through input-output analysis. But it can be very important if the local community is relatively isolated and unable to capture the benefits of any spending that leaks outside the community. Even if it is not critical for the economic well-being of that community, retail market analysis may be critical for efforts such as downtown revitalization and preservation of historic "main street" buildings.

The key variables affecting the strength of the local retail sector usually include the following (McClure 2001):

- The total amount of retail spending by residents of an area (determined primarily by the average household income and the size of the population)
- The portion of that spending that is done locally (determined primarily by the amount and type of local retail businesses)
- The quantity (square footage) of retail floor space in the area
- Local retail sales per square foot of local retail space

Data on the supply of gross and net leasable square footage of retail space are generally available through local property tax assessors. Data on the planned growth of the retail base over time can be gleaned from building permit records.

On the demand side, retail sales data, which should be adjusted for inflation, using the consumer price index or CPI, can usually be obtained from the agency that collects sales tax revenue. Unfortunately, these sales tax data provide only information on total spending within a given area, not the spending by residents of that community. Consequently, they omit expenditures local residents make outside the area and include local spending by people who live outside the area. In other words, "leakage" of local residents' retail spending to other communities cannot be estimated using these data. Similarly, the effects of local expenditures by tourists and other visitors cannot be determined. The Census Bureau's website provides historical data on sales per establishment, sales per square foot, and other factors.

In general, the steps for a retail market analysis include the following:

- Define the type of retail activity for which the analysis is being conducted; namely, define whether the activity is for an individual business or for a retail center.
- Determine the trade area (the area from which the retail center or business draws most of its customers). The analysis will identify the number of people living in the trade area and their income levels, and will estimate their expenditures for the goods and services of interest. In an area study, these goods and services consist of the entire package of consumer need, while in a site study they are limited to those carried by the particular retail outlet being considered.
- Calculate the total demand, which depends on the household size, incomes, and relevant expenditures of the people living in the trade area.

THE USE OF ES–202 DATA

Economic analysts often use state employment data referred to as ES (Employment Security) 202 data, which is derived from unemployment insurance filings required by federal law that report the number of employees by location. States publish summaries of employment by industry and county that protect the confidentiality of individual businesses as "covered" or "wage and salary" employment. Confidential employment data for more detailed analysis can be requested from state employment departments, but use of this data is typically restricted to government agencies for planning purposes, and the confidentiality of individual firms must be maintained in any published analysis of the data.

Please note that a significant proportion of employment (perhaps 10 to 20 percent, depending on the area) is not covered, including sole proprietors and many agricultural workers. Thus, the data on covered employment, though good for describing the relative composition of employment in large metropolitan areas, understimates the amount of total employment.

- Estimate the capture percentage or market penetration rate, based on an evaluation of the business or retail center relative to the competition. The expected sales volume can then be estimated by multiplying the total demand by the capture percentage. These figures must be calculated both for the present and the future to reflect changes that can be expected to take place over time.
- Calculate, given the expected sales volume, the potential size of the project based on the available data about sales per square foot for different types of stores. The analysis can be concluded by estimating the project's income and expenses and evaluating its financial feasibility (Wiewel and Mier 1981, 3).

Tracking past trends in the sales-per-square-foot ratio can show how the retail market has responded to changes in demand over time. It may reveal a number of past trends. Consider these two examples:

- Local retail sales may have increased, but the amount of retail floor space may have also increased, thus keeping the sales-per-square-foot ratio fairly constant (or even decreasing it).
- Local retail sales and local retail floor space (and hence the ratio of sales per square foot) may have all remained relatively constant. This may obscure the fact that *total* retail spending by residents increased and some "leakage" of residents' increased spending power to other communities occurred.

This type of analysis can suggest a variety of responses, depending on the situation:

- If both the total retail spending and local retail spending by residents are decreasing or stagnating, the culprit is probably slow or nonexistent growth in household income growth or population growth, suggesting that better employment opportunities or a population increase could remedy problems.
- If total retail spending by residents is increasing, but *local* retail spending is decreasing or stagnating, there is "leakage." Strategies to reduce leakage depend on whether the problem is one of undersupply of retail space or one of decreasing competitiveness of local retail space. If the sales-per-square-foot ratio has remained constant, local space is competitive but there needs to be more of it. If the sales-per-square-foot ratio has decreased, local retail needs to increase its competitiveness (by changing, for example, the product mix, the shopping environment, the location within the community, etc.).
- If local retail spending is increasing but sales per square foot are decreasing to unsustainable levels, an oversupply of retail space exists and no efforts should be made to provide additional retail space to meet current demand.

To convert these past trends and current conditions into estimates of future retail activity, assumptions must be made about likely changes. Changes could occur to future demand (based on expected income and population growth, as well as changing consumer preferences), future supply (based in part on development "in-the-pipeline" as well as the supply of readily available and serviced retail land), and public policy that might affect land supply or relevant infrastructure like parking and transportation.

EXAMPLE CALCULATIONS FOR RETAIL MARKET ANALYSIS

A retail market analysis is to be conducted to determine whether to expand an existing 4,800-square-foot supermarket. Enough land is available on the site to build a 15,000-square-foot supermarket with 38 on-site parking spaces.

The existing store draws most of its customers for an area of approximately three blocks in all directions. The trade area for the expanded store is estimated to extend approximately eight blocks in three directions; on the fourth side, a 17-acre park, four blocks away, forms a natural barrier.

Population data show that the number of households in the projected trade area is 12,546. The median household income is $30,000. At that income level, the expenditure in grocery stores is approximately 20 percent of income, or $6,000 per household. The total demand in the area for grocery store products is therefore 12,546 households multiplied by $6,000 per household or $75,276,000.

The competition in and immediately surrounding the trade area is considerable. A new store is estimated to be able to achieve a capture rate of about 16 percent. This yields an expected sales volume of 0.16 times $75,276,000 or $12,044,160.

Because grocery stores have an average $528 of sales per square foot, the store could have a potential size of $12,044,160 divided by $528 per square foot, or 22,811 square feet. As a result of these findings, the store owner begins talking with lending institutions, and hires a consultant to perform a full-scale study.

Source: Wiewel and Mier 1981, p. 3

Market-Share Analysis

What: Shows how an area's share of a larger area's business activity is changing over time.

Why: Provides context for deciding on target sectors and policies.

Market-share analysis is related to some of the other techniques above, such as retail market analysis, but it can be applied to office and industrial activity as well as retail. The idea is to define a market within which a local economy is competing and to then identify the share of that market the local economy is capturing. Changes in the area's market over time are especially important in quantifying changes in a local economy's competitiveness.

The first challenge is identifying the market. The market of competition for a local economy will vary, depending on the good or service considered. For example, most retail activities compete only within their metropolitan region, while manufacturing and some specialized service firms can compete in national or even international markets.

Once the market area has been identified, the next step is to gather data to provide a measurement of the local economy's share of that market. Sales or receipts are the most common factor measured (unlike location quotients and other techniques that usually focus on employment). Data sources include the U.S. Census Bureau's Census of Retail Trade, conducted every five years.

In comparison with location quotients, which measure the relative concentration of a local economy in one industry vis-à-vis all industries, market share looks at only one industry at a time. Market-share analysis might reveal that a local economy captures 20 percent of the retail sales in its metropolitan region, while location quotients would compare that retail share to the local share in all business sectors.

An evaluation of comparative advantages (and disadvantages) is essential to get at the reasons for a city's or region's economic situation, and to identify opportunities and constraints for future economic development.

EVALUATIONS OF COMPARATIVE ADVANTAGES

The techniques above provide an overview of the composition of a local economy—they do not explain why a locality has that makeup, or its strengths and weaknesses that have implications for future economic growth. An evaluation of comparative advantages (and disadvantages) is essential to get at the reasons for a city's or region's economic situation, and to identify opportunities and constraints for future economic development.

The production factors described in Chapter 2 are important for this evaluation. To the extent that a city or region can supply these and other factors in relatively ample amounts, high quality, and low prices, it has a *comparative advantage* (O'Sullivan 2003, 20-22).

In contrast to the quantitative economic overview techniques described above, the evaluation of comparative advantages is often qualitative. It does not usually yield numbers that can be applied to the current economy to predict future conditions. It does, however, highlight factors that may influence the future—positive factors that economic development efforts may seek to enhance, or negative factors that economic development efforts may seek to mitigate or reverse.

To analyze comparative advantages, cities or regions have to be chosen for comparison. Because the goal is to isolate a city or region's strengths and weaknesses relative to places that could logically be seen as competitors, it is important to choose cities or regions comparable in size, location, or market influence.

This section provides some information on the ways in which this evaluation of comparative advantages can be done. What this section *does not do* is analyze the relative importance of each factor. For some businesses, for

example, labor market characteristics are more important than factors like land supply or infrastructure.

The factors on which comparative advantage can be evaluated are the same factors listed in Chapter 2, in the same order.

Natural Resources and Supplies

As transportation costs have declined, fewer firms need to locate close to the source of their raw materials. Therefore, whether the natural resources and supplies are immediately available is not as important as how easily they can be brought in from elsewhere. This is a function of location relative to supplies and of the quality of infrastructure that brings supplies to a business (primarily transportation). Both these factors are described below.

Infrastructure constraints include streets not up to urban standards, high levels of traffic congestion on nearby arterial streets, and inadequate sewer, water, power, or telecommunication systems.

Building and Land Supply and Markets

Economic activity requires built space. Built space requires land with basic and, often, extended public services. Land provides the physical foundation upon which buildings are constructed and the production process occurs. Demand for land derives from a demand for built space. A large inventory of vacant office space, for example, substitutes for the need to build new space and, other things being equal, reduces the demand for land.

Demand for land depends on the type of firm. For example, manufacturing firms need more space and tend to prefer suburban locations where land is relatively less expensive and less difficult to develop. Warehousing and distribution firms usually need to locate close to interstate highways. Service firms often need to locate centrally in a region to be close to their client base.

To determine whether a city or region has a comparative advantage in land supply and markets, it is necessary to consider all the following:

- The supply of vacant, unconstrained land
- The potential for infill and redevelopment
- The amount of demand for land
- Characteristics of the land supply (including price and specific site characteristics) (Landis 2001)

Vacant land and relevant constraints. To identify vacant land, a local jurisdiction can use county assessor parcel maps, aerial photos (if available), or direct field analysis. Comprehensive plan and zoning maps are also useful to show what land can be used for.

Vacant land is not useful for development if it cannot be economically used because of one or more constraints. Development constraints can affect the timing of private investment on a site and can even preclude development activity for many years. There are three primary types of development constraints (Hall 2001):

1. *Lack of urban services and infrastructure*. Infrastructure constraints include streets not up to urban standards, high levels of traffic congestion on nearby arterial streets, and inadequate sewer, water, power, or telecommunication systems. These constraints are not specific to individual properties, but to the area as a whole, and they can be remedied by capital investment.

2. *Environmental issues and land-use regulations*:

- Natural geologic hazards (e.g., seismic instability)
- Steep topography
- Wetlands, floodplains, and riparian buffer setbacks
- The presence of hazardous waste materials

- Regulations limiting the type, location, and extent of development that can occur (e.g., marine and aviation use restrictions)

  Some of these barriers are absolute, especially if they are backed by public policy prohibitions on development (e.g., a prohibition on development within wetlands or a 100-year floodplain). Others are not absolute barriers—they can be addressed by design and construction techniques—but they may raise costs to uneconomic levels (e.g., a multi-million-dollar environmental cleanup of a contaminated brownfields site or expensive cut-and-fill earthworks to create a reasonably flat building site on steep terrain).

3. *Unwilling sellers.* Land may be buildable and suitable for development, but not readily available because of land banking or speculation by existing property owners. For example, some firms may be holding onto large parcels of undeveloped land adjacent to their existing operations to provide a location for future expansion. Property owners may also be holding onto land as a speculative investment, waiting to sell until they receive the price they expect the market will bring at some future point. Properties with unwilling sellers may be counted in the long-term land supply, but they should not necessarily be included in the short-term land supply because they may not be currently available for sale. The smaller the land area in the local economy, the more of a problem this is: a 50-acre property being withheld from development is a more significant barrier in a small town with few large developable, serviced sites than in a large metropolitan region with several available sites.

Identification of development constraints occurs through evaluation of existing data (e.g., planning or assessment data sets, including GIS data), aerial photo interpretation, or field work.

Potential for infill and redevelopment. The next step is to identify parcels with infill and redevelopment potential. Some land parcels may be only partially vacant, but the vacant portion of the parcel may be able to support significant new economic activity through infill. Land parcels that are not vacant at all may have redevelopment potential if buildings can be reused or replaced to support a higher level of economic activity. This is particularly likely if the current use of the site is outmoded given current market conditions (Moudon 2001).

Redevelopment opportunities, such as opportunities for the reuse of a vacant manufacturing site, are often unique to a particular jurisdiction. The basic method relies on local knowledge to make these assessments. Interviews with realtors and developers can be helpful.

In addition, some quantitative rules-of-thumb can be applied. On the supply side, they often rely on the calculation of the ratio between improvement value and land value. The lower the ratio, the higher the likelihood of redevelopment will be (all else being equal). Since land values reflect the hypothetical value of the "highest and best use" of the land, a low-value improvement (e.g., old and abandoned storage space) will generate a lower improvement-to-land ratio (and thus a higher likelihood of redevelopment) if it is located in a high-demand area (e.g., a central business district) than if it is in an undesirable location unsuitable for business or large-scale residential activity. There is no absolute cutoff point for this ratio beyond which redevelopment is possible or impossible, but a typical rule of thumb is a ratio of 1.0: when the improvement value is no greater than the land value, redevelopment starts to look feasible.

Also on the supply side, the presence of large areas of vacant land within one particular tax lot may be an indication of redevelopment potential. For

example, a 20-acre parcel may have a multimillion-dollar home on it. The improvement-to-land value would probably be high because of the value of the home. Still, the homeowner may not feel the need for more than five acres surrounding the house and may therefore sell the other 15 acres for development. While this is technically "infill" or "redevelopment" because it is taking place on what was originally one tax parcel, it is really more similar to the development of vacant land. Some planning agencies recognize this and divide large parcels of land into vacant and nonvacant sections for their analysis, rather than categorizing an entire large parcel as "developed" because of the existence of one building.

Estimating land demand involves converting projected population and employment growth into demand for vacant or redevelopable land.

Redevelopment and infill potential can also be estimated from a demand-side perspective rather than from a supply-side perspective. Using actual data on the use of land and buildings by firms, Portland's regional planning agency, Metro, estimated the percentage of new employment accommodated on "developed" sites as opposed to on vacant sites. What Metro calls "refill" includes various more intensive uses of a site, including more employees per square foot of building space, more building space per square foot of land, and the move from an eight-hour work day to a longer day with multiple shifts. It is likely that refill (redevelopment and infill) could accommodate anywhere between 15 percent and 50 percent of job growth, depending on many factors, including the type of business and the initial vacancy rates in existing buildings.

Land supply compared to demand. Estimating land demand involves converting projected population and employment growth into demand for vacant or redevelopable land. Population and employment forecasts can be done based on historic trends in population, age, income, and employment, as well as public policy considerations like tax policy. These forecasts can more simply be obtained from state or regional agencies that produce them (Waddell and Moore 2001).

Forecasted employment or population can be converted to land demand by making assumptions about the amount of space each new job or each new household requires (employment density or population density), and then making assumptions about how much building space can be provided on a certain amount of land (based on planning and zoning regulations, such as maximum floor-to-area ratio or "FAR"). For example, if 1,000 employees each require 800 square feet of building space, they will require a total of 800,000 square feet of building space. If an FAR of 0.5 is expected under current zoning regulations, that 800,000 square feet of building space will require 1.6 million square feet (36.7 acres) of land.

The land demand can then be compared with buildable land supply, to see if the amount of land available is adequate for the projected growth. Where possible, this comparison should be categorized by type of land (industrial, commercial, residential, recreational, etc.).

Land price and other land characteristics. The price of land is an important factor for businesses and the jurisdictions trying to attract them. If land is not affordable, the amount of land available doesn't really matter. Generally, though, land markets operate to find the equilibrium for demand and supply—for price and quantity. The more land available, the more affordable it is. Regions with very few unconstrained vacant parcels of land will tend to have higher land prices than regions with large tracts of vacant, serviced land.

Some businesses are more sensitive to land price than others; land-intensive firms (e.g., large, single-story manufacturing plants or businesses that need space for indoor or outdoor storage of supplies and equipment) will be the most sensitive to land price differentials.

Other characteristics of land can be very important. In general, sites that are readily available, readily served by roads and infrastructure, pre-approved for specific uses, competitively priced, and actively marketed by public or private sectors are the most competitive.

Buildings are also very important. In general, a range of building types appropriate to the mix of potential tenants is desirable. The existence of historic buildings in a central location is often a plus in attracting creative firms, while high-amenity office space ready for move-in is a plus in attracting service firms.

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The Labor Market

The availability, quality, and cost of labor are all important to businesses. Cities and regions that have a large labor pool are more attractive than those with a small labor pool, all else being equal. Productivity can decrease if certain types of labor are in short supply. A shortage of appropriate workers decreases productivity by requiring more pay to acquire the labor that is available, the recruiting of labor from other areas, or the use of the less-suited local labor (O'Sullivan 2003, 76-79; Galambos and Shreiber 1978, ch. 3; McLean and Voytek 1992, ch. 6).

Quality, as reflected in the education and skills of the labor market, is a critical factor. Cities or regions with a labor force that has the required skills or that can attain the required skills through accessible education and training programs are more attractive than cities or regions with few educational opportunities and a labor force that is poorly educated or mismatched with the needs of businesses.

As with land and infrastructure, the cost of labor is important to businesses. Rural regions where the costs of housing and other household needs are low often have lower wages as a consequence, and these rural regions can be seen as competitive by businesses looking for low-cost labor. Businesses most sensitive to the price of labor are labor intensive (e.g., some types of nonautomated manufacturing, or services, such as call centers, as opposed to most retail firms). For nearly all businesses, however, the skills and other qualities of the potential employees are at least as important as labor cost.

If the skills of the current workforce do not match those required for the growing, high-wage occupations that an area wants to attract, workforce training efforts will be critical.

Because employers are concerned about the quality of employees, they may be willing to pay increasingly higher wages for increasingly skilled workers. The more a region is able to attract employers on the basis of highly skilled workers, as well as high quality of life, good value-for-money public services, efficient regulations, and well-supported business clusters, the less pressure for a region to have a "low-cost" workforce.

The labor force of a local economy can be analyzed in a number of ways. One is to examine the distribution of educational backgrounds in the workforce, as reported in the decennial U.S. Census. Another is to look at the distribution of occupations among local workers from both the decennial Census and the U.S. Department of Labor's Bureau of Labor Statistics. Information on average wages can be garnered from "covered employment" data from state employment departments or from the BLS website.

The next step is to compare the characteristics of the current workforce with the opportunities likely to arise in the future. The BLS publishes an *Occupational Outlook Handbook* every two years, as well as a quarterly report, providing insight into what occupations are expected to grow and shrink nationally over the upcoming years. The BLS and many state employment departments also provide information on the skills and training required for an occupation. If the skills of the current workforce do not match those required for the growing, high-wage occupations that an area wants to attract, workforce training efforts will be critical.

Location Relative to Supplies and Markets

Where a city or region is placed with respect to supplies (including natural resources and labor) and markets is very important (McLean and Voytek 1992, ch. 7). To measure a city or region's comparative advantage, analysts can use techniques such as analyzing the amount of population within a 100-mile radius. These simple measures of "market area" illuminate differences between regions surrounded by vast rural areas (e.g., Salt Lake City) and regions surrounded by other urban regions (e.g., New York City). It is not just distance but ease of access to supplies and markets that is important. The distance to a key market may be short "as the crow flies," but the actual distance traveled via roads may be greater. Travel times are also a consideration. Because of this, transportation (described below) is often as important a factor as the location itself (O'Sullivan 2003, 66-70).

As pointed out in Chapter 2, some industries are more sensitive to location relative to supplies and markets than others—particularly those with heavy and/or bulky shipments, or the need for frequent face-to-face contact with customers. For many other types of firms, improvements in transportation infrastructure and telecommunications have lessened the importance of location. High-speed communication technology, passenger airline service, and express freight shipping have allowed firms, particularly those in the service, software, and high-technology manufacturing sectors, to locate away from supplies and markets. This is partially counteracted by the importance of "just-in-time" delivery of inputs into modern production processes, and customers' increasing expectation that they will receive what they buy in swift fashion.

Infrastructure and Utilities

Different places have different infrastructure capacities, including roads and other transportation infrastructure, sewer, water, electricity, and telecommunications. The more a local jurisdiction can provide businesses with public or private infrastructure that meets their needs cost-effectively, the more competitive that local jurisdiction will be (O'Sullivan 2003, 39-58).

Transportation remains very important in bridging the gap between local businesses and their supplying and receiving markets. The availability of a variety of modes of transportation (air, rail, road, water) and the quality, frequency, and price of these modes are important factors in evaluating comparative advantage. Sewer and water infrastructure also remains important in providing inputs and dealing with byproducts of the production process.

As the "information age" has arrived, the availability of fiber optic and other high-capacity telecommunications systems is growing in importance. Telecommunications provide the information that is a direct input to the production process, and which is sometimes the product itself (in the case of service firms that can transmit their product electronically).

Cost-effectiveness is key. Businesses may not be willing to pay for "gold-plated" infrastructure that exceeds their needs, and they may also not be willing to pay for infrastructure they perceive as being a poor value in relation to the high taxes or fees charged.

At the same time, low taxes alone are not sufficient. While businesses prefer localities that offer low tax rates, they will be less likely to choose an area if low taxes are reflected in poorly maintained infrastructure and a substandard communications network. The perceived value when comparing tax rates (costs) and quality infrastructure (services) is a key element of a location's competitiveness.

Business Clusters

Some types of firms tend to locate in areas where there is already a concentration of firms like their own, thus forming a "cluster." Joseph Cortright

(2006) says clusters are the key organizational unit for understanding and improving the performance of regional economies.

Firms form clusters for several reasons.

- They have access to a large pool of appropriately skilled labor if they congregate in the same location as similar existing firms.
- They can realize operational cost savings by using suppliers and other service providers that have located in the area to serve the cluster. Transportation and communication costs are often lower when the firms that need to interact are close to one another.
- They can benefit from the interchange of ideas that occurs, formally or informally, through proximity. Competition with other firms in a cluster can also promote innovation and creativity.

Joseph Cortright (2006) says clusters are the key organizational unit for understanding and improving the performance of regional economies.

These cluster factors work similarly to "economies of scale" within a firm, and they improve the odds of attracting similar firms in the future (O'Sullivan 2003, 39-58).

The benefits of clustering vary across industries. Manufacturing and other "traded-sector" industries generally benefit from clustering. Services competing for a fixed amount of business in an area might see the benefits of clustering overwhelmed by the negative effects of saturating a local market. As pointed out in Chapter 2, examples of regional industrial clusters in the U.S. include the high-technology "Silicon Valley" in California and the bioscience sector in the Salt Lake City region.

In terms of comparative advantage, cities or regions with concentrations of firms in industries are generally more attractive to other firms in those industries because they offer the economies of scale that can lead to cost savings for businesses. That concentration also advertises very clearly that the region possesses the factors of production necessary for the success of businesses in that cluster. Cortright (2006) highlights the need to build on the unique strengths of regions, rather than trying to replicate other region's clusters, and the benefits of creating an environment for new clusters to emerge rather than trying to "pick winners."

Quantitative techniques (e.g., location quotients) can point to the existence or lack of clusters in certain industries. Input-output analysis can also show the extent to which firms in a region are interconnected by trade, possibly indicating clusters. Past and projected employment growth rates are useful in showing whether a cluster is one with future potential or one on its way out. Finally, qualitative analysis, such as interviews and focus groups, can provide insight into the extent of formal and informal linkages and support between firms in a potential cluster. Cortright (2006) points out the importance of engaging in dialogue with cluster members to identify a cluster's strengths and needs. The value of "cluster thinking" is that it orients policymakers and practitioners towards working with groups of firms on their common issues rather than working with individual firms in a diffuse, uncoordinated manner.

Amenity and Other Quality-of-Life Factors

A city or region that features many amenities and quality-of-life factors, such as good weather, recreational opportunities, a diverse and exciting culture, low crime, good schools, and a clean environment, attracts people simply because it is a nice place to be. A place's amenities attract skilled workers, who are often willing to accept a lower wage in exchange for the "second paycheck" of a relatively high quality of life.

These broad dimensions of quality of life are determined in part by: factors outside the control of cities and regions (e.g., climate); factors outside of the

control of government (e.g., cultural opportunities); and factors government can influence (e.g., public services). These public services (e.g., education, public safety, parks and open space, and environmental management) are all key factors for employees and firms seeking a location (Segedy 1997).

Housing Costs

Affordable housing policies are an important economic development tool as well as a route to social inclusion.

Housing opportunities are also important to workers. If a range of housing types is available at a range of prices affordable to various workers, a local jurisdiction will have an easier time attracting workers and thus attracting firms. This is an especially critical issue in regions such as the northeast U.S. and the San Francisco Bay area, where rising housing costs have made it increasingly difficult to expand the economy because of a lack of affordable housing for workers. Housing costs have increased in these areas due not only to the desirability of the location, but also to supply-side constraints on the availability of land (e.g., topography, traffic congestion, and restrictive local government regulations). The existence of large-lot or "snob zoning" in local communities, for example, can discourage economic growth at the same time it preserves amenity (green space, uncongested streets, etc.) for existing residents.

In short, affordable housing policies are an important economic development tool as well as a route to social inclusion.

Government Policies

In addition to directly providing infrastructure and support services, government plays an important role through its policies. Public policy can affect factors that are important to businesses, primarily through regulation, taxes, and incentives (Cohen 2000; Buss 2001; Peters and Fisher 2004).

- **Regulation.** Regulations protect the health and safety of a community and help maintain the quality of life. However, simplified bureaucracies and straightforward regulations can help firms react quickly in a competitive marketplace. Predictability is usually more appreciated by business than a lax regulatory system.
- **Taxes**. Firms tend to seek locations where they can optimize their after-tax profits. But tax rates are not a primary location factor; they usually matter only after corporations have made decisions on labor, transportation, raw materials, and capital costs. Once a firm has selected a region and is looking for a location within that region, differences in tax levels across communities are more important because the other production factors within the region are likely to be similar across communities.
- **Financial incentives**. Governments sometimes offer incentives to businesses to encourage growth. Generally, economic research has shown that most types of incentives have had little significant effect on firm location between regions. For manufacturing industries with significant equipment costs, however, property or investment tax credits or abatement incentives can play a significant role in location decisions. Like low taxes, incentives are more effective at redirecting growth within a region than at providing a competitive advantage between regions.

To evaluate the comparative advantages a local economy has with respect to government policies and incentives, consider whether government is using the tools above to create a climate for business that is welcoming and supportive but which is also financially and environmentally sustainable. A city with low taxes and an array of financial incentives does not necessarily have an advantage over a city with higher taxes and no financial incentives if it does not provide the infrastructure and services businesses

need to thrive. All else being equal, however, a business will appreciate a location where it is not overburdened by taxes and where some assistance is offered. More important than financial assistance is probably the assistance a government can provide by ensuring that its regulatory system is logical, straightforward, and predictable, as well as any assistance government can offer in negotiating the regulatory process.

A city with low taxes and an array of financial incentives does not necessarily have an advantage over a city with higher taxes and no financial incentives if it does not provide the infrastructure and services businesses need to thrive.

COMPETITIVE EVALUATION

Appendix C contains a competitive evaluation checklist to help a local government assess its strengths and weaknesses in engaging in economic development. The checklist is organized, as is the discussion in Chapter 2, into factors that directly and indirectly affect inputs. In the category of directly affecting inputs are land and buildings, labor, and natural resources, as well as location relative to supplies and markets, and infrastructure and utilities. In the category of indirectly affecting inputs are amenities and quality-of-life factors, governmental policies and regulations, and organization for economic development.

An automated version of the checklist, in a Microsoft Excel spreadsheet, is available at www.envisionutah.org/plans.phtml?type=toolboxes under:

Local Government Economic Development Toolboxes

Filename: Community Readiness Survey (Interactive Excel Sheet).xls

CHAPTER 4

Selecting and Implementing Local Economic Development Strategies

Chapters 2 and 3 described how economic development may be defined and what tools are available for analyzing local and regional economies. With these as a backdrop, this chapter describes how local governments can select economic development strategies that work.

AN ECONOMIC DEVELOPMENT VISION

A standard planning process starts with goals (values, principles, a vision) and then looks at actions (strategies, policies, investments, initiatives) that seem to increase the odds of achieving that vision and do so in an affordable and cost-effective way. An *economic vision* is the formal expression of what the local government and its citizens want to be at some point in the future. Visioning processes frequently use public or town meetings, focus groups, questionnaires, newsletters, and computers to engage citizens in identifying problems and opportunities facing their community, and to depict a formal expression of what citizens want their community to be. Two good resources about the visioning process are Woodmansee (1994) and Ames (1992). Specifically, the economic vision is the opening statement and objective of an *economic development strategy*: a list of actions a local jurisdiction will take to achieve its economic vision.

There are many possible economic futures for any given jurisdiction; there are some impossible ones as well. The challenge is to decide on a future that is not only desirable, but also possible given the factors that constrain it.

There are many possible economic futures for any given jurisdiction; there are some impossible ones as well. The challenge is to decide on a future that is not only desirable, but also possible given the factors that constrain it. Thus, a vision for the future economy of any jurisdiction should meet four important criteria:

1. *Balance what the jurisdiction would like to achieve with what resources and public support the jurisdiction can realistically expect to muster in support of that vision*. For example, if the vision involves large expenditures for public infrastructure, such as water and sewer, the local government must be willing to find a way of paying for that.
2. *Be consistent with the role of the jurisdiction's economy in the larger regional and state economies*. Regional employment patterns influence the direction the local government can take, although it may find a way to carve a special niche, such as tourism or entertainment, that departs from the dominance of regional trends. Thus, understanding the dynamics of the regional and state economies is important.
3. *Be understandable to citizens without technical training or experience with economic development*. Despite the emphasis on the desirability of technical studies and analyses to underpin strategy, what a local government proposes as its vision should be clearly written and easy to comprehend.
4. *Be produced in a way that makes it possible to incorporate it in the jurisdiction's comprehensive plan*. The economic development strategy must be integrated with other actions affecting land use, transportation, community facilities, and environmental quality. Thus, some actions may take the form of land-use measures, while others may take the form of proposals for infrastructure improvements.

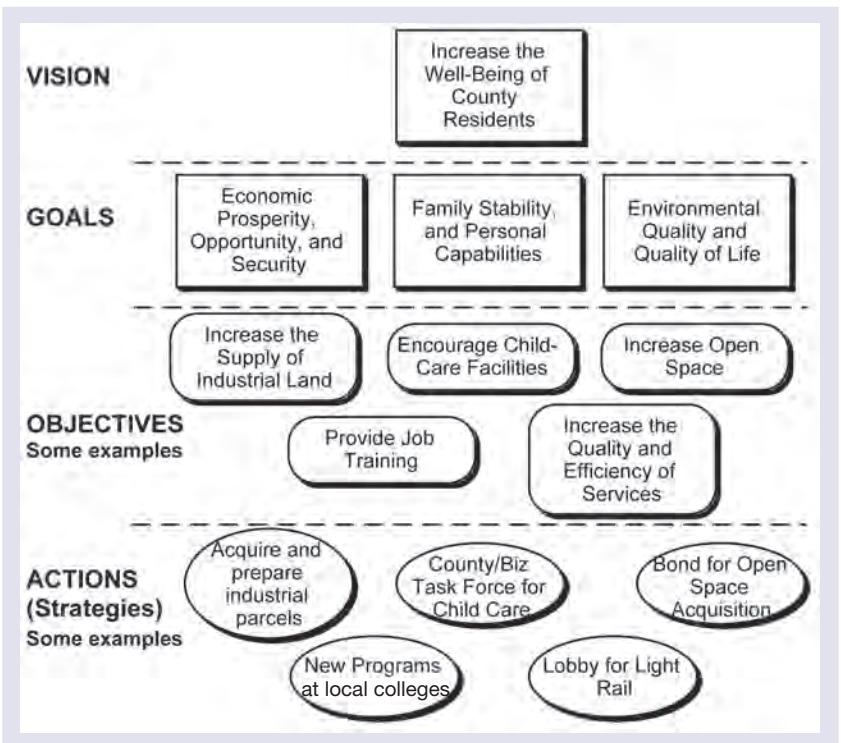
A visioning process yields the statement of what the local government hopes to become. The technical analyses describe in Chapter 3 help: (1) set a context for the visioning process (by putting some realistic boundaries for the vision statement); and (2) determine which actions will most effectively move a jurisdiction toward its vision. Here are some examples of how the analyses will help create the economic development strategy:

- The local government believes it needs new businesses and industry to support residential growth. It wants to diversify the tax base to make it more resilient to changes in the national economy. It also wants to ensure that local residents can have their daily needs met by businesses in the community. To determine the level of diversification in local employment and whether residents are going elsewhere for their daily shopping needs, the government conducts a detailed economic base analysis. It also

conducts a retail market analysis to determine how much local buying power is being captured by local businesses and whether additional retail opportunities exist.

- The local government hopes to capitalize on its inherent location- and resource-based strengths. It wants to determine which one of its local industries has grown because of certain competitive advantages in the regional economy. It uses shift-share analysis to analyze changes in the regional economy at several points in time. The critical factor, of course, is the regional share of employment growth. If trends in the regional share of employment growth are positive, and consistently so, factors in the regional economy are probably at work and causing that growth. The local government then decides to further investigate the requirements and characteristics of growing industries because of positive changes in the regional share. This analysis will help refine its vision and corresponding strategies.
- A new employer says it is difficult to attract employees with the required skills to high-technology businesses. This may be the first time the local government has heard this complaint, but it is concerned this might be the harbinger of a trend. It decides to survey local firms regarding their future employment and training needs. In addition, it commissions a formal analysis of the local labor market to determine whether the supply of certain types of workers is sufficient to meet demand. It may decide that, as part of its vision, it needs to work more closely with local schools and universities to make sure they have or are developing curricula and programs to produce the skills and knowledge the labor market needs, as indicated by the analysis of trends. It may also decide that the community lacks the cultural and lifestyle amenities prospective employees are seeking.

FIGURE 4-1. EXAMPLE OF TRANSLATING VISIONS TO ACTIONS



Source: ECONorthwest, Clackamas County Economic Development Strategy

WASHINGTON COUNTY, UTAH'S "CORE VALUES"

These "core values" arise from the vision statement in Washington County's 2003 strategic plan for economic development.

Expanding diversified economy with increasing wages: We encourage a diverse mix of growth from both existing value-added businesses as well as those we recruit that will provide high-quality career opportunities for our citizens and their children, and that will increase wages and income, enabling our citizens to improve their standard of living.

Advanced quality of education: We value quality education for our youth and life-long learners, which includes the technical advanced skill courses necessary for our work force and employers. We seek to deliver this education through neighborhood schools, Dixie Applied Technology Center, and increasing four-year offerings at Dixie State College.

Essential services and infrastructure: We are committed to ensuring the availability of services that are essential to sustain our growth and business development. This includes, but is not limited to, improving airport services, enhancing traffic flow, increasing telecommunications capability, and maintaining adequate supplies of water, sewer, electrical power, and natural gas.

Cooperation among communities and the region: We value a spirit of cooperation and coordination between all cities within the county, region, and state to resolve issues of common concern, and recognize the need to work together to promote the economic development of the region.

Maintain quality of life: Any economic development must maintain our traditional quality of life, which consists of quiet neighborhoods, supports and cultivates the arts and culture, and encourages affordable housing, especially for young families.

Stewardship of our natural beauty and preservation of open space: All economic development must be consistent with the stewardship we have over the natural scenic beauty that is an inherent part of our environment and natural surroundings. In doing so, we seek only those economic business opportunities that will enhance our natural environment and preserve the quality of our air and water. We maintain the amount of county land under private ownership by balancing public and private land development with the active preservation of targeted lands for open spaces.

- A local government decides it wants to increase tourism and has come up with two ambitious programs of capital investment: one involving a sports stadium and a second involving a new multipurpose performance center. Which approach will have the most beneficial impact on the local economy, given the cost? It commissions an economic benefit-cost analysis, an input-output analysis, and a fiscal analysis of the two alternatives to help government leaders understand the impacts of each on the local economy.

General goals for growth, development, and livability are very similar across jurisdictions. The sidebar shows typical high-level goal statements. Figure 4-1 shows a typical example of how broad goals get increasingly more detailed, ultimately leading to specific short-run actions or strategies. And the sidebar shows an example of an economic vision statement from Washington County, Utah.

POTENTIAL STRATEGIES

A strategy is a "collection of actions and activities that help achieve a predetermined goal" (Blakely and Bradshaw 2002, 167). This section describes some potential strategies local governments can use, either alone or with other institutions, to carry out their economic development vision. Such strategies are not neutral in terms of economic, political, or social consequences: Some communities accept low-wage jobs others shun; some jurisdictions place a high priority on maintaining the natural beauty of the environment and impose the costs of maintaining those standards on new development; and yet others give incentives to attract that same development. Elected officials shape the economic direction of the community by actively pursuing strategies to retain, attract, or create jobs, or by imposing regulations that enhance quality of life by requiring private and public spending (which may have different impacts on economic development in the short and long run). Development choices—even a do-nothing strategy is a choice—will influence the long-term economic health of a community (Koven and Lyons 2003, xiii).

We organize our discussion of economic development strategies into the following categories:

1. Coordinate economic development programs and support services
2. Business development
3. Development incentives and financing
4. Business attraction and retention
5. Workforce education and training
6. Land supply
7. Infrastructure
8. Quality of life conducive to business innovation

These categories are comprehensive: they are capable of covering everything that we have ever seen addressed in an economic

development plan. But each plan seems to have its own variations on the organization. The logic of the one we propose is:

A. *First, make sure whatever it is you are doing now is coordinated.* In other words, make sure that your current policies are not inadvertently stifling economic development without creating offsetting benefits.

Then simultaneously…

B. *Do the things that economic development agencies typically focus on:*

- Business development (helping existing firms grow)
- Retaining and attracting businesses
- Incentives and financing (a key tool for retaining, attracting, creating, and growing local businesses)
- Workforce education and training (since labor is on the order of half of the costs of doing business on average, and as much as 85 percent of the costs for some firms).

C. *Look at all those things that some other government agency or department is probably in charge of, but that has a big impact on economic growth*:

- Land
- Infrastructure
- Aspects of quality of life (urban amenity and environmental protection).

Each section that follows describes the strategy and its subsets, and assesses the strategy's strengths and weaknesses.

STRATEGY 1. COORDINATION OF ECONOMIC DEVELOPMENT PROGRAMS AND SUPPORT SERVICES

Method 1.1: Intraregional Coordination

Intraregional coordination, which works at the very broadest level of coordination, is the effort to avoid competition among communities in a region. There are various degrees of intraregional coordination. At one end of the spectrum is the establishment of a formal organization to perform an economic development planning, financing, recruitment, and retention function. At the other end is informal coordination that entails the jurisdictions within the region talking to each other on a regular basis or on an ad-hoc, as-needed basis for specific issues.

One component of intraregional coordination would be pooling resources to attract companies to the region.

One component of intraregional coordination would be pooling resources to attract companies to the region. This could occur in an informal setting as well as through a formal organization. Providing funding for transportation infrastructure (e.g., light rail or airports) or participating in regional industrial land studies are examples of this. The motivating factor for this coordination is the recognition that job creation and retention have economic effects that spill over city boundaries. If a company comes to a central city, for example, workers from nearby suburbs can benefit by commuting to those jobs. Businesses in the entire region would benefit from all workers spending some of their money in their home city or nearby, and from the new business making some of its purchases within the region.

At some point, though, the firm has to decide on a city or county within the region, and jurisdictions realize that, despite the spillover economic effects, the city where the firm locates receives the added benefit of property tax revenue. Regional tax-base sharing can be used to:

- mitigate the potential intraregional competition in the quest for more property tax revenue;

- reduce disparities in fiscal capacity—per capita property valuation—among local units of government (which often results by chance of geographic location); and
- provide needed revenues at different points in a community's life cycle.

Intraregional coordination can protect public revenue from being used for unnecessary financial incentives that would otherwise only affect the choice of location within the region.

In 1971, the Minnesota legislature created a tax-base sharing program to allocate 40 percent of the growth in the commercial and industrial property valuation in the seven-county Twin Cities area to a regional pool that is taxed at a weighted areawide rate. Funds from this areawide pool are distributed via an allocation formula, taking into account a local government's population and fiscal capacity. The effect of this program in the Twin Cities area has been to reduce tax-base disparities on a regional level from 50:1 (the relationship between the wealthiest and least wealthy communities in terms of per capita valuation) to 12:1. One of the coauthors of this PAS Report has overseen the drafting of a model regional tax-base sharing statute that uses the Twin Cities legislation as a basis (Meck 2002, 14-4 to 14-25). He also discusses tax-base sharing systems in other regions in that same work.

For an intraregional coordination strategy to be effective, a region's influential leaders must champion intraregional cooperation. A city's elected officials could take such a role, but for the strategy to have the greatest impact it would need similar action by officials in other cities, as well as community support among the voters. Organizations like a local development corporation could play the role of an advocate, bringing the issue into the public debate, where it could find an influential champion.

Assessment. Intraregional coordination is potentially very effective because it uses resources towards a shared goal. Resources are not used to draw firms from one city in the region to another, but from another part of the country to the region. In particular, it can make a stronger impression on potential businesses outside the region, especially important when the region sees itself as competing with other regions in the U.S. and indeed the world.

Intraregional coordination can protect public revenue from being used for unnecessary financial incentives that would otherwise only affect the choice of location *within the region*. By protecting public revenue, it allows for the provision of key public services (e.g., education and parks) important for economic and community development. Tax-base sharing, in addition to reducing the incentives for intraregional competition, can directly reduce some of the inequities in public funding for key services in a region.

Method 1.2: Economic Development Institutions (Organizational Alternatives)

The location of the economic development function in a local government sends an important signal to existing and potential businesses as well as the local government's operating departments. For small local governments, it is common to find an **economic development coordinator** who works for the government's chief executive officer in a staff capacity. In some cases, the economic development coordinator may not work directly for the chief executive officer but will be a staff person in a line department (e.g., the planning department). While not having the same level of authority as a department head, the coordinator is responsible for serving as the lead when economic development projects arise. This person may be the single contact point in the organization for handling requests for information about the community, undertaking staff work about tax incentives, and generally seeing that other local government departments are responsive to business needs.

A second alternative is the creation of a department, typically called a **department of community and economic development**, which includes such functions as: economic development; community development (administering federal Community Development Block Grant monies and other federal and state grants); engineering; and zoning, building, and related permitting and inspection functions. Here the purpose is to make economic development a line or operating function rather than a staff function. The activities that most closely align with economic development, including permitting and engineering, are incorporated into this department. The economic development director may be a division head within such a department. A variant on this would be to make the economic development function an operating department by itself, as opposed to combining it with community development.

There is no ideal organizational form for economic development.

A third alternative is the creation of **a nonprofit organization** that relies on the contributions of businesses, local industries, and individuals. Such entities are usually organized as 501(c)(6) organizations and have boards of directors elected by their memberships. They may be community development corporations or chambers of commerce (although they may not have that name). They are not part of the local government but coordinate with it. They will tend to serve as a voice for the private business and nonprofit sectors rather than the public sector. Such entities will typically have a staff that responds to an executive director (WEDI 2003).

The final organizational form is a **public-private partnership** organized as a nonprofit 501(c)(6), (5), (4), or (3) organization where the board of directors consists of elected and appointed officials. Contributions from business, industry, and private individuals are used to support such an organizatin, and the local government may also contribute to it. Here the organization represents both the public and private sectors, but it is still outside the day-to-day functioning of local government (WEDI 2003).

Assessment. There is no ideal organizational form for economic development. Much of the success of the economic development function depends on the capabilities of those engaged in economic development as well as the overall culture of the organization and the attitude of governmental and private sector leaders.

In general, placing the function in government itself as a government department or staff function will give it the perspective of the local government. Here its important function will be to coordinate local government actions and serve as an internal advocate for business interests.

Placing the function outside government, as a nonprofit, allows the economic development entity to function without regard for governmental boundaries and to move quickly where the local government could not. Another plus is the ability to maintain confidentiality on such sensitive matters as the identity of prospects and making of loans and grants, situations in which a business will have to provide financial information (WEDI 2003). On the other hand, privatizing the economic development function may distance the activity from key local government activities and may lead to questions about how the nonprofit is conducting itself out of the public eye, especially if it is receiving public funds.

Method 1.3: Streamlining Development Review

Local governments regulate businesses and industry in a variety of ways—through building, zoning, and environmental regulations. These regulations are essential for protecting businesses, workers, public health, and the overall quality of life in a community. Over time, however, development review processes and regulations may present a series of lengthy and uncertain

procedural hurdles for business. This is due to several factors common to many jurisdictions:

- The development review process has become more layered. Not only is there more discretionary review of developments, but also more entities involved: planning commissions, boards of zoning appeals, and historic preservation and design commissions, to name a few. Each of these layers of review involves an additional level of discretion and extends the review process.

- Old development regulations may, for a variety of reasons, prove unworkable or ineffective in addressing the problems for which they were originally enacted. For example, the development standards in subdivisions may be producing streets too wide and too costly to maintain. Over time, the patchwork amendment of the local regulations may have created a system that even staff find difficult to understand, much less the average citizen or business.

- There may be turf problems in the permit processing system. For example, perhaps the chief building official differs with the zoning administrator, and the city engineer is in dispute with the planning director. When these disputes arise, there may be no simple way to resolve them.

To minimize regulatory burdens and streamline development review, governments should carry out comprehensive reviews of their key regulatory programs on a periodic basis, preferably every five years, to improve their effectiveness and lower their compliance costs.

To minimize regulatory burdens and streamline development review, governments should carry out comprehensive reviews of their key regulatory programs on a periodic basis, preferably every five years, to improve their effectiveness and lower their compliance costs (Arimes 2003; Vranicar, Sanders, and Mosena 1980). This includes examining the organizational structure for development review, staffing and skill levels, patterns in petitions for appeals and variances, quality and timeliness of inspections, and time involved in obtaining permits. It may also involve looking at the physical space in which the development review function takes place to determine if it is pleasant and humane or bureaucratic and oppressive. It is also useful to bring businesses into the review process for their views on how they are treated and what changes need to be made.

Assessment. The ability of a business to obtain approval for its developments without undue delay and administrative hassle is significant. In the development world, time is money, and reducing the time necessary for approval can make the difference in efforts to attract target employers. The strategy will remove bureaucratic barriers that keep local entrepreneurs from entering the market place, giving businesses a single point of contact on compliance issues. Nonetheless, evaluating regulatory processes is complex and sometimes contentious. Consequently, the local government that undertakes this strategy must acknowledge it is a major commitment of time (much of it volunteer time) and money (for outside assistance, if necessary).

STRATEGY 2. BUSINESS DEVELOPMENT

Method 2.1 Business Skills and Management Training for Small Businesses

Small business assistance centers provide accessible management training, counseling, consulting, and research services for small firms. Programs respond to the needs that individual businesses identify in the areas of technology transfer, management, financing, marketing, and workforce

training. A variant on small business centers is **entrepreneurship training** in which high schools and community colleges establish business programs. Another component is an annual or semi-annual **business start-up fair** where prospective entrepreneurs can meet with those who have experience launching a business or who can offer useful support services. At a start-up fair, an economic development agency places fledgling businesses in contact with low-cost or no-cost mentors (such as retired executives) who could provide advice for small businesses in the area of management, marketing, accounting, financing, and other skills.

An economic development agency can take a less direct coordinating role in small business assistance, such as getting a small business assistance center off the ground and then letting it perform. One view is that the best form for the small business center is a specialist institution organized in close association with, rather than within, university business schools and technical colleges (Blakely and Bradshaw 2002, 26).

Compared to general commercial or industrial space, incubators offer an opportunity to target industries with identified growth potential, high wages, compatibility with local skills, or unique themes (like "green" or "high-tech" businesses).

Assessment. Small businesses, by definition, do not have as many employees as larger firms, but they are more numerous, so they account for a significant proportion of jobs in a city. Since many large employers are increasingly owned by companies outside a region, small business development is a way of fostering economic benefits that stay within the region. In addition, most large businesses started off as small businesses, so small business development can eventually lead to large local businesses. Because this strategy focuses on assisting local businesspeople who are likely to have strong ties to the community, the results can be a benefit for the community if the small business hires locally or serves as a role model for other local entrepreneurs. Another advantage is that these programs are usually not as costly as loans, grants, or tax relief.

Method 2.2 Business Incubator

In this strategy, a public entity acquires or constructs a building and provides, or arranges provision of, low-cost space and support services for start-up businesses in targeted industries, with graduation criteria. The goal of an incubator is not simply to provide low-cost space, but to provide shared support services smaller companies might not be able to afford on their own. The goal is also to foster synergy through the communication and proximity of incubator tenants. Mentoring and business advice is often provided by the entity operating the incubator and through linkages to the Small Business Administration, retired executives, or local colleges.

An economic development agency could provide the inspiration and initial guidance for an incubator; it could also provide land and buildings at favorable lease rates. Because of the high degree of involvement required for incubator formation and management, however, an economic development agency might have to look to a separate organization to take the lead on developing, operating, and managing an incubator.

Assessment. The effect of incubators is meant to be the nurturing and eventual success and expansion of targeted companies. Compared to general commercial or industrial space, incubators offer an opportunity to target industries with identified growth potential, high wages, compatibility with local skills, or unique themes (like "green" or "high-tech" businesses).

Besides direct job creation, incubators can foster community development by nurturing local companies and encouraging skill development of local residents. Often incubators are linked to a local community college and provide internship opportunities that benefit both college students and the tenant companies.

One drawback in terms of the effectiveness in leading to job creation is that many of these small businesses still fail, and the ones that succeed still take some time to create significant job growth outside the incubator setting. The job creation efforts of an incubator take more time to mature than those of a large existing employer. Another potential limitation to the effectiveness of an incubator is the need for growth opportunities outside the incubator; if the city lacks suitable space for a graduating company, it will lose the investment it made in that company.

Incubators have high initial costs for the acquisition or construction of the building space, and they can have high costs for the management of the nurturing programs, such as shared services and mentoring. Most incubators are run by nonprofit organizations, able to access multiple grant sources to subsidize the capital and operating costs. However, incubators operated on a for-profit or self-sufficient basis—taking a stake in the success of the firms that "graduate" from the incubator—are becoming more popular over time.

Targeting usually focuses on sectors with growth potential, linkages to existing businesses in the area, and reasons to be attracted to the particular region or local government setting because of particular competitive factors.

STRATEGY 3. BUSINESS ATTRACTION AND RETENTION

Many state departments of community development, tourism bureaus, and regional chambers of commerce employ a variety of business attraction and retention techniques as a matter of course. Local governments may undertake them as well, although they may be more suited to a nonprofit group or a private marketing firm.

Method 3.1 Marketing to Attract Businesses

Before an economic development agency or local government undertakes a program to attract a business, the objective of the program should be clear. That is why many marketing strategies employ the technique of **targeting**, identifying a group of firms the development organization wants to reach. Targeting usually focuses on sectors with growth potential, linkages to existing businesses in the area, and reasons to be attracted to the particular region or local government setting because of particular competitive factors (Canada 1995, 59). As noted above, linkages can be identified through industrial cluster analysis (Bergman and Fesser, ch. 3).

An examination of groups included in the North American Industrial Classification System (NAICS) will provide those involved in formulating a business attraction strategy with a starting point. NAICS divides firms into categories that can be broken up into market segments on the basis of products or services. This approach, although relatively simple and using easily accessible data, requires a fairly fine-grained analysis of industrial classification to get at specific firm types. Such an analysis would disclose the type of skill mix such businesses desire, as well as general wage levels—an important issue if the objective is to raise the level of wages in a community. Unless such an analysis is done, economic development "recruiters" might identify firms without a full appreciation of their locational requirements with respect to the region or local government's attractions. While it is possible to segment markets using the categories employed by the older Standard Industrial Classification (SIC) system, the system has limits that should make the planner wary (Canada 1995, 59-62).

The direct marketing techniques employed as part of a business attraction strategy can take many forms:

- Brochures or pamphlets, either general in nature or targeted to a specific industrial classification, about the region's or local government's attractions to business and industry
- Advertising in trade publications or generalized advertising supplements

- Direct mail to specific industries or locational consultants
- Participation in industry trade shows
- Telemarketing of potential businesses
- Prospecting trips to certain areas of the country (or other countries) where potential new businesses are located
- Seminars for prospective businesses
- Websites
- Maintenance of a publicly accessible database of available commercial and industrial land and buildings (see the section on land market monitoring below)

Assessment. Marketing strategies can be an expensive proposition, and the costs may be well beyond those of small local governments. Moreover, existing businesses may see little advantage in attracting new businesses that might constitute regional competition; they are more focused on their immediate needs. As a practical matter, no matter how elegant or refined the targeting strategy, few local governments will turn down a business prospect that does not fit the profile of a particular targeted industry.

Method 3.2 Business Retention

Everything we have said about attracting new business applies to retaining existing businesses. We have made the point several times that most economic development policies are aimed, in one way or another, at reducing the costs to businesses of development or operation. Thus, local governments can help retain businesses by reducing those costs with financial incentives, waivers of fees or taxes, or in-kind services. We discuss all those techniques in other sections of this PAS Report.

In this section we talk about one other, related action a local government can take to retain existing businesses: make sure that it knows what those businesses value, and that the local government cares. Most of the techniques here are common sense:

- Surveys of local businesses to determine plans for changes or expansions and attitudes toward local governments
- Periodic business roundtables or breakfasts
- Regular personal visits by local government officials to businesses
- Creation of teams of top local government managers to expedite responses to problems identified by local businesses
- Publication of newsletters to local businesses
- Active involvement by local government officials in chambers of commerce and other business groups
- Appointment of local business owners or managers on local boards and commissions, even if they are not residents

These tasks can be assigned to a staff person or a department head in the city or county, although nothing quite suffices like direct contact by a mayor, city manager, or county commissioner to convey the impression the government is serious about business retention.

Assessment. Business retention strategies sometimes take a back seat to business attraction because they are less dramatic. Many of the problems local businesses identify are routine: problems with getting a sign permit; difficulties in obtaining a variance to expand a building or parking lot; or

lack of responsiveness by a utility department to a stormwater problem. Constant contact between the local government and businesses can help rectify these problems.

The communication between local government and local businesses may also identify longer-term problems, such as infrastructure needs in a certain section of the community or difficulties with current development codes. This communication can also serve as an early warning system for government so that it can plan to address major internal problems facing local businesses (e.g., a distant parent company may be planning to close a local plant) or other issues that suggest an at-risk firm. This communication can also help businesses better understand and even express support for regulations that citizens and government officials believe to be good for quality of life in the community. Finally, good relations with existing businesses may lead to other prospects for new businesses and get the participation of existing businesses in the courting of potential new ones.

The communication between local government and local businesses may also identify longer-term problems, such as infrastructure needs in a certain section of the community or difficulties with current development codes.

STRATEGY 4. DEVELOPMENT INCENTIVES AND FINANCING

Method 4.1 Financial Incentives

States and local governments offer incentives to attract or retain businesses on the theory that the incentives will lead to business investment and thus to new jobs. Those investments and jobs in turn will produce an increase in demand for goods and services. In turn, that demand will result, through a multiplier effect, in demand for an additional round of services. Economic development resulting from incentives should also increase the tax base, allowing either expanded public services or lower taxes on residents (Peters and Fisher 2004, 28).

Local governments can offer a variety of financial incentives, either through the state or directly. The best known is **tax-increment financing** (TIF). TIF is a method of financing redevelopment activities directly tied to the success of those activities. The local government conducts a study of the need for TIF and prepares a plan for the area to be designated as the TIF district. The local government determines the property tax revenue collected in that area before redevelopment occurs. The local government then borrows money, by getting loans or selling bonds. The borrowed funds are used in various ways to improve the development prospects of the area:

- Construction or improvement of any publicly owned building, facility, structure, landscaping, or other improvement within the project area from which the tax increment funds were collected
- Paying for the installation of publicly owned utilities in the project area
- Meeting the cost of administrative, overhead, legal, and other operating expenses of the redevelopment agency created to oversee the TIF program

As private development occurs in the area, tax revenue increases, and the excess above pre-redevelopment property tax revenue in the area pays off the loans or bonds and finances further redevelopment activities. That excess is the "tax increment" in TIF.

Another incentive is the tax-exempt **private activity bond**, also known as an industrial development bond. Such bonds finance land, buildings, or equipment to develop or expand businesses and have a lower interest rate than conventional financing because they are issued by the state (or in some states, by local government as well).

These examples are only two of the many ways local governments have available to them to provide incentives for the kind of economic development it wants. Any financial technique that raises money a local government can use to contribute to any of the multiple costs of development can have a

similar effect. Ultimately, all these financial incentives are ways to *reduce the development costs* for the private sector. Those costs can be reduced by:

1. giving money directly as a grant or loan to the development;
2. providing in-kind services or resources (e.g., environmental impact statements, infrastructure, land); and
3. reducing or waiving fees or tax (e.g., reduction of impact fees, property tax abatement).

The first and third techniques are commonly considered "financial incentives."

A review of incentives in the Journal of the American Planning Association in Winter 2004 declared that the literature on incentives is simply inconclusive.

Assessment. There is a large body of empirical research on whether traditional economic development incentives of the types described above have any impact on job growth. A review of incentives in the *Journal of the American Planning Association* in Winter 2004 declared that the literature on incentives is simply inconclusive:

> It is possible that incentives do induce significant new growth, that the beneficiaries of that growth are mainly those who have the greatest difficulty in the labor market, and that both states and local governments benefit fiscally from that growth. But after decades of policy experimentation and literally hundreds of scholarly studies, none of these claims is clearly substantiated. (Peters and Fisher 2004, 28)

Despite the fact that incentives are widespread, say the authors, the reason for their unclear impact appears to be that incentives, for all their cost to state and local governments, are still too small to matter much. "Typically," they write, "a firm's wage bill will be much greater than its tax bill; for the average manufacturing firm in the U.S., payroll is about 11 times the firm's state and local taxes before incentives. . . . Thus fairly small geographic differentials in wages could easily outweigh what appear to be large tax and incentive differentials" (Peters and Fisher 2004, 28).

Tax increment financing sounds very attractive—the local government is (theoretically) not giving up any revenue, as the tax increment would not (again, theoretically) exist were it not for the redevelopment activities financed by that increment. However, there are potential problems with TIF. If a government uses TIF where it is not needed to encourage development—where development would have occurred in the absence of TIF—the tax increment does not represent (or only a portion represents) local government revenues that would not have otherwise been collected. Instead, the tax increment cuts into general revenue the government would have otherwise received. If the government structures TIF in this manner and imposes it when not necessary, the tax increment also deprives other governmental bodies that receive property tax revenue—school districts, other special districts, the county, and so forth—of the increase they would otherwise have received.

Man (2001), in a comprehensive review of the empirical research literature evaluating the impact of TIFs on economic development, found conflicting evidence about the effectiveness of TIF programs. Evidence suggested that TIF-adopting cities in Michigan experienced faster property value growth than non-TIF cities. In Indiana, researchers found that TIF programs raised property values and employment in a city beyond the level that would have been expected if the TIF program had not been created. Two studies in the Chicago metropolitan area yielded different results. One found TIFs to have a substantial positive effect on economic development, but a second concluded that the adoption of a TIF reduces assessed property value growth rates over an entire city and TIFs stimulate the growth of blighted areas at the expense of non-target areas.

Some states permit enterprise zones to be established. Enterprise zones were the subject of a great deal of discussion and debate in the late 1970s and early 1980s. The original concept of the enterprise zone came out of Great Britain. The enterprise zone approach in Britain sought to stimulate local projects by removing financial and regulatory obstacles. Some of the characteristics of enterprise zones are: (a) focus on an area of one square mile or so in the most depressed part of a city, not a rural area; (b) complete relief from land-use controls, but requirements for compliance with basic anti-pollution, health, and safety standards; (c) reductions or exemptions from property taxes for new development in the enterprise zone and a reduction in capital gains taxes.

The first major study on enterprise zones was conducted on Evansville, Indiana, in the late 1980s. Using shift-share analysis, it found substantial growth in employment in the Evansville enterprise zone was due neither to metropolitan area growth nor to the industrial composition of the zone, but instead was a function of the comparative advantage of the zone. It also concluded that, as implemented in Indiana and in the Evansville enterprise zone, the program was cost-effective in job generation, with a lower cost per job than most economic development programs (Rubin and Wilder 1989).

Subsequent research on enterprise zones in other states (Greenbaum and Engberg 1998; Rubin and Wilder 1996) has shown mixed results, depending on the state and particularly the analytical technique employed. Greenbaum and Engberg (1998, 26-27) cite studies concluding that enterprise zones lead to a "churning" of economic activity. In other words, enterprise zones did have an impact on employment growth among new establishments, but that growth was offset by employment losses among ongoing establishments. Findings for changes in shipments, payroll, capital spending, and number of establishments were similar. The research suggested possible explanations:

- New businesses may merely be displacing previously existing businesses.
- Local politicians and policy professionals were eager to publicize new jobs and activity in the enterprise zones as evidence of their success. Evidence of "success" thus served to help continue or expand the programs. Jobs lost in the zones were often unlikely to be attributed to the zone policies.
- The enterprise zone programs may have replaced economic development initiatives that were better suited for existing establishments.

One literature review on the impact of industrial revenue bonds concluded that the growth effects of these instruments are ambiguous as best (Fisher and Peters 1997). As a practical matter, because of changes in federal tax laws in 1986, which imposed a loan-volume cap on states, private activity bonds or industrial development bonds are used less in economic development than they used to be (Zimmerman 1991). States are exhausting their cap for all types of tax-exempt financing and resorting to taxable bonds (GFOA 2002).

Method 4.2. Venture Capital Networks and Revolving Loan Funds

Access to capital is a special problem for small businesses. This is particularly true for technology-based businesses. Banks may not be comfortable with making loans to technology-based companies because they lack the knowledge and tools to assess the risks of financing deals for these types of companies (State and Science Technology Institute 1999, 31).

Venture capital refers to capital invested or available for investment in the ownership element of a new enterprise. The capital investor retains some equity in the venture. Venture capital firms may provide private seed money to finance the early development of a product or a service. They may also

provide start-up capital sufficient to generate initial sales and profits and to get the enterprise through its first three to five years of business. Eventually, the new enterprise may seek an initial public offering (IPO). An IPO creates a viable market for the company's stock and provides its founders and early-stage investors with a cash return on their investment and, eventually, liquidity for their remaining shares. A venture capital network is a network of early-stage investors who participate privately in high-risk/high-return enterprises with the prospect of seeing outstanding returns on investment when the new enterprise either goes public or, alternatively, is acquired or merged with another enterprise. There are large numbers of venture capital networks in the U.S. (Venture Net Partners n.d.).

Revolving loan funds are a useful way of inducing small to medium firms to locate or expand when private financing is insufficient and bridge between the owner's equity and bank loans is needed.

A **revolving loan fund** (RLF) gets established by a state or local government with public money and gets lent to the private sector for certain purposes or with certain conditions. The fund "revolves" because as the private sector pays back the loan, the fund has money it can then lend to the next business. A RLF could be used to support new business start-ups and expansions. Monies from the fund are offered at below-market or negotiated interest rates. They serve as bridge financing to close the gap between the business owner's resources (including private financing) and the owner's needs. Standard uses of such funds include real estate, machinery, permanent working capital, and business improvements. Such funds may require that a certain number of jobs be created per dollar of RLF contribution (e.g., one job per $20,000 of the loan) and may also require a certain proportion of jobs be set aside for low- and moderate-income persons. Principal and interest payments from loans are returned to the fund for investment in future projects.

Assessment. As a practical matter, operating a venture capital fund is beyond the authority and technical competence of most cities and counties. The need for seed money and for working capital for high-risk initiatives in exchange for an equity position is more appropriately satisfied by banks and other sources, such as venture capital networks. Revolving loan funds, however, which are only loans as opposed to equity positions in a company, are a useful way of inducing small to medium firms to locate or expand when private financing is insufficient and a bridge between the owner's equity and bank loans is needed. Still, an RLF is not a substitute for private debt and equity, and RLF programs typically place a limit on the proportion of the project they will finance.

An RLF still requires the local government or someone retained by the local government to assess the quality of the business plan for the prospective recipient of the loan. If the loan were granted, the local government would need to monitor the development to see if prospective jobs of the number and type proposed have in fact materialized and to ensure that the loan is paid back in a timely manner so that the monies may be used again.

STRATEGY 5. WORK FORCE EDUCATION AND TRAINING

Workforce training programs include customized instructional approaches based on firms' requirements. A program can be part of a financial assistance package, where benefiting firms are obliged to give preference to qualified local personnel when seeking employees. Local employment programs can provide training and personal skills development programs to help especially disadvantaged social groups gain employment or acquire necessary skills. Cities can also provide online systems to provide job seekers with information about potential employers and public programs for skill development.

The public school system is obviously a key player in this strategy, being responsible for primary and secondary education in the city, but other groups

can also play important roles, particularly for workforce training. The local community college system, local businesses, nonprofit workforce training groups, and economic development agencies can all use their resources to address workforce-training issues.

Assessment. Though some firms bring workers with them, and the labor force outside a city can be tapped through lengthy worker commutes, most firms rely on the local workforce. If a company requires unskilled workers, education and workforce development may not be that important. But most firms today require some job-related skills in addition to a quality primary and secondary education. In addition, quality local schools are important for attracting future employees who care about their children's education. The benefits of education extend beyond job creation to quality-of-life issues difficult to quantify.

Without an accurate land inventory, public policies affecting the amount of land available for development may regulate growth too rigidly.

STRATEGY 6. LAND SUPPLY

Method 6.1 Monitoring Land Markets and Providing Adequate Buildable Land*

Government land-use policies affect the supply of buildable land for commerce and industry, as well as residential development. Shortages in various categories of land use can result when local governments fail to adapt land-use designations in the face of increased demand. (For additional discussion of land market monitoring, see Bollens 1998.)

Without an accurate land inventory, public policies affecting the amount of land available for development may regulate growth too rigidly. Consequently, they can have disastrous effects on the price of raw land. In addition, when infrastructure is not properly sized, due to uncertain knowledge about the actual supply of buildable land, the government pays more for public facilities. Also, imperfect information about land supply and availability multiplies the risk of private development decisions. Such risk and uncertainty make development more expensive because greater-risk projects require higher investor returns. Market uncertainty limits competition, as fewer developers are willing to invest time and money in the process.

While monitoring land-use change used to be a time-consuming task, modern geographic information systems (GIS) make the effort a great deal easier. To that end, many communities are instituting **land market monitoring systems** to evaluate the demand for and supply of land (Knaap 2001; Mouton 2000). GIS software is used in the tracking process.

A land market monitoring system focuses on the availability of "buildable land" and the rate such land is being consumed for urban development. Buildable land supply can be measured according to several factors described in Chapter 3 of this PAS Report.

Local governments usually view buildable land as vacant, physically unencumbered, serviced by infrastructure, and properly zoned. By contrast, private developers would not view such land as buildable if it were not available for purchase at a price that made its development economically feasible. It is possible to gauge whether land is on the market by interviewing landowners, identifying large blocks of land under similar ownership, and tracking real estate sales through Multiple Listing Service data maintained by Realtors. Comparing the sale prices of housing and nonresidential structures to the costs of constructing residential, commercial, and industrial sites can give a rough estimate of economic feasibility.

The inventory of available land can be related to forecasts for the need for industrial, commercial, residential, and public/institutional land, which are

*This discussion is adapted in part from Scott Bollens, "Land Supply Monitoring Systems" in *Modernizing State Planning Statutes: The Growing Smart℠ Working Papers, Volume 2*, Planning Advisory Service Report 480/481 (Chicago: American Planning Association 1998), 133-41.

based on density (housing units/net acre), employment intensity (employees per net acre, which will differ for the type of business or industry), and public service standards that affect the amount of public land new development consumes (e.g., so many acres of parks for certain levels of population).

A subset of land market monitoring is ensuring that sufficient buildable land is available for development of various types of housing units at differing price and rental ranges. A good supply of housing, including affordable housing, is important in order to ensure that workers in local businesses can live in the community and not have to commute excessive distances because they cannot find suitable housing nearby. Moreover, having a suitable supply of buildable land for housing sends the message to employers that the local government wants both the business and its employees in the community.

A subset of land market monitoring is ensuring that sufficient buildable land is available for development of various types of housing units at differing price and rental ranges.

A simple, though not conclusive, indicator used to monitor land supply with respect to job and housing growth is the **jobs/housing balance**, a ratio between the full-time jobs in the community and the number of housing units. In general, a jobs/housing indicator is probably more accurate at the regional level, where it would take into account a larger number of jobs and units. (For a more extensive discussion of jobs/housing balance, see Weitz 2003.)

A high ratio, say 2:1, indicates job growth is accompanied by insufficient housing production levels, resulting in a scarcity of workers living in the same region (or local government) in which the jobs are created. There will therefore be a housing shortfall and a great deal of interregional or interjurisdictional commuting. The San Francisco area is a good example of a region where there is a high jobs/housing ratio. Resort communities, like Aspen, Colorado, where the available stock of affordable housing is bid up because the area is attractive, are another example.

A lower ratio, between, say 1.25: 1 to 1.5:1 indicates housing is favored over jobs, and the housing market probably has an adequate supply to meet the needs of most families. If that ratio is consistent over most of the local units of government in a region, a healthy and diverse market probably exists (Meck, Schwab, and Retzlaff 2003).

A more technical approach is to conduct a market analysis and examine housing prices and rents in relation to household income in the community, not only for existing residents, but for those expected to reside there. Then, determine whether a shortfall exists in any particular segment of the market. A local government may decide it wants to achieve some future mix of different housing types. For example, it may decide that 20 percent of all new housing should be affordable to households of between 50 and 80 percent of the gross median household income in the area. A housing market analysis would disclose whether the market was producing this type of unit and could suggest a change in the local government's housing strategy.

Assessment. Land market monitoring will help a community determine when to make changes in the allocation of different types of land use to respond to changes in the local or regional land market. This will prevent both an oversupply of land in certain categories in advance of market need and an undersupply that would push up land prices for certain categories while underused land would lie fallow. Often, local governments adopt a wait-and-see attitude regarding the land market, largely because they may not understand its dynamics. A land market monitoring system can provide valuable signals to both the public and private sectors about the appropriate amount of land to set aside for industrial and commercial uses in responses to changes in the local and regional economy. Land market monitoring is a particularly appropriate vehicle for a regional planning agency on behalf of member local governments. The software, hardware, and the skills to operate such a system may be more efficiently provided by a regional agency than by individual small local governments.

CHARACTERISTICS OF TECHNOLOGY AND BUSINESS PARKS

- A campus-style physical environment
- Mixture of ownership and management, ranging from government to private sector
- A frequent association with some form of university- or science-oriented establishment
- Low-density development with high-quality buildings
- Specific criteria for the eligibility of prospective tenants to ensure that all the activities within the park are compatible with each other

Source: Blakely and Bradshaw 2002, 233.

Method 6.2 Industrial, Technology, and Business Parks

Government can combine its ability to acquire property and assemble land with its ability to build infrastructure (roads, utilities, etc.) and create an **industrial park or business park** to meet the specific needs of sought-after industries (ULI 1988, ch.7). The private market normally does this, but government has the added advantage of being able to use public land and eminent domain. In addition, it can focus on a public purpose like job creation rather than on making a profit through the development. A redevelopment agency, as authorized in some states, or a community development corporation could lead the public development of an industrial or business park.

Assessment. Industrial and business park development is expensive and risky. If the community fails to attract firms to the park, the land remains vacant and underused. The park could be locking up land more attractive as smaller parcels for various other uses. As with land and building purchase, site selection is very important. Furthermore, if an industrial park development merely pulls existing jobs from another part of the community or region, it will be ineffective in *creating* job growth.

The design and character of industrial and business parks can affect economic development by affecting quality of life. Industrial or business park development that is not mixed use goes against current planning goals of decreasing motor vehicle trips by increasing proximity among working, living, and shopping/entertainment options (ULI 1987). On the other hand, sometimes mixed-use development is not practical: for example, if tenant companies as a group have too many negative external impacts (e.g., noise, odors, etc.) or if the government deliberately wants to group similar enterprises together to create market efficiencies.

Method 6.3 Brownfields

A **brownfield** is an abandoned, idled, or underused industrial and commercial facility where expansion or redevelopment is complicated by real or perceived environmental contamination. Since one cannot be aware with certainty of all the chemicals and materials ever used on industrial or commercial premises, or of the level of care with which they were stored, used, and disposed of, the class of land with "perceived environmental contamination" can potentially encompass any lot or parcel ever used for industrial purposes and even for certain commercial purposes (auto repair shops, for instance).

The brownfield problem—a reluctance to purchase and develop already-developed sites due to the perception they may be polluted—exists to the degree it does because of the nature of liability under federal and state laws regarding the cleanup of contaminants and the assessment of the costs of that cleanup. The Comprehensive Environmental Response, Compensation, and Liability Act, commonly called CERCLA (42 U.S.C., Sections 9601 et seq.), was adopted with the purpose of holding parties responsible for the pollution of land liable for the costs of removing the pollution and restoring the land to its natural state.

But the language of the statute is somewhat broader: the past and current owners and operators of premises where hazardous substances have been released are financially responsible for the cleanup of the contamination. CERCLA essentially imposes liability for contamination of land upon the past and present owners and users of the land regardless of their culpability in actually polluting it.

Nonetheless, brownfield sites are often located in areas convenient to housing and transportation. Local governments see them as a resource, particularly since new infrastructure would not need to be extended, and their reuse would ensure a continuation of compact development patterns.

Assessment. Brownfield redevelopment usually costs more than greenfield development because of the cleanup and related costs, including the time it takes for the proposal to receive approval of federal and state agencies. Before site remediation can be completed, the government must conduct an environmental assessment. Until the assessment is completed, the full cost of making the site suitable for redevelopment may not be known. All these additional costs and delays have made brownfield redevelopment difficult.

Method 6.4 Land Assembly

Land assembly means the public sector acquires land and/or buildings, either on the open market or through eminent domain, or it makes use of land already under public ownership to promote economic development. Purchase of adjacent land parcels can be used to assemble a larger parcel under a single owner. The land and any buildings are then made available to public or private developers, usually through a bidding process.

If a public entity acquires a vacant building or one threatened with demolition, it can prevent the loss of economic momentum that results from seeing landmark buildings sit vacant or become vacant lots.

Assessment. Land assembly is most important for land-intensive firms and less so for services firms. If there is little contiguous vacant land under unified ownership in a city, attracting employers who need large parcels of vacant land is difficult, unless the employers are willing to buy existing buildings and redevelop or demolish them. Many employers are not willing to face the costs of redevelopment or demolition, nor are they willing to negotiate with multiple landowners. The public assembly of land can make it possible for these land-intensive businesses to locate in the city.

Public purchase of buildings is less important because most companies prefer to construct purpose-built structures. One notable exception is preserving historic buildings that may not be economical for a private company to rehabilitate, but are important to the image of the city or a commercial area. If a public entity acquires a vacant building or one threatened with demolition, it can prevent the loss of economic momentum that results from seeing landmark buildings sit vacant or become vacant lots. The public entity can then recoup its investment if the private market picks up and the building is later sold.

Even if the public entity has to rehabilitate the building for a private company, it may be a good investment to keep economic momentum going in a commercial area.

Land purchase is expensive, and building purchase and rehabilitation are even more so. The government must use discretion when choosing to acquire a property to not waste public investment on land or buildings employers will never want. On the other hand, the payoff can be significant if an employer is able to move to the city simply because a large piece of assembled property is made available.

STRATEGY 7. INFRASTRUCTURE PROVISION

Communications infrastructure, water supply, sewers, roads, sidewalks, parks, public transit, and airports are critical components of an area's development capacity and long-term competitiveness. Businesses rely on infrastructure to conduct their work and transport their goods and services. Also, a well-maintained city looks good, making it a pleasant place in which to live and work. Local government is responsible for most of these infrastructure components and can therefore exert significant influence on development type and pattern. An economic development agency can suggest infrastructure improvements to other departments.

In their study of the Bellingham, Tacoma, Spokane, the Tri-Cities, and Wenatchee regions in Washington State, which have chosen a technology focus for their economic development efforts, Sommers and Heg (2003) recommended that, of all of the types of infrastructure, high-quality, reliable

broadband Internet access is a necessary component to high-tech development. Here, the five regions were attempting to emulate the success of Seattle. All five of these regions had been built around resource industries—agriculture and food processing, forestry and wood products, petroleum refining, aluminum smelting, and nuclear energy-related technologies, but these were not seen as having long-term economic growth potential. The common factor to the success of the five, according to the study, was the willingness to invest in broadband access and related communications infrastructure.

The capital improvement program (CIP)—a five- to six-year schedule of capital improvement projects—is one of local government's most powerful tools for implementing a local comprehensive plan and supporting both commercial/industrial and residential growth.

Method 7.1 Capital Improvement Programming and Funding

The capital improvement program (CIP)—a five- to six-year schedule of capital improvement projects—is one of local government's most powerful tools for implementing a local comprehensive plan and supporting both commercial/industrial and residential growth. By carefully selecting and timing capital projects, the CIP process can ensure that a local government:

- repairs and replaces existing infrastructure;
- meets needs in mature, growing, and redeveloping areas;
- coordinates activities of various government departments; and
- ultimately influences the pace and quality of development in a community.

The CIP document itself consists of project descriptions along with schedules and tables showing revenue sources and expenditures by year. Capital improvements include major nonrecurring expenditures for such projects as civic centers, libraries, museums, fire and police stations, parks, playgrounds, street construction or reconstruction, sewage and water treatment plants, water and sewer lines, and swimming pools. Costs associated with capital improvement projects include architectural and engineering fees, feasibility studies, land appraisal and acquisition, and construction.

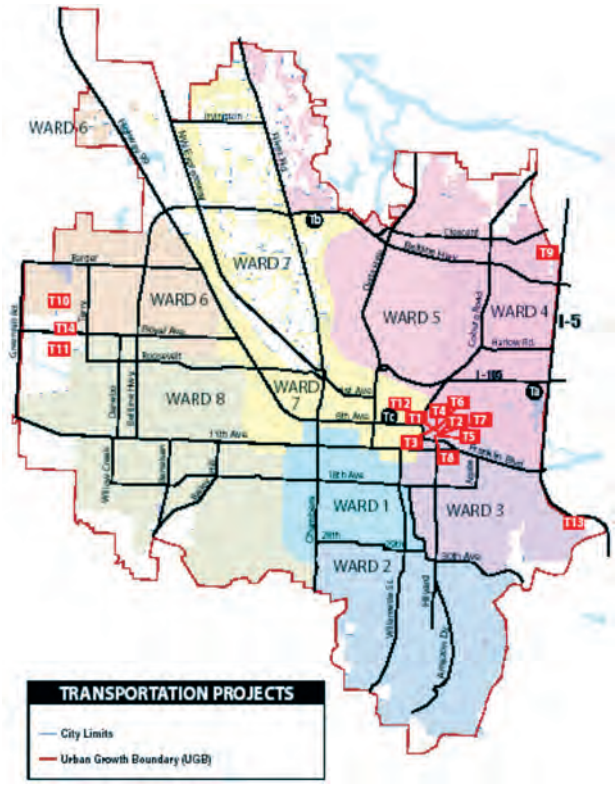
The local government's chief administrative officer (mayor or city manager) or another designated official begins the CIP process about six months before the document needs to be adopted. The budget office prepares a revenue forecast, and municipal departments are asked to submit projects to be evaluated, prioritized, and sequenced by year. Often the local planning commission is asked to review a draft of the CIP in order to relate project priorities to the comprehensive plan. After holding a public hearing, the local legislative body considers the CIP, revising project selection and scheduling as appropriate. It then adopts the CIP as a general policy document (although this can vary from community to community).

The first year of the CIP becomes the capital budget when it is adopted by ordinance, along with the operating budget by the legislative body. Once the capital budget has been adopted, government departments can begin to spend money on individual projects, contract for architectural and engineering design, acquire land and easements, sell bonds as necessary, and send out requests for construction bids. Local governments that apply the CIP process rigorously monitor the condition of existing infrastructure and carefully evaluate the costs of proposed projects with design studies so that future expenditures come as no surprise and projects can stay within budgets.

Figure 4-2 shows the easy-to-read format for the transportation portion of a six-year CIP for Eugene, Oregon. A map accompanies the CIP schedule showing the location of projects in the community.

Assessment. Providing infrastructure is expensive, but it is essential in leading to job creation; without the infrastructure, most job creation cannot take place. The mere provision of infrastructure is not enough; the quality of infrastructure is important as well. Because nearly all regions have vacant or built land with acceptable infrastructure, public infrastructure provision

FIGURE 4-2: TRANSPORTATION PROJECTS, 2004-2009, EUGENE, OREGON



City of Eugene, Oregon, Capital Improvements Plan

Transportation

Table of Funded Projects
(Figures in $1000s)

	2004	2005	2006	2007	2008	2009	Total
Preservation/Maintenance							
Bicycle System Preservation and Rehabilitation	405	405	405	405	405	405	2,430
Street and Alley Preservation	8,575	8,575	8575	8,675	8,675	8,675	51,750
Subtotal	**8,980**	**8,980**	**8,980**	**9,080**	**9,080**	**9,080**	**54,180**
Upgrades and Capacity Enhancement							
3rd-4th Connector	120	1,451					1,571
5th Avenue, Mill Street Intersection Improvements				1,810			1,810
Broadway, Mill to Hilyard Modifications					1,190		1,190
Perry Street, 5th to Broadway					400	400	
Judidra Point Interchange/Glenwood Avenue	250						250
Neighborhood Traffic Calming	30	30	30	30	30	30	180
Priority Bikeways	300	300	300	300	300	300	1,800
Royal Avenue, Prairie Mt. School to A-Channel		2,200				2,200	
Services for New Development	400	400	400	400	400	400	2,400
Sidewalk Access Ramps	30	30	30	30	30	30	180
Street Lighting (Arterials and Collectors)	60	60	60	60	60	60	360
Street Lighting (Residential)	30	30	30	30	30	30	180
Street Tree Stocking and Planting Program	30	30	30	30	30	30	180
Traffic Operations Improvement Program	55	55	55	55	55	55	330
Traffic Signal Improvements and Upgrades	150	150	150	150	150	150	900
5th Avenue, Perry to Hilyard				1,215			1,215
5th Avenue, Mill to Perry	810						810
Subtotal	**2,265**	**2,536**	**3,295**	**4,110**	**2,675**	**1,085**	**15,956**
New Capital Facilities							
5th Avenue, Perry to Broadway	1,318				1,318		
5th Avenue, High to Perry	437						437
Chad Drive to Extension	1,112						1,112
Perry Street, 6th to 8th	400						400
Legacy Extension, Avalon to Royal Avenue		262	263	823	824		2,172
Roosevel Extension, Terry to Royal		270	274	160	963	963	2,630
Subtotal	**2,211**	**533**	**2,415**	**984**	**963**	**963**	**8,069**
Total	**13,456**	**12,040**	**14,680**	**14,174**	**12,718**	**11,120**	**78,205**

is likely to be more effective in influencing an *intraregional* location decision or a specific site decision—that is, in steering development within a region or city—than in affecting *interregional* decisions.

Infrastructure provision is less effective when the government is too far ahead of the market, putting infrastructure in areas of little interest to the private sector. In nearly all cases, though, the private market is clamoring for infrastructure improvement well in advance of any government decision to provide it. To that end, the CIP is an important indicator to existing and prospective businesses that a local government is willing to anticipate the need to maintain and expand infrastructure. The regular preparation of the CIP and the systematic execution of projects contained in it give strong notice to the private market about the local government's commitment and competence.

STRATEGY 8. CREATION OF A QUALITY OF LIFE CONDUCIVE TO BUSINESS INNOVATION

"Quality of life" is a term used to describe various, sometimes intangible factors that make a community attractive to live. A quality-of-life strategy assumes government or some type of public/ private partnership is able to have a significant influence on these factors and improve them over time. In theory then, new businesses will be attracted to communities with the most appropriate combination of factors, and existing businesses will expand for the same reason. Figure 4-3 provides a summary of these factors, as suggested by readers of *Money* magazine.

Yet despite the availability of easily identified factors, no universal agreement exists about which factors are important, to whom, and how to measure them. Dowell Myers, a professor of planning at the University of Southern California, has described the three different approaches to measurement (Myers 1998). The first, a **livability comparison**, emphasizes ranking places based upon composites of objective indicators. The definition focuses on "urban livability," the quality of

FIGURE 4-3. ALPHABETICAL LIST OF QUALITY-OF-LIFE ATTRACTION FACTORS

- Affordable car insurance
- Affordable medical care
- Clean air
- Clean water
- Close to big airport
- Close to colleges/universities
- Close to relatives
- Close to skiing area
- Diversity of local firms
- Far from nuclear reactors
- Good public transportation
- Good schools
- High civic involvement
- High marks from ecologists
- Housing appreciation
- Inexpensive living
- Lack of hazardous wastes
- Local symphony orchestra
- Low crime rate
- Low housing prices
- Low income taxes
- Low property taxes
- Low risk of natural disasters
- Low risk of tax increase
- Low sales tax
- Low unemployment
- Many hospitals
- Museums nearby
- Near a big city
- Near amusement parks
- Near lakes or ocean
- Near national forests and parks
- Near places of worship
- New business potential
- Plentiful doctors
- Proximity to major league sports
- Proximity to minor league sports
- Recent job growth
- Short commutes
- Strong state government
- Sunny weather
- Zoos or aquariums

Source: Smith and Nance–Nash 1993, cited in Segedy 1997.

the shared living environment in cities. Relevant factors include those measurable from secondary data sources, he says, including local income and education levels, housing prices, health care, climate, and arts and entertainment. Myers comments that a lack of theory to guide measurements is a significant flaw of the livability approach, particularly because place comparisons are not designed to measure quality of life as residents see it.

A second approach Myers describes is measuring **wage differentials**. Places with a less favorable quality of life or higher cost of living will have to offer higher wages to attract workers.

The third approach is measurement of **personal well-being**, in which individuals are asked to reflect on the personal details of their lives, not on shared community factors. This might involve happiness with marriage and family life, a job, or housing, or specific recreational pleasures. This approach, notes Myers, stresses matters largely beyond governmental control.

Of the three approaches, the one that is best known is the livability approach, which is featured in such publications as *The Places Rated Almanac*. Myers observes that livability measurements allow users to make comparisons between cities, particularly for the purpose of competing for new firms, but these measurements do not "meet the needs of locally committed businesses and citizens who seek to protect and improve their community's quality of life over time." He argues instead for a hybrid "community trend" approach in which local trends in components of quality of life using secondary data and personal interviews are monitored over time. This combines both an objective indicator profile of changing community character and a subjective citizen assessment of each factor. The approach would track which factors are growing better or worse, as they apply to a given community.

No contemporary discussion of the relationship between quality of life, regional growth, and appropriate economic development strategies would be complete without mentioning Richard Florida's theory of economic development. This theory bears directly on a community's desire to see growth in higher-than-average paying jobs, especially in high-technology sectors. He argues that regional economic growth is linked to the presence of creative people who prefer places that are diverse, tolerant, and open to new ideas:

> Diversity increases the odds that a place will attract different types of creative people with different skill sets and ideas. Places with diverse mixes of creative people are more likely to generate new combinations. Furthermore, diversity and concentration work together to speed the flow of knowledge. Greater and more diverse concentrations of creative capital in turn lead to higher rates of innovation, high technology business formation, and generation of job growth. (Florida 2004, 249)

No contemporary discussion of the relationship between quality of life, regional growth, and appropriate economic development strategies would be complete without mentioning Richard Florida's theory of economic development.

Florida contrasts his controversial theory with traditional theories of economic development, among them the belief that regional growth comes from attracting companies or building clusters of industries, or from concentrations of educated people. In their Brookings Institution monograph on the relationship between diversity and high-technology growth, which summarizes the research work, Florida and Gates (2001) use statistical analysis to show the relationship between diversity and high-technology growth. The study looked at the top 50 metropolitan areas.

Florida and Gates constructed three indices and a composite index to determine this relationship:

1. A gay index, which measures the over- or under-representation of gay male couples in a metropolitan area relative to the population

2. A "bohemian" index, which measures the over- or under-representation of artists (writers, designers, actors, directors, painters, sculptors, photographers, and dancers) and musicians in the metropolitan area

3. A foreign-born index, which is the percentage of those within a metropolitan area who were not born in the United States or its territories

4. A composite diversity index, which is the sum of the rankings of the individual diversity measures.

Using regression analysis, the Florida/Gates study found that the leading indicator of a metropolitan area's high-technology business success is a large gay population. Similarly, large concentrations of bohemians and the foreign born are also related to high-technology business success. Indeed, 11 metropolitan areas with the highest levels of overall diversity (based on gays, bohemians, and foreign-born people) were among the top 15 high-technology areas. San Francisco, Boston, Seattle, and Washington, D.C., were the top four high-tech regions and ranked in the top six regions on the composite diversity index.

"The bottom line of our analysis," Florida and Gates (2001, 8) wrote, "is basic: tolerance and diversity clearly matter to high-technology concentration and growth." Anticipating the obvious criticism that the presence of gays and bohemians cause regions to grow, they state: "We do not mean to imply that these results prove that a large gay population or concentration of bohemians causes the development of a technology industry; the theory is that people in the technology businesses are drawn to places known for diversity of thought and open-mindedness, and that our measures potentially get at a broader concept of diversity and inclusiveness."

Still, while problems of distinction exist, the livability comparison Myers identifies, which highlights the shared objective characteristics of communities using secondary data is probably the most popular and can be applied for attracting firms and workers.

Assessment. Quality of life is often thought of as access to open space; the presence of symphony orchestras, theatre, and museums; clean air and water; opportunities for recreation; and good schools. Nonetheless, evaluating quality of life is difficult, given the conceptual problems of distinguishing the factors government can address from those arising from an individual's satisfaction with his/her situation in life. Still, while problems of distinction exist, the livability comparison Myers identifies, which highlights the shared objective characteristics of communities by using secondary data is probably the most popular and can be applied for attracting firms and workers. The livability comparison approach allows local governments to look at what other communities are doing that lead to seeing them ranked "better" on various evaluation scales, provided those scales indeed measure factors that affect business decisions.

The Florida/Gates work poses new implications for the meaning of quality of life and its relationship to economic growth. While the Florida/Gates work does not lay out a roadmap or a set of specific actions for attracting the "creative class" (a weakness of the research), it does tend to support the proposition that metropolitan areas will grow, in Florida's words (2004, 293), by "remaining open to diversity and actively working to cultivate it, and investing in the lifestyle amenities that people really want and use often, as opposed to using financial incentives to attract companies, build professional sports stadiums or develop retail complexes."

This concept does not fit easily into conventional economic development or city planning. It does imply, however, that such planning should work to create vibrant communities with rich ethnic, educational, cultural, and lifestyle environments, and opportunities for human interaction. "Cities and regions," Florida (2004, 302) writes, "need to recognize the importance of incorporating all three facets of the new economic model: technology, talent, and tolerance. Without all of these factors working together, communities will be unable to become true Creative Communities and achieve the economic growth and quality of life their citizens deserve."

SELECTING STRATEGIES

The process of selecting strategies and particular actions for economic development planning is not always a straightforward one and indeed can sometimes present uncertainty. Clearly, it should relate to the evaluation of the strengths and weaknesses of the area economy and the organizational capacity of the local government and potential partners. Here are some questions that local officials should ask themselves when deciding and detailing different courses of action:

- What are the direct costs of the strategy?
- How is the strategy to be funded?
- How stable or accessible is the funding?
- Who is to implement the strategy?
- What are the benefits? Can those benefits be quantified?
- How long will it take?
- Has it been tried before, either in our community or in others? If so, what were the outcomes?
- What are the legal implications of the strategy? Does the local government actually have the authority to carry out the strategy, or will it need to rely on other public or private partners to implement it?

- What is the anticipated outcome?
- Do the strategies need to be implemented in any particular order?
- Which strategies are central to the success of the whole plan? To other strategies?
- Which strategies are time-sensitive (e.g., those that depend on a funding source with a cut-off date)?
- What strategies can be implemented quickly in order to demonstrate tangible results and build momentum?
- What strategies are mutually exclusive, duplicative, or negating?
- What strategies clearly have lower priorities? (WEDI 2003, 20)

This chapter has discussed eight categories of strategies. There are several different ways the strategies could be categorized. Tables 4-1 and 4-2 give an example of one alternative. For these summary tables, the strategies are grouped into not only "direct" vs. "indirect" assistance, but also "projects" vs. "programs and policies." The tables are illustrative, not comprehensive.

TABLE 4-1. DIRECT ECONOMIC DEVELOPMENT STRATEGIES

1. Direct Business Assistance

Projects	Location Factor Addressed	Pros	Cons
• Land or building purchase and assembly	• Land availability and cost	• Puts ownership of key property in hands of public job-creation authority • Overcomes fragmented ownership and scarcity of large developable sites	• Risk of holding undesirable property • Expensive
• Industrial park creation	• Land availability and cost • Access to markets	• Prepares land for development • Designed for multiple users and many jobs	• Land can remain vacant and underused while waiting for desired firms
• Business accelerator (incubator)	• Land availability and cost • Workforce • Business formation	• Focus on job creation • Nurtures companies of the future	• High initial costs for space and program management • Need to have management expertise or provide technical assistance • Small businesses do not lead to employment and tax base growth immediately

2. Direct Business Programs and Policies

Programs and Policies	Location Factor Addressed	Pros	Cons

• Financial incentives; grants and loals, including revolving loan fund	• Varies depending on what the grants and loans are used for, could include:
	  • Business climate
	  • Land availability and cost
	  • Business formation
		• Some existing programs have low cost per job
		• Can be targeted for various goals (historic preservation, job creation, etc.)
			• Effectiveness varies and is hard to measure
			• Improvements can capitalize by property owner through increased tenant rent
			• Requires local government to monitor loans, grant conditions

• Small business assistance	• Workforce • Business formation	• Relatively inexpensive • Local focus • Small businesses are numerous	• Requires dedicated, knowledgable staff

Source: ECONorthwest

TABLE 4-2 . INDIRECT ECONOMIC DEVELOPMENT STRATEGIES

1. Indirect Business Assistance

Projects	Location Factor Addressed	Pros	Cons
• Infrastructure improvement	• Access to markets (transportation and telecom) • Business environment (other utilities)	• Expands production possibilities • Increases access for workers and clients • Improves environment for workers and clients	• Expensive • Difficult to measure effectiveness
• Other public service improvement	• Community stability	• Promotes quality-of-life factors essential to attract workers	• Expensive • Difficult to measure effectiveness
• Planning and redevelopment studies	• Various	• Provides useful market information and visions for redevelopment • Few direct costs	• Relies on action by private sector, unless public agency owns relevant property

2. Indirect Business Programs and Policies

Projects	Location Factor Addressed	Pros	Cons
• Regulatory relief	• Business climate	• Makes it easier for development to occur • Not necessary to lower standards; can lessen duplication and burden	• Can remove necessary regulatory oversight if not done properly
• Financial incentives: tax relief	• Business climate	• Decreases cost of doing business	• Costly; may take away necessary resources from other services • Research shows that taxes are less important than quality of life, labor force, access to supplies
• Education and work-force development	• Workforce	• Workforce skills are a key requirement for job growth	• Costly • Requires coordination among multiple groups
• Business recruitment and marketing	• Varies	• Not as costly as grants or tax relief; relies on relaying information on positive attributes	• Can be "zero-sum" when viewed regionally or nationally • May not address the needs of existing businesses
• Intra-regional coordination	• Varies	• Decreases wasteful competition • Focuses on cross-boundary benefits	• Requires coordination of multiple groups/interests

Source: ECONorthwest

What does an economic development strategy ultimately look like? Table 4-3 shows an excerpt of an economic development strategy formulated by Washington County, Utah, to be consistent with its statement of core economic values (see above, p. 38).

TABLE 4-3 . EXCERPT FROM WASHINGTON COUNTY, UTAH, STRATEGIC PLAN

1. Retain and Expand Business

Goals	Measure of Success	Key Strategies	Implementation Agent
• Retain and expand existing businesses within the county that are consistent with the core economic values	• Employment in existing county businesses will expand by 5 percent per year	• 1.1 Facilitate incentive program for existing businesses equivalent to what is offered to new businesses • 1.2 Increase the education and training opportunities of the existing workforce to prepare employees to better meet customer needs • 1.3 Provide an outreach effort to directly contact and assist existing businesses • 1.4 Develop and provide financing packages to assist in financing gowth of existing businesses • 1.5 Facilitate conflict resolution between businesses and government	• Washington County Economic Development Council • Custom Fit Program/Dixie State College/Washington County School District/ DXATC • Chamber of Commerce/ Washington County Economic Development Corporation • Dixie State College Small Business Development Center/Five County AOG Loan Fund/Local Financial Organizations • Washington County Economic Development Council

Source: Washington County, Utah, *A Vision for Tomorrow, a Strategic Plan for Economic Development* (2003, unpublished).

APPENDIX A

Using Economic Base and Shift-Share Analyses to Analyze the Regional Economy

This appendix describes simple methods for analyzing the regional economy with economic base analysis and shift-and-share analysis.

Economic Base Analysis

Economic base analysis measures the extent to which the local or regional economy is exporting goods and services to the rest of the world. The underlying theory is that the more goods and services are exported, the more the local or regional economy will grow.

A simple way of analyzing the economic base is to use location quotients. The formula below shows what a location quotient looks like.

Regional location quotient for an employment sector =
(*Regional* employment in the sector ÷ Total regional employment in *all sectors*) ÷
(*National* employment in the sector ÷ Total national employment in *all sectors*)

Example:
Assume the following data for a hypothetical region:

(a) Total national employment = 66,713,000

(b) Total national employment for electrical equipment manufacturing = 1,943,300

(c) Total local employment = 328,580

(d) Total local employment for electrical equipment manufacturing = 28,080.

Insert the data above into the equation above:
(28,080 ÷ 328,580) ÷ (1,943,300 ÷ 66,713,000) = 2.9338

A number of 1.0 or greater suggests the particular industrial category is an export or basic industry. Here the calculations would indicate electrical equipment manufacturing is a very strong exporter in this particular region; its location quotient is 2.9. An analyst should track the changes in the ratio over time. If the ratio drops, it indicates some type of weakness in the export-oriented nature of the business within the region.

An alternative way of using a location quotient gives actual numbers of basic and non-basic industries using the following formula:

X_i ÷Total local employment =
National employment in industry *i* ÷ Total national employment

This assumes the relationship of national employment in an industry to total national employment is the same as the relationship of local employment in an industry (X_i) to total local employment.

Solving for X_i identifies the number of employees that industry i would need in order to serve local needs. Assuming that local residents have the same demand patterns that prevail at the national level, any employment in excess of X_i is assigned to the export sectors.

X_i ÷ 328,580 = 1,943,300 ÷ 66,713,000

Solve for X_i as follows:

$66{,}713{,}000 \times X_i = 1{,}943{,}300 \times 328{,}580 = 638{,}548{,}514{,}000$

$X_i = 638{,}548{,}514{,}000 \div 66{,}713{,}000 = 9{,}571$

which is the theoretical number of employees who are engaged in local-serving activity.

To determine the amount of employment in electrical equipment and supplies that is basic or export-oriented:

28,080 - 9,571 = 18,509

Thus, of the jobs in the electrical equipment category (28,080), 65.9 percent are export-oriented, and the remainder, 34.1 percent, are local-serving, or at least in proportion to national ratios.

Shift- Share Analysis

Shift-share analysis (or shift-and-share analysis) is a technique used to identify and explain regional departures from national growth rates by comparing regional and national growth rates among specific industrial sectors. It may also be used to project economic activity. In explaining differentials among regions, shift-share analysis breaks down the total amount of change, whether positive or negative, as measured either by an industry's income or employment, into three components, which, when added together, represent the total change in a particular industry (industry *i*) for a region.

The first component is the *national share*, which reflects the influence that the overall growth or decline of the national economy has on a region's industry.

The second component is *the industrial mix*. Also known as the "proportionality shift," this component identifies the influence an industry's national growth rate has on a region's economy.

The third component is the *regional share*. This component, also termed the "differential shift," reflects the fact that industries are generally expanding more (or less) rapidly in some regions than they are at the national level.

Here are the equations for shift-and-share analysis:

National share of an industry *i*'s employment in region at time t = ((Change in total national employment between time t and time t–n) ÷ (National employment time t-n)) × (Employment in industry *i* for region at time t-n.)

Industrial mix component for industry *i* in region at time t = (((Change in total national employment for industry *i* between time t and time t–n) ÷ (National employment for industry *i* at time t-n)) – ((Change in total national employment between time t and time t-n) ÷ (Total national employment at time t-n))) × (Employment in industry *i* for the region at time t-n)

Regional share of industry *i* at time t = (((Change in total regional employment for industry *i* between time t and time t-n) ÷ (Employment in industry *i* for region at time t-n)) – ((Change in total national employment for industry *i* between time t and time t – n) ÷ (National employment for industry *i* time t-n))) × (Employment in industry *i* for region at time t-n)

Example:

Assume the following hypothetical region:

Total national employment in 1000s for year t = 74,224

Total national employment in 1000s for year t-n = 66,713

Total national employment in 1000s in trucking and warehousing for year t = 1,126.4

Total national employment in trucking and warehousing for year t-n (in thousands) = 1,020.4

Total regional employment in trucking and warehousing for year t = 3,621

Total regional employment in trucking and warehousing for the region for year t-n = 2,976

Place the figures in the formula

National share = ((74,225 – 66,713) ÷ (66,713)) × (2,976) = 335

Industrial mix = (((1,126.4 – 1,020.4) ÷ (1,020.4)) – ((74,225 – 66,713) ÷ (66,713))) × (2,976) = –26

Regional share = (((3,621 – 2,976) ÷ (2,976)) – ((1,126.4 – 1,020.4) ÷ (1,020.4))) × (2,976) = 336

Total change = 335 + (-26) + 336 = 645

These data indicate, of the total change of 645 employees, 335 changed due to the overall growth in the national economy and 336 due to a set of unique regional factors. However, the particular industrial sector, trucking and warehousing, was not growing nationally during the analysis period; hence, the negative (-26) number. Again, these figures could be tracked over time to determine how the various shares are changing proportionally.

Sources: The examples in this appendix have been adapted, in part, from Meck 1976; Klosterman 1990, chaps. 9-13; and Krueckeberg and Silvers 1974, chap. 12.

APPENDIX B

Model Economic Development Element From the American Planning Association's *Growing Smart℠ Legislative Guidebook*

[*Editor's Note*: Bracketed citations refer to other parts of the *Legislative Guidebook*.]

7-208 ECONOMIC DEVELOPMENT ELEMENT

(1) An economic development element shall be included in the local comprehensive plan, except as provided in Section [7-202(5)] above.

(2) The purposes of the economic development element are to:

(a) coordinate local economic development initiatives with those of the state through its state economic development plan prepared pursuant to Section [4-206] and other state initiatives;

(b) ensure that adequate economic development opportunities are available in order to provide a heightened quality of life and to enhance prosperity;

(c) relate the local government's initiatives to the distinct competitive advantages of its surrounding region that make it attractive for business and industrial growth and retention, including its historic, cultural, and scenic resources;

(d) assess the local government's strengths and weaknesses with respect to attracting and retaining business and industry; and

(e) define the local government's role in encouraging job retention and growth and economic prosperity, particularly in relation to the availability of adequate housing for employees of existing and potential future businesses, industries, and institutions within its jurisdiction, transportation, broadening of job opportunities, stimulating private investment, and balancing regional economies.

(3) In preparing the economic development element, the local planning agency shall undertake supporting studies. In undertaking these studies, the local planning agency may use studies conducted by others, such as those conducted in preparation of the state economic development plan or any regional plan. The supporting studies may concern, but shall not be limited to, the following:

(a) job composition and growth or decline by industry sector on a national, statewide, or regional basis, including an identification of categories of commercial, industrial and institutional activities that could reasonably be expected to locate within the local government's jurisdiction. This shall include any studies and analyses of trends and projections of economic activity made as part of the land-use element pursuant to Section [7-204(5)(b)];

(b) existing labor force characteristics and future labor force requirements of existing and potential commercial and industrial enterprises and institutions in the state and the region in which the local government is located;

(c) assessments of the locational characteristics of the local government and the region in which it is located with respect to access to transportation to markets for its goods and services, and its natural, technological, educational, and human resources;

(d) assessments of relevant historic, cultural, and scenic resources and their relation to economic development;

(e) patterns of private investment or disinvestment in plants and capital equipment within the jurisdiction of the local government;

(f) patterns of unemployment in the local government and the region in which it is located;

(g) surveys of owners or operators of commercial and industrial enterprises and institutions within the local government's jurisdiction with respect to factors listed in subparagraphs (a) to (e) above. This shall also include an identification of the types of sites and supporting services for such sites that are likely to be needed by such enterprises and institutions that might locate or expand within the local government's jurisdiction;

(h) inventories of commercial, industrial, and institutional lands within the local government that are vacant or significantly underused. Such inventories may identify the size of such sites, public services and facilities available to it, and any site constraints, such as floodplains, steep slopes, or weak foundation soils. In conducting such an inventory, the local government shall utilize the existing land-use inventory prepared pursuant to Section [7-204(5)(f)] above. This inventory shall also identify any environmentally contaminated sites that have the potential for redevelopment for commercial and industrial uses once such contamination has been removed;

(i) assessments of organizational issues within the local government for encouraging economic development and the roles and responsibilities of other organizations that are involved in economic development efforts within the local government's jurisdiction and/or the region in which it is located, including the potential for cooperative efforts with other local governments;

(j) the adequacy of the existing and projected housing stock within the local government's jurisdiction for employees of existing and potential future commercial and industrial enterprises and institutions within its jurisdiction;

(k) assessments of regulations and permitting procedures imposed by the local government on commercial and industrial enterprises and institutions and their effects on the costs of doing business as well as their effect on the attraction and retention of jobs and firms; and

(l) opinions of the public, through surveys, public hearings, and other means, as to the appropriate role of the local government in economic development and desired types of economic development. Such opinions may also be obtained through the process of preparing the issues and opportunities element pursuant to Section [7-203] above.

(4) Based on the studies undertaken pursuant to paragraph (3) above, the economic development element shall contain a statement, with supporting analysis, of the economic development goals, policies, and guidelines of the local government. This shall include:

(a) a definition of the local government's role and responsibilities as a participant in the development of its region's economy;

(b) an identification of categories or particular types of commercial, industrial, and institutional uses desired by the local government; and

(c) a commitment to designate an adequate number of sites of suitable sizes, types, and locations and to ensure necessary community facilities through the community facilities element of the local comprehensive plan.

The economic development element may also include goals, policies, and guidelines to maintain existing categories, types, or levels of commercial, industrial, and institutional uses.

(5) The economic development element shall contain actions to be incorporated into the long-range program of implementation required by Section [7-211] below. These actions may include, but shall not be limited to, proposals for:

(a) rezoning of an adequate number of sites for commercial, industrial, and institutional uses during the 20-year planning period;

(b) reuse of environmentally contaminated sites for commercial and industrial activities through [*cite to state statute authorizing brownfields redevelopment*];

(c) capital projects of transportation and community facilities to service designated sites for commercial, industrial, and institutional activities;

(d) creation of or changes in job training programs;

(e) use of economic development incentives authorized by state law such as [tax abatement, industrial development bonds, tax increment financing, and urban renewal] and grant and loan programs that use local, state, or federal monies;

(f) creation of a joint economic development zone pursuant to Section [14-201] below;

(g) amendments to land development regulations that affect commercial, industrial, and institutional uses and other changes in administrative and permitting processes of the local government to facilitate economic development;

(h) programs of monitoring the needs of existing businesses and institutions to ensure their retention;

(i) design guidelines for commercial, industrial, and institutional areas;

(j) creation of new or continuation and enhancement of existing economic development organization(s), such as a chamber of commerce, community development corporation, tourism bureau, or community improvement corporation; and

(k) public information programs to market the economic development potential of the local government.

Source: Meck 2002, pp. 131-34.

APPENDIX C

An Economic Development Checklist

This *PAS Report* builds from work done by the authors to develop a guidebook for Envision Utah. The full guidebook can be found at:

www.envisionutah.org/plans.phtml?type=toolboxes
(accessed October 6, 2006).

Appendix E of that guidebook is called "Economic Development Readiness Evaluation Tool and Feedback." The tool was designed by Barry L. Bartlett, Director, Best Practices Institute of Utah. It is based on the structure for thinking about economic development that is developed in this *PAS Report*. The evaluation tool is also contained, in a slightly different version, in:

www.envisionutah.org/projectsfiles/24/PART%201%20-%20Executive%20Summary.pdf

Those two documents describe the tool, but we think that the spreadsheet that implements the tool is easier to understand. We show an example of the spreadsheet on the next three pages. In summary, it:

- Asks local planners 15 questions about their jurisdiction. The questions are in the three major categories of development factors that this *PAS Report* uses: (1) direct input factors; (2) factors directly affecting input costs and output revenues; and (3) factors indirectly affecting input costs. For each of the 15 factors, a local planner must score from poor/little to perfect/a lot (1 to 9). Filling out those 15 scores is all a local planner has to do; everything else is mechanical and done by the spreadsheet.

- Consolidates those scores into three summary reports: (1) Job and Firm General Factors; (2) System Inventory: Resources, People, Organizations, and Capabilities; and (3) Regional Planning and Governance Issues. The summaries use different combinations of the scores on the 15 questions (previous bullet) to give a numeric assessment of performance in several categories of concerns for each summary report. The first summary report (Job and Firm) is just a straight compilation of the 15 questions under the three factor headings. The other two reports use different measures. The following table shows how the 15 questions are used to create measures in the three reports (shaded cells show which of the 15 questions were used to create each of the 11 report categories (3 + 5 + 3 = 11).

Report Title & Sub-Category Titles *Item#:*	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Totals**	**/ #**	**Avg. Scores**
Jobs & Firms General Factors																		
1-Direct input factors																	5	
2-Factors directly affecting input costs, revs.																	4	
3-Indirect input cost factors																	6	
Number of times item used:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		3	
System Inventory: Resources, People, Organizations & Capabilities																		
1-Baseline Economic Resources																	5	
2-Community & Civic Organizations																	5	
3-Economic Development Capacity																	6	
4-Environmental Issues, Plans & Vision																	6	
5-Human Resources & Leadership																	8	
Number of times item used:	2	2	2	2	3	2	2	2	2	1	1	2	2	2	3		5	
Regional Planning & Governance Issues																		
1-Building sense, scope & need for region idea																	8	
2-Creating regional vision																	5	
3-Developing preservation, restoration, change																	6	
Number of times item used:	1	1	1	1	1	1	3	2	1	1	1	1	1	2	1		3	

Envision Utah: Economic Development Readiness Assessment Survey

Instructions: For each item, please indicate the *level of capacity and capability* you feel your community/area has in place right now to meet the standard indicated. Use the numerical indicators at the right (you can think of the numbers as percentages, **1**=11%, **2**=22%, etc):	Answers can range from **1-3** (low), **4-6** (medium), to **7-9** (high). Select one answer per each item.

Land and Buildings

1. **We have sufficient and appropriate types of land, buildings, and capital available to sustain the level of increased economic development we desire over the next 10 years.**	8-High, very well develo
2. **There are programs and services now in place appropriate to incent/support the rezoning, sale, and development of land tracts and buildings in our area to reach our economic development goals.**	7-High, pretty good sha

Labor

3. **There are sufficient amounts of (and incentives for) available labor, training mechanisms for, and data on workforce needs to meet current and future labor force requirements.**	6-Med., over half of nee
4. **There is a regional workforce plan available to coordinate available resources and help develop additional resources to ensure adequate worker availability to reach our goals.**	5-Med., about half of ne

Natural Resources

5. **Our community is actively engaged in preserving and regulating its critical natural resources.**	9-High, top 10% nation

Location Relative to Supplies and Markets

6. **Transportation systems are adequate to meet current and expected future growth.**	3-Low, some, very basic
7. **There is a comprehensive transportation plan available to coordinate future development.**	4-Med., under half of ne

Infrastructure and Utilities

8. **The community has enough critical infrastructure systems and services for existing and near-term future development requirements, as well as the means to develop expansion.**	5-Med., about half of ne
9. **There are comprehensive, up-to-date infrastructure development plans in place.**	2-Low, a little, not much

Amenity and Other Quality-of-Life Factors

10. **Our area has an adequate supply of housing and personal lifestyle support services.**	7-High, pretty good sha
11. **Our area has high-quality education, cultural, recreation, and business services.**	4-Med., under half of ne

Government Policies, Regulation, and Leadership

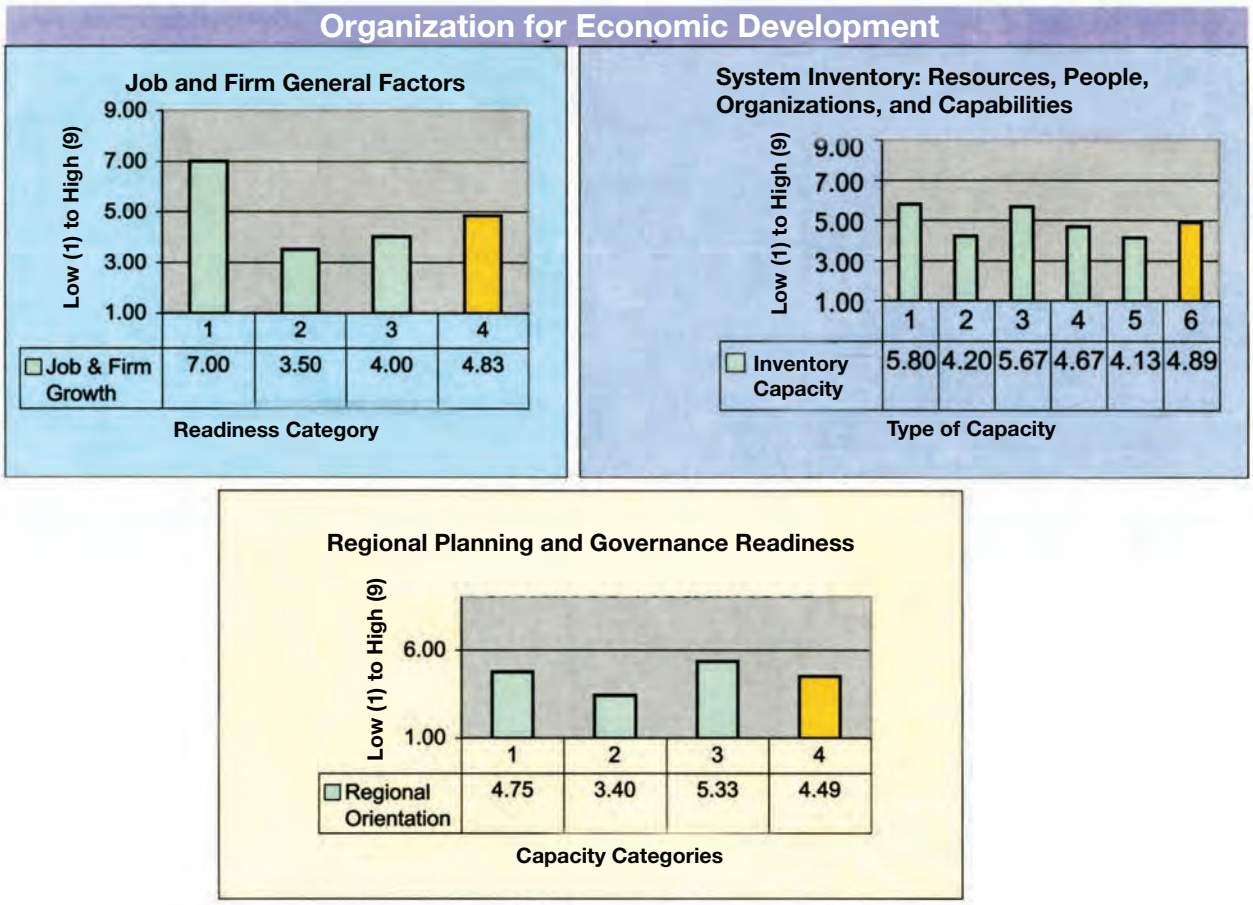
12. **Local governments have updated comprehensive plans integrated to our development goals.**	5-Med., about half of ne
13. **Our government institutions have the professional staff, local ordinances, administrative procedures, and political ability in place to support land development to reach our goals.**	5-Med., about half of ne

Organization for Economic Development

14. **Our area has highly qualified economic development professionals, programs, and agencies.** — 2-Low, a little, not much

15. **We have completely integrated economic development plans for business retention, targeted attraction, cluster and local growth, and effective plan monitoring and implementation.** — 1-Low, almost none, litt

Analysis Reports	Average Score	Percentage	Comments and Recommendations
1 Direct input factors	7.00	77.8%	Excellent. Work to sustain and increase those capabilities and programs now in place.
2 Factors directly affecting input costs and output revenues	3.50	38.9%	Consider additional factor improvement strategies. Focus on planning issues for fastest improvement.
3 Indirect input cost factors	4.00	44.4%	Good progress. Consider programs, ordinances, and planning strategies for sustained progress.
TOTAL AVERAGE SCORE	**4.83**	**53.7%**	Good progress. Consider additional long-term plans and resource development for sustained progress.
System Inventory: Resources, People, Organizations, and Capabilities			
1 Baseline Economic Resources	5.80	64.4%	Good progress. Review other long-term baseline strategies and programs for further improvement.
2 Community and Civic Organizations	4.20	46.7%	Good progress. Consider additional long-term people and civic program development options.
3 Economic Development Capacity	5.67	63.0%	Good progress. Consider more long-term strategies for further economic development growth, progress.
4 Environmental Issues, Plans and Vision	4.67	51.9%	Good progress. Additional planning, program development will usually help make improvements.
5 Human Resources and Leadership	4.13	45.8%	Making progress. Consider leadership recruitment, development and training for further improvement.
TOTAL AVERAGE SCORE	**4.89**	**54.4%**	Inventory looks fairly good. Review several more strategies for further progress. Focus on planning.
Regional Planning and Governance Issues			
1 Building sense, scope and need for regional area concept	4.75	52.8%	Good progress. Consider additional long-term, area-wide plans and programs for more improvement.
2 Creating regional vision	3.40	37.8%	Regional vision is very challenging. Look at area-wide needs, benefits, possibilities, and strategies.
3 Developing preservation, restoration and change strategies	5.33	59.3%	Good work so far. Regional strategies are often hard to develop, but worth the effort. Keep going.
TOTAL AVERAGE SCORE	**4.49**	**49.9%**	Regional economic development requires lots of cooperation. Keep building on your successes.


Organization for Economic Development
Job and Firm General Factors
Low (1) to High (9)
9.00
7.00
5.00
3.00
1.00
1
2
3
4
Job & Firm Growth
7.00
3.50
4.00
4.83
Readiness Category
System Inventory: Resources, People, Organizations, and Capabilities
Low (1) to High (9)
9.00
7.00
5.00
3.00
1.00
1
2
3
4
5
6
Inventory Capacity
5.80
4.20
5.67
4.67
4.13
4.89
Type of Capacity
Regional Planning and Governance Readiness
Low (1) to High (9)
6.00
1.00
1
2
3
4
Regional Orientation
4.75
3.40
5.33
4.49
Capacity Categories

APPENDIX D

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APPENDIX E

Glossary

[*Editor's note:* The following definitions are taken from *A Planners Dictionary*, PAS Report Nos. 521/522, edited by Michael Davidson and Fay Dolnick. Please consult that resource for other planning- and economic development-related terms and definitions. If the dictionary based its definition on a government document, the jurisdiction that was the source of the definition is shown in parentheses at the end of the definition.]

basic activities (*see* ***economic base theory***)

benefit-cost analysis: A form of project analysis in which the future benefits and the future costs of alternative projects in economic terms are discounted to a present value and ratios computed in order to compare different alternatives.

brownfield: A site which has remained un- or underused due to real or perceived environmental contamination; often a site of previous industrial use. (Washtenaw County, Mich.)

business improvement district: A special assessment district in which property owners agree to have an additional charge placed on their tax bill in order to fund special activities such as capital improvements or business promotion. (Milwaukee, Wisc.)

business incubator: A facility dedicated to the start-up and growth of small businesses, accomplished through management and facility support systems. For purposes of this definition, management support systems include access to professional advice, information on small business regulations, management, advertising, promotion, marketing, sales, inventory, employees, labor relations, and financial counseling. Facility support systems include clerical and reception staff, cleaning and building security, and access to copy and facsimile machines, computers, faxes, and other electronic equipment. (Galesburg, Ill.)

cluster: A geographically critical mass of companies that have some type of relationship to each other—generally in product, process, or resource. Such a critical mass attracts supportive suppliers and services. (National Governors Association)

comprehensive plan: The adopted official statement of a legislative body of a local government that sets forth (in words, maps, illustrations, and/or tables) goals policies, and guidelines intended to direct the present and future physical, social, and economic development that occurs within its planning jurisdiction and that includes a unified physical design for the public and private development of land and water. (American Planning Association)

cost-revenue analysis: Also known as fiscal impact analysis, a form of analysis used to determine whether developments will generate enough taxes and other related general revenues to pay for the added public services they require.

economic base theory: A theory holding that the structure of the economy is made up of two broad classes of productive effort: basic activities that produce and distribute goods and services for export to firms and individuals outside a defined localized economic area, and nonbasic activities whose goods and services are consumed at home within the boundaries of the local economic area. Basic activity exports goods and services and brings new dollars into the area; nonbasic activity recirculates dollars within the area.

goal: A desired state of affairs to which planned effort is directed. (American Planning Association)

guideline: An agency statement or a declaration of policy that the agency intends to follow, which does not have the force or effect of law and that binds the agency but does not bind any other person. (American Planning Association)

infrastructure: Those facilities and services needed to sustain industry, residential, commercial, and all other land-use activities, including water, sewer lines, and other utilities, streets and roads, communications, and public facilities such as fire stations, parks, schools, etc. (Redmond, Wash.)

input-output analysis: A form of analysis that directly measures the inter-relationships between industries in a region, as well as the extent of importing and exporting. For example, it shows the effect of a dollar of new spending within one industry on the income (or employment) of other industries with which it trades goods and services.

jobs/housing balance: A ratio between the expected creation of jobs in a region or local government and the need for housing. The higher the jobs/housing ratio, the more the region or local government is generating jobs in comparison with housing, and is thereby exporting the need to create new housing units to other regions or other local governments. (American Planning Association)

linkage (*see also* ***jobs/housing balance***): With respect to jobs/housing balance, a program designed to offset the impact of employment on housing need within a community, whereby project approval is conditioned on the provision of housing units or the payment of an equivalent in lieu fee. The linkage program must establish the cause-and-effect relationship between a new commercial or industrial development and the increased demand for housing. (California Planning Roundtable)

location quotient: A technique used in economic base analysis that measures the concentration of industry in a geographic area relative to a larger area. Location quotients describe the extent to which a particular industry is concentrated in one area relative to a larger reference area. A location quotient is simply a ratio of ratios: the ratio of an area's employment in one industry to its employment in all industries, divided by the ratio of a larger area's employment in that same industry to this larger area's employment in all industries. Location quotients greater than 1.0 indicate that the industry is more represented in the smaller area (e.g. the region) than it is in the larger area (e.g. the nation), while location quotients less than 1.0 indicate that the industry is less represented in the smaller area than it is in the larger area.

market-share analysis: A type of analysis in which the local government's share of a larger regional market for certain goods and services is tracked over time to determine whether it is growing, declining, or remaining stable.

multiplier: The effect of a dollar of new spending within one industry on the income (or employment) of other industries with which it trades goods and services.

non-basic activity (*see* ***economic base theory***)

policy: A general rule for action focused on a specific issues, derived from more general goals. (American Planning Association)

retail market analysis: A technique for estimating how much retail activity (and therefore how much retail building space and land zoned for retail) will be required by a community in the future and identifying which types of retail are likely to be most in demand or least in demand.

shift-share analysis: An analytical technique used to identify regional departures from national industrial growth rates and to compare and contrast growth rates among industrial sectors.

tax increment financing (TIF): A tool used by local governments to finance certain types of public improvements. The public purposes of TIF are the redevelopment of blighted areas, construction of low- and moderate-income housing, provision of employment opportunities, and improvement of the tax base. With TIF, a local government captures the additional property taxes generated by the development that would have gone to other taxing jurisdictions and uses the "tax increments" to finance the public improvements related to the development project.

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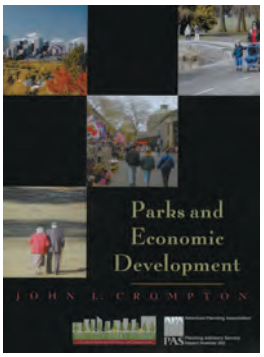


Parks and Economic Development

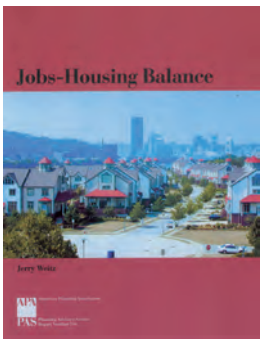
PAS 502. John L. Crompton. 2002. 74 pp.

Crompton explains how to measure and report the positive economic impact of parks and open space on the financial health of local businesses and government. Impact studies, graphs, charts, and other aids included in the report show how these contributions more than compensate for local tax dollars spent on acquiring, upgrading, and maintaining parks and other outdoor recreational areas.

Jobs-Housing Balance

PAS 516. Jerry Weitz. 2003. 41 pp.

Some argue that the market is the mechanism that will achieve jobs-housing balance. Weitz researched four types of jobs-housing imbalance and concluded that, in fact, the market failed to achieve such balance in three of the four scenarios he lays out. The report points to actions planners can take to help bring appropriate housing, jobs, and workforces together, resulting in overall community improvements.



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PAS 536. Al Zelinka and Susan Jackson Harden. 2006. (APA Planning Advisory Service.) 133 pp.

Do residents in your community have to travel to Disneyland to experience a distinctive main street? Do visitors need a road map to differentiate your town from the next? Public spaces are failing in many communities—and they are often barometers of vitality, social cohesion, and public health. This report offers help for small towns, neighborhoods, and downtowns that need to enhance identity and social connections without spending a lot of money.

Find out how citizens can get involved in identifying the history, culture, and resources that make their community unique. Learn to recognize opportunities for expressing community values. Case studies show how communities across the country have successfully used the approaches described in the report. Some towns have transformed streetscapes to reflect their agricultural past. Other communities have used bus shelters and security gates as venues for public art.

Project Rating/Recognition Programs

Matthew R. Cuddy and Douglas R. Porter. 2006. (APA Planning Advisory Service.) 48 pp.

What is smart growth? As communities around the country embrace the principles of smart growth, this becomes less a question of theory than of implementation. Communities who want to achieve smart-growth objectives need criteria and standards for evaluating the extent to which proposed developments qualify as smart growth.

This report explains how communities can create project rating systems that help them turn smart-growth principles into built projects. It offers examples of ratings systems employed by various organizations, describes their scope and intentions, explains the administrative processes involved, and evaluates their effectiveness. It also describes ways such systems can be used to educate the public and officials about smart growth and how some communities are using them in recognition and awards programs.

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ORIGINAL PAPER

Local and social: entrepreneurs, information network effects, and economic growth

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Abstract

Information is an essential input to the entrepreneurial process. Information based on the trials of past entrepreneurial projects can be particularly useful as it reveals details about the local market, benefiting subsequent ventures. Through a formal model of entrepreneurial search characterized by information flows and networks, we hypothesize a diminishing returns relationship between entrepreneurial information, in the form of births and deaths of entrepreneurial projects and economic benefits in the form of employment growth. We leverage the natural experiment contexts of regional economies to explore the role of information as it varies across market scale. In addition, given that networks, an important channel for information, are most powerful and effective in localized settings, we use the regional socio-demographic variation to explore the role of networks defined by gender. We indeed find statistically and economically significant evidence for the information-growth relationship in terms of both market scale and gender, with larger positive employment effects in less dynamic markets and less-networked market contexts. After building the empirical case for the importance of information flows and networks, we conclude with policy implications with particular attention to broadening and deepening entrepreneurial ecosystems.

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1 Introduction

Job creation is often a focal component of economic growth. New establishment startups, almost all of which comprise enterprises of less than ten employees, are disproportionately responsible for job growth in the USA (Haltiwanger et al. 2013). Recent research has further highlighted that younger firms are the source of virtual all labor productivity growth, implying that systematic decreases in startups may be linked to sluggish aggregate productivity trends (Alon et al. 2018). These relationships are not unique to the USA; similar gains have been found in other countries as well [as reviewed in Van Praag and Versloot (2007)].

The basis for these recent findings is the value-added innovations that are the hallmark of young firms which lead directly to higher productivity. Fresh entrepreneurial projects are constantly testing market frontiers in sectors from retail to manufacturing to services. The sheer volume of innovative startups is regularly cited for the US continuing economic strength and job creation prowess. However, the declining dynamism of the entrepreneurial sector in the new millennium is an area of increasing concern, particularly in terms of its effects on macroeconomic job growth. Yet entrepreneurship is inherently local, leveraged most effectively in proximate business clusters (Saxenian 1994).

A critical component of the entrepreneurial process is information. By their success and even their failure, past entrepreneurial projects reveal information about the contours of the market landscape such as consumer demand, the accessibility of complementary business services, and the availability of feasible financing. Thus, in addition to the direct benefit of generating jobs, the indirect information externality generated by the entrepreneurial process benefits future projects by reducing market uncertainty, improving the prospect for success, and culminating in a stronger local economy. This indirect informational effect of births is similar to the indirect effects of births discussed in Fritsch and Mueller (2004) studying Germany and applied in Portugal (Baptista et al. 2008) and Sweden (Andersson and Noseleit 2011). In emphasizing the informational spillover specifically, we offer a complementary framework for understanding how births can drive market change and ultimately employment growth, beyond their direct employment effect. This externality is developed in an informational networking model based on Leyden et al. (2014) linking networks and the information provided by establishment births and deaths to entrepreneurial projects' chances of success.

Based on the hypotheses emerging from the theoretical model, we leverage the natural experiments inherent in the spatial specificity of regional economies to empirically explore entrepreneurial information and its impacts on economic growth. We then extend the inquiry within such spatial units to explore the potential information transmission mechanisms within social networks such as those that form within a profession, religious affiliation, university alumni networks, or political ideology. In this case, we focus on that formed by socio-demographic groups, specifically by gender, to understand such networks' impacts on regional entrepreneurial dynamism. Thus, similar to Roper et al. (2017), we theorize that spatially specific market-based information influences entrepreneurial activity via social networks but distinctly posit that entrepreneurs generate such information and that it is

shared through networks, such as that defined by socio-demographic groups, particularly, gender.

The local informational benefits from entrepreneurial activity are not uniform across all entrepreneurial projects. We hypothesize a diminishing returns relationship between information increments from entrepreneurial projects and the economic payoffs in terms of stronger long-term job growth through improved entrepreneurial projects. This dynamic implies a relatively large return to the marginal entrepreneurial project in "thin" markets with less entrepreneurial activity compared with the marginal project in a highly dynamic market with a well-known market terrain.

In this research, we consider the diminishing return to information in two contexts. First, we evaluate this concept spatially, exploiting the regional variation in market scale to find evidence of relative diminishing returns as market thickness increases. We then consider the importance of specific social networks within each context. Leveraging the literature on gender and networks, we explore the gender variation in entrepreneurial activity within communities to evaluate the effects of flows of entrepreneurial information through social networks. Given the data and historical trends, gender provides a particularly useful example for applying the concepts of market scale and diminishing returns. Despite impressive growth trends, women-owned enterprises remain a small subsection of the broader market and system of information-channeling networks. In that sense, a pioneering female entrepreneur entering a local network not only adds establishment-specific information for potential followers, the entrepreneur herself also incrementally adds a further node to the local women's business network. Early-stage entrants in relatively lesser-developed "thin" networks may thus be particularly impactful, not simply in the information revelation process of her business project but also by providing critical nodal foundations for subsequent local women entrepreneurs.

Using an empirical model based on a spatial-equilibrium endogenous growth framework, we test the effect of entrepreneurial information through establishment dynamics and indeed find evidence of a decreasing returns relationship between incremental entrepreneurial information and subsequent job growth. Our baseline spatial results suggest the information from entrepreneurial projects produces positive and diminishing returns, meaning entrepreneurial activity produces relatively large employment payoffs in thin markets where there is less business activity. Furthermore, in a given spatial context, entrepreneurial activity by women has seemingly higher job payoffs than parallel activity by men. This finding suggests that informational increments in relatively lesser-developed social business networks have greater economic impact. The additional activity in thin markets adds to the network and thus enhances informational flows.

1.1 Information and entrepreneurship

Entrepreneurs must amass, combine, and filter large amounts of information at each stage of the entrepreneurial process. Identifying a viable business idea requires some insights on an innovative new good or service or a valuable variation on a product already on the market. Entrepreneurs must recognize an

unexploited market niche or an unmet consumer demand. They have to learn about market suppliers and business services available to complement their venture. Securing financing, finding a location, and establishing contact with clients all require information about competitors and the business community in general. As entrepreneurs learn more about the market, they can use the new information to continually improve their prospects for success, better source their inputs, and make decisions regarding the growth and promotion of their business.

In addition to accessing and processing information about the market for their own venture, entrepreneurs also generate information as they carry out their business activities. Each entrepreneurial project, either by its success or failure, reveals information about the market (Bunten et al. 2015). A project may reveal a viable product, a successful innovation, consumer demand, supplier networks, or labor pools, as examples. Entrepreneurial creation thus sheds light on a specific combination of demand and supply characteristics in terms of feasibility. Success in terms of growth underscores the viability of that particular project's combination.

Yet a project failure may be equally valuable, in that it signals that a particular demand/supply combination does not work, knowing what path NOT to pursue is valuable business information in itself. In that sense, follower entrepreneurs build on the failures of unsuccessful projects to make themselves stronger. Information generated by the success and failure of past projects effectively creates a significant positive externality because it is available for incoming entrepreneurs for the benefit of their forthcoming projects. Subsequent entrepreneurial projects will be carried out with more information on the local market and relevant industries. Our view is similar to Fritsch and Mueller (2004, p. 970), who argue that, "…it is not necessary that the new entities survive and exhibit strong growth…The point is that improvements are made whether on the side of the newcomers or on the side of incumbents." Entrepreneurs can imitate the successes of past projects and reengineer the projects that failed. In this formulation, current entrepreneurship is a causal factor in determining future entrepreneurship and thus in creating sustained economic development, as game-theoretically formalized in Weiler (2000).

To more fully understand this role of entrepreneurs in economic growth, we must understand the ways in which uncertainty shapes their actions. Akerlof (1970) and Stiglitz and Weiss (1981, 1983) argued that uncertainty of quality limits the extent of markets, whether it be the market for cars, for loans, or for labor. Greenwald et al. (1984) theorized that uncertainty about future prices can exacerbate small price shocks and thereby deepen business cycles. Weiler et al. (2006) found that the social benefits of information provision are likely to exceed the private benefits, implying that market outcomes are likely to result in underinvestment, particularly in thin markets. Microeconomic uncertainty can thus have macroeconomic effects. If entrepreneurs are crucial for the implementation of innovations, then uncertainty about their potential success can discourage participation and lead to a dearth of entrepreneurship and suboptimal growth.

Thus, we view entrepreneurship as a process of information revelation that is integral to economic growth. While entrepreneurs may seek to apply new technical knowledge to produce a new product or lower costs, they do so with uncertainty as to the eventual success of this application. In pursuing the implementation of an

innovation, entrepreneurs reveal its viability to the marketplace, reduce uncertainty, and thereby encourage investment; others can follow the successful pioneer while sidestepping the pitfalls made clear by the failures.

Entrepreneurial information has a distinctly local characteristic in such a formulation (e.g., Weiler 2006). The potential for business success is market-specific, both in its potential demand contours (e.g., for service industries) as well as more universally in its supply/cost character (i.e., labor, land, capital, insurance, among others). In regions with "thinner" markets—fewer openings, closings, and other business transactions—information on the potential of such markets will consequently be more limited.[1] Such information gaps may themselves impede prospective entrepreneurs directly, but may also indirectly restrict business opportunity through higher perceived uncertainty by critical loan and insurance suppliers.

The statistical analogy is straightforward. Even if the underlying probability profiles of two potential projects are identical, having fewer data points in a given market heightens variance, which in turn increases perceived project risk. In turn, emerging entrepreneurs in such markets see lower expected returns all while facing higher cost premiums for loans and insurance even if the underlying probability of project success is the same. As first presented and empirically evaluated in Bunten et al. (2015), we thus see differences in market-specific entrepreneurial experience as driving geographical informational asymmetries, in the spirit of Akerlof (1970), which in turn can yield suboptimal local investment and growth (Weiler et al. 2006).

1.2 The role of networks

Networks can have meaningful impacts on economic outcomes (Granovetter 2005). Perhaps the primary way networks impact outcomes is through the quality and flow of information (ibid.). In particular, people rely on people they know and trust for information that is tacit, difficult to verify, nuanced or locally specific—precisely the type of information many entrepreneurs use in developing a competitive venture. As an example, in his case study of 23 firms in the New York apparel industry, Uzzi (1997) found that information shared through networks was more proprietary and tacit than the simple price and quantity data that are regularly exchanged. This information, how much and to whom it flows, can determine the opportunities available for network members (Burt 2000). For these reasons, networks as an information transmission mechanism are essential for the positive information externality discussed in the previous section to materialize as employment growth.

To this end, entrepreneurs with dense and diverse ties have an advantage. As discussed in Granovetter (2005), the denser the network, the more unique paths along which information and ideas can travel between any two members. Thus, greater density can both reveal and verify information as it is encountered through

[1] In our view, informationally thick markets are both the cumulative result of dynamism over time as well as the immediate (or cross-sectional) result of a larger and denser region. In this paper, we offer empirical insights on dynamism through our specification which explicitly includes dynamic variables. In calculating the marginal effects, we gain insight on the cross-sectional sense of market thickness, as marginal effects incorporate a region's level of entrepreneurial activity.

multiple sources. However, dense networks with repeated ties, often driven by likeness between the members, lead to redundant information (Burt 2000). So, while dense networks may feature stronger relations, unique contacts are a better source of a new flow of information.

Weak ties are more likely to be a source of unique informational increments than strong ties (Granovetter 2005). Informational overlaps occur in small, close-knit social circles, so connecting with people outside one's primary social circle gives access to novel informational flows, adding informational value to an otherwise weakly connected network. From an entrepreneur's perspective, these novel pieces of information can be essential to establish a niche or gain a competitive advantage.

Entrepreneurs must balance network benefits of novelty with those of trust and reliability. It may be the case that entrepreneurs primarily associate with other entrepreneurs and leaders of the business community and get only limited new information. While that may be the case in a static setting, each time an entrepreneur attempts a project, which almost inarguably has some element of novelty be it location, industry, lending strategy, or an entirely original product or service, there will be new information available to share through the network. Entrepreneurial networks may thus be less vulnerable to redundant information even among similar members. Further, one can imagine that these contacts, by nature of their work, could also be the link to valuable weak ties such as lenders, real estate agents, laborers, local politicians, and other sources of information. Thus, large, dense networks are valuable sources of unique and reliable information for entrepreneurs.

1.3 Theoretical motivation

The information hypotheses can be structured by varying a model first proposed by Leyden et al. (2014). In the original model, more effective networks reduce costs resulting in an expanded search for inputs and improved prospects for success. Augmenting the model to more explicitly account for networks as well as market information generated by past entrepreneurial ventures motivates our hypotheses.

The entrepreneur, in exploring the optimal combination of inputs x, must procure resources and choose production methods and strategies. These N inputs can be combined into sets represented by $N \times 1$ vectors $x \in \mathbb{R}$.

Letting A_t be the Lebesgue measure of the size of the search space A_t at time t:

$$A_t = A(A_t) = \int_{x \in A} x \mathrm{d}x \tag{1}$$

The entrepreneur will search for inputs x that optimize her venture, sequentially expanding the search space such that

$$A_0 \subset A_1 \subset A_2 \subset \cdots \tag{2}$$

With each entrepreneurial venture in a region, the aggregate entrepreneurial experience and the entrepreneurial network itself expand with both new and deeper connections. These network ties, both strong and weak, provide important

entrepreneurial information. Strong ties are associated with access to fine-grained information and tacit knowledge, whereas weak ties provide relatively novel information as they bridge between otherwise disparate networks (Elfring and Hulsink 2003). Thus, network quality γ *in a local market* i is a function of the heterogeneity of the entrepreneurs' social ties s_i and the past experiences they share which are themselves a function of establishment births and deaths within a particular local network.

$$\gamma_i = \gamma_i(s_i(b_i, d_i)) \tag{3}$$

$$\frac{\partial \gamma_i}{\partial b_i} > 0, \quad \frac{\partial^2 \gamma_i}{\partial^2 b_i} < 0 \tag{4}$$

$$\frac{\partial \gamma_i}{\partial d_i} > 0, \quad \frac{\partial^2 \gamma_i}{\partial^2 d_i} < 0 \tag{5}$$

The entrepreneur's search is costly. Assume that this cost increases with the size of the search space and decrease in network quality. That is, entrepreneurs will be able to use their network to pursue cost-effective strategies through relationships and lesser-known price advantages that they have learned about through local network channels. The costs of searching depend both on the size of the region and the effectiveness of the network.

$$c_t = c(A_t|\gamma) \tag{6}$$

Costs are characterized by rising marginal costs and convex average costs with respect to A_t as shown with a second-order Taylor series expansion of the cost function evaluated at γ over the search area A_t:

$$\frac{\partial c}{\partial A_t} > 0, \quad \frac{\partial^2 c}{\partial^2 A_t} \geq 0 \tag{7}$$

$$\frac{c(A_t|\gamma)}{A_t} \ni A\frac{\partial^2 c}{\partial^2 A_t} - 2\frac{\partial c}{\partial A_t} + 2\frac{c}{A_t} \tag{8}$$

As the entrepreneurs' network becomes more effective, due to an increase in entrepreneurial activity, costs decrease. The implication is that more effective networks drive down total, marginal, and average costs. Or, at any given level of cost, an entrepreneur with a more effective network will benefit from greater efficiency and can explore a larger input space A_t.

$$\frac{\partial c}{\partial \gamma} < 0 \tag{9}$$

$$\frac{\partial^2 c}{\partial A_t \partial \gamma} < 0 \tag{10}$$

The relative size of the search space is important because entrepreneurship is inherently uncertain. The probability of success in A_t is unknown and, as a result, entrepreneurs rely on estimates of the probability of success which increases with the entrepreneurs' search region. Their estimates, however, are updated and improved based on their observations of the experiences of past entrepreneurs. Suppose, in local market i, there is an information production function that is increasing in establishment births and deaths.

$$\lambda_i = \lambda_i(b_i, d_i) \tag{11}$$

and has the following properties:

$$\frac{\partial \lambda_i}{\partial b_i} > 0, \quad \frac{\partial^2 \lambda_i}{\partial^2 b_i} < 0 \tag{12}$$

$$\frac{\partial \lambda_i}{\partial d_i} > 0, \quad \frac{\partial^2 \lambda_i}{\partial^2 d_i} < 0 \tag{13}$$

Assuming the M-dimensional set $K \in \mathbb{R}$, M describes the entrepreneur's knowledge set and increases in λ, and the entrepreneur's subjective probability of success in region A_t is defined by the cumulative probability function $F(A_t|K(\lambda))$.

$$0 \leq F(A_t|K(\lambda)) \leq 1 \tag{14}$$

and

$$F(A_t|K(\lambda)) < F(A_{t+1}|K(\lambda)) \tag{15}$$

To finance their venture, assume the entrepreneur enters capital markets and her access is bound by the expected value of her venture V^e where that value is defined as the product of the maximum value V of a successful venture and the probability of success.

$$V^e(V, A_t|K(\lambda)) = V * F(A_t|K(\lambda)) \tag{16}$$

Her resource constraint is thus:

$$c(A_t|\gamma) \leq V^e(V, A_t|K(\lambda)) \tag{17}$$

Assume an entrepreneur optimizes her probability of success by choosing a region of size A subject to the budget constraint. The optimal solution will equalize costs with expected value, because the probability of success of the project increases with size of the search area.

$$c(A_t|\gamma) = V^e(V, A_t|K(\lambda)) \tag{18}$$

Births and deaths thus affect the entrepreneurial ecosystem in a discernible manner that leads to empirically testable hypotheses, both in themselves and their interaction. Births and deaths contribute directly to the information set represented by λ, as well as to the evolution of network channels in γ. As outlined in Bunten et al. (2015), however, simple births and deaths devalue the impact of their interaction. Markets with higher levels of births in the presence of more

deaths emphasize the importance of market dynamism, where births and deaths together create a second-order effect above and beyond their first-order level impact. The significance of these interactive effects in Bunten et al. (2015) and the present study even when controlling for births and deaths individually indicate that such dynamism is indeed a crucial element of their information-channeling role. Marginal effects will thus include both direct and interactive components when evaluating births and deaths.

Leveraging the above model, births should have an unambiguously positive impact on eventual job growth. In addition to the direct and immediate effect of new jobs associated with startups, births also have positive indirect employment effects similar to the work of Fritsch and Mueller (2004). Births indirectly enhance both the information environment λ and network effectiveness γ. Holding other inputs equal, more developed network channels lead to a larger search area via lower costs and a consequent higher probability of projects' success. Similarly, holding costs and other inputs equal, more market information also leads to higher probabilities of success. Aggregating across all establishments and projects at the regional level, a greater likelihood of entrepreneurial project success yields higher employment growth. Thus, establishment births should have a clear positive marginal effect on local job growth.

Deaths have competing effects, generating a more robust empirical test. As explicitly shown in the model, deaths too have eventual positive indirect λ information and γ network effects. Deaths, however, also result more immediately in a direct negative effect associated with the job losses from closure. Thus, the marginal impact of an establishment death will have two competing elements. If the positive indirect information and network job effects are greater than the immediate and direct job losses, the total effect on success, and ultimately employment growth, will be positive in the long run. In that sense, deaths effectively have an especially high bar for positive job growth effects, where informational and network impacts must be sufficiently strong to outweigh the self-evident immediate job losses with an employer establishment closure.

1.4 Market scale

One of the primary predictions of the theoretical model is that market scale should have a substantive effect on employment returns. Markets with relatively little entrepreneurial activity such as those defined by smaller, remote, or rural communities are in a position to benefit considerably from each additional establishment birth or death, as noted by the increasing but diminishing returns to λ. Intuitively, thin informational markets get large benefits from just a few additional openings or closures, as each informational increment translates into relatively wide swaths of new understanding about previously unexplored entrepreneurial terrain that improve the search for intermediate inputs and infrastructure. Incremental births and deaths have a relatively high job growth payoff for the information those openings and closures produce as they help refine the entrepreneurial search and improve the prospects of subsequent entrepreneurial projects.

Ultimately, the effect of entrepreneurial information enhances startup activity and the probability of success culminating in stronger economic performance. Henderson and Weiler (2009) found that county startup rates positively influence future employment growth in the same and surrounding counties. The own county effect is stronger when it is a lower-activity county and has neighbors with relatively high startup rates. Startups thus have dynamic external effects—precisely what this view of entrepreneurship as information revelation would predict.

Thus, if the information revelation perspective is in fact relevant to the regional growth process, one would hypothesize that regions where births and deaths were significantly below a broader average would have high-growth payoffs to entrepreneurial activity. Conversely, regions which have dynamic entrepreneurial activity would have lower payoffs to additional births and deaths. Thus, in thin markets, we hypothesize that the marginal effect of an additional establishment birth or death on employment growth is quite large, and conversely, that the marginal effect of additional birth or death on employment growth in highly dynamic economies is relatively small. These propositions can be directly tested through marginal effects to an endogenous growth framework, as outlined in the empirical section below.

2 Empirical framework

To empirically explore the effects of market information λ and networks γ on local economic growth, their role must be placed in the broader context of regional economic growth dynamics. The empirical model for this research relies on that of Bunten et al. (2015), expanded to consider these effects as they relate to market scale and gender. They consider geographic information asymmetries using a spatial-equilibrium endogenous growth model. Their model is influenced by Roback (1982) in that equilibrium results from households and firms optimizing utility and profits, respectively, across space as well as Stephens et al. (2013) in that they consider the factors that drive the supply and demand for labor. Households choose their location to maximize utility which is a function of several factors that vary regionally including rent and amenities. Attractive regions will feature higher rent in equilibrium such that no household has incentive to move. Firms locate production to maximize profit which is a function of wages and labor productivity among other factors. Structural factors taken together with household and firm behavior determine wages, rent, and labor market dynamics.

Households maximize utility over space by choosing to reside in a particular location, indexed i. The optimal choice offers the best combination of amenities, local characteristics, rent, and expected wages given the skills of the household members. In the long run, optimizing behavior will result in equilibrium utility such that no household has incentive to relocate. In the medium run, households will move according to the difference in relative utility across locations i resulting in changes to labor supply

$$\Delta\text{Labor Supply}_i = L_s(U_i - U - M_i) \tag{19}$$

where labor supply (L_s) is increasing in relative local utility given by U_i, U, and M_i summarizes moving costs.

Firms consider the potential set of locations for production, indexed i, based on several factors including relative wages, labor availability and productivity, market access, the cost of inputs, and positive externalities from agglomeration. Firms will choose the location that maximizes expected profit π. In the long run, no firm will have a profit incentive to enter or relocate. In the interim, firm entry and migration will determine changes in labor demand

$$\Delta\text{Labor Demand}_i = L_{\text{d}}(\pi_i - \pi) \tag{20}$$

where the change in labor demand (L_{d}) is increasing in relative local profit given by $\pi_i - \pi$.

Equations 19 and 20 describing labor force dynamics can be summarized in a reduced-form equation that describes the relationship between regional employment growth and the factors that drive household and firm behavior. Local characteristics such as natural amenities and the accessibility of metro areas will affect local labor supply. Similarly, certain local attributes that affect firms' profitability, such as the skills of labor force and industrial composition, will determine labor demand. The reduced-form equation can be described generally as follows

$$\text{Employment Growth}_i = G(B_i, D_i, E_i, \text{IN}_i, \text{PD}_i, \text{PG}_i, \text{HC}_i, \text{MA}_i, A_i, \text{DM}_i) \tag{21}$$

where employment growth in county i is a function of entrepreneurial information and networks via the establishment birth rate (B_i), death rate (D_i), and their interaction, employment conditions (E_i), income (IN_i), population density (PD_i) and growth (PG_i), human capital (HC_i), the median age (MA_i), natural amenities (A_i), and distance to metro areas (DM_i).

If entrepreneurial projects do in fact enhance networks and provide a positive information externality that benefits subsequent entrepreneurs and ultimately supports local employment growth, the combined effect of entrepreneurial activity, measured by the establishment birth rate (B_i) and death rate (D_i), should be positive in support of our fundamental hypothesis (Hypothesis 1). Further, if there are diminishing returns to market information, the marginal effect of entrepreneurial activity should be quite large in places with relatively little entrepreneurial activity, and conversely, the marginal effect of entrepreneurial activity should be small in more dynamic economies (Hypothesis 2).

2.1 Endogeneity

Including measures of market information and networks using entrepreneurial activity in a model of employment growth has the potential for endogeneity. Employment growth may result from successful entrepreneurs growing their businesses and adding employees. However, it is equally plausible that entrepreneurs themselves respond to an expanding economy, pursuing their ventures on signs of economic growth. Thus, growth and entrepreneurial activity may each reinforce the other and/or respond to an exogenous factor that leads to both employment growth and increased entrepreneurial activity simultaneously. Following a well-worn trail negotiating such statistical conundrums (e.g., Sander 1992), we use an instrumental

variable strategy to address the possible endogenous variables.[2] In doing so, we seek to clearly identify the causal relationship between entrepreneurship and regional employment growth.

The IV analysis to assess the endogeneity of the key entrepreneurial variables—births, deaths, and their interaction—is detailed in the "Appendix". The diagnostic results[3] taken together are evidence that our measures of entrepreneurial activity and employment growth are not endogenous. We thus choose to focus the OLS results for the following discussion of the results.

3 Empirical model and data

The empirical strategy follows directly from the reduced-form solution summarized by Eq. 21, and we estimate Eq. 22 for 3072 counties or county equivalents in the contiguous United States. Counties typically feature a primary city, usually the county seat that forms the industrial, population, and political center for the area. While the city may be integrated socially and economically with adjacent areas, the primary city is typically the most relevant employment center which anchors the nearby population, thus making a relatively small cohesive economic unit. As the smallest feasible unit of observation for this study, we focus on counties in the contiguous United States.

$$\begin{aligned}\text{Employment Growth}_i = {} & \beta 0 + \beta 1 * \text{Births}_i + \beta 2 * \text{Deaths}_i + \beta 3 * (\text{Births}_i * \text{Deaths}_i) \\ & + \beta 4 * \text{Employment}_i + \beta 5 * \text{Income}_i + \beta 6 * \text{Lagged Emp Growth} \\ & + \beta 7 * \text{Predicted Emp Growth}_i + \beta 8 * \text{Human Capital}_i \\ & + \beta 9 * \text{Population Growth}_i + \beta 10 * \text{Population Density}_i + \beta 11 * \text{Median Age}_i \\ & + \beta 12 * \text{Amenities}_i + \beta 13 * \text{Distance to Metro}_i + E_i \end{aligned} \tag{22}$$

[2] The instruments for our measures of entrepreneurship are primarily deep lags of entrepreneurial and small business activity. Historically high levels of entrepreneurship are a signal of an entrepreneurial culture that likely persists over time leading to more business activity in the future. Usefully, in contrast, historical entrepreneurship likely has no relationship to future employment growth. Given these characteristics, our instruments, specifically the proprietor's share of employment (1979) and the share of employment in small businesses (1974), can usefully disentangle the relationship between entrepreneurship and employment growth.

However, the deeps lags of entrepreneurial activity are not adequate instruments by themselves across the variations of our focal explanatory variables. Therefore, we also include the employment–residents ratio (1980) and exploit the gendered aspects of entrepreneurship for additional instruments, in particular the female employment–population ratio in 1950 (both from Haines 2010). The lagged employment–residents ratio indicates a region that was relatively employment dense, which in turn would have crowded out demand for new entrepreneurial niches while also stifling the supply of potential entrepreneurs through the density of relatively stable wage and salary jobs (Low and Weiler 2012). The female employment–population ratio corresponds to regions that may have had relatively significant male job losses, which is likely to have negative repercussions on the local business environment including those seeking niches to start enterprises.

[3] Based on the first stage test of weak identification, the instruments are strong for births, deaths, and the interaction. First stage results are available from the author upon request. The relatively high Cragg–Donald statistic also provides evidence of strong instruments. Hansen's J statistic suggests that the instruments are exogenous. Last, we cannot the reject the null of exogenous regressors based on the GMM distance test.

One unique aspect of this research is the data source for several of our key variables. We use the National Establishment Time Series (NETS) to calculate the dependent variable, employment growth, as well as the establishment birth rates and death rates, the key explanatory variables. The NETS database tracks US establishments annually in detail from the first year they are active to their last. The NETS database originates with Dun & Bradstreet and is compiled into a time series by Don Walls and Associates who also clean and update the data with each year's release.

The employment growth rate from 2000 to 2007 calculated using NETS is the dependent variable for the analysis. The 2000 to 2007 period is advantageous because it captures a complete business cycle, spanning the (mostly) expansionary period that peaked in December 2007 (NBER) and comes before the possible structural shifts that accompanied the Great Recession. It is also consistent with using the 2000 Decennial Census for several explanatory variables. The NETS employment data deviates from some common sources in that it measures employment more broadly than government agencies that typically use nonfarm payroll employees. NETS spans all sectors and includes all forms of employment attached to a location including the owners themselves. Despite the methodological differences, we find that NETS employment growth for the period is close to that using data from the Bureau of Economic Analysis, as detailed in the "Appendix".

The NETS database is advantageous for this analysis primarily because of the level of detail. Using the establishment level data in NETS, we calculate county-level aggregates for the establishment birth rate and death rate in total.[4] The establishment birth rate and death rate include both nonemployer and employer establishments making the measures distinct from comparable statistics available from the Census Business Information Tracking Series. Including nonemployers also implies that NETS measures entrepreneurship more broadly—capturing early-stage business openings and closings that reflect subtler entrepreneurial experiments than are captured by more obvious employer establishments.

These data, particularly the data capturing establishment births, deaths, and their interaction, combined with the model given in Eq. 22 provide the basis for analyzing the theoretical relationship between the market information, networks, and employment growth. Though not an explicit test of information exchanges through networks, we expect this relationship exhibits diminishing returns in the context of market scale. Specifically, we expect that in more dynamic economies and more developed networks, the incremental effect of an additional entrepreneurial project will be smaller than in less dynamic (and seemingly less-networked) segments.

Births and deaths are each an input into market information and network effectiveness. Therefore, the specification includes the establishment birth and death rates each separately as well as their multiplicative relationship. Conceptually, this multiplicative relationship, which can be thought of as squaring the informational components, is comparable to a quadratic term in that it yields an enhanced interpretation

[4] Please see "Appendix" for details on definitions and methodology.

Table 1 Hypotheses and empirical testing

Hypotheses	Empirical implication
(1) Entrepreneurial projects (establishment births and deaths) generate a positive effect on employment growth	The marginal effects of establishment births and establishment deaths will both be positive
(2) The marginal effect of entrepreneurial activity is relatively large in less dynamic economies compared to the marginal effect of entrepreneurial activity in highly dynamic economies	The marginal effect of an increase in the establishment birth (death) rate will be decreasing in the interval ± three standard deviations from the mean establishment death (birth) rate

of establishment births and deaths.[5] Using the interaction is one dimension richer, in that it also isolates the likely informational interplay between births and deaths in generating a richer information set. To determine whether there is empirical evidence of diminishing returns, we consider both the sign and significance of our focal variables, including their interaction, as well as evaluate the marginal effects.

If the marginal effects of our core informational sources, namely births and deaths, are decreasing across a range of entrepreneurial activity, then the empirical results are consistent with the motivating theory. Such a finding implies that there are diminishing returns, in terms of employment growth, to entrepreneurial information. Table 1 summarizes these hypotheses and empirical assessment. For an interesting extension and robustness check in our gendered case, we compare these marginal effects across gender with the expectation that women-owned establishment births and deaths generate larger marginal effects because of the relative lack of market information and established based on more limited female entrepreneurial experiences.

The remaining explanatory variables follow Deller et al. (2001), Huang et al. (2002), Rappaport (2007), Acs and Armington (2006), Stephens and Partridge (2011) as well as the more recent Stephens et al. (2013) and Bunten et al. (2015). First, to assure that we measure the effect of entrepreneurial projects on employment growth apart from any underlying trends, we include lagged employment growth, as well as the log of employment in 2000, and historical population growth. Such variables control for the initial conditions in each county that are important drivers of subsequent regional economic conditions (Huang et al. 2002). Additionally, as in Partridge et al. (2009) and Bunten et al. (2015), we include a measure of predicted employment growth based on the county industrial profile and the national growth trend of those industries. The variable thus controls for any local employment trends that may reflect regional industrial concentrations in industries that expanded or contracted nationally during the study period. For each county, the predicted

[5] Alternatively, the baseline gender blind regressions using the establishment birth rate, establishment death rate, and their respective quadratic terms yields the diminishing returns posited by the theoretical motivation. However, using the interaction of births and deaths in place of squared terms more directly reflects our theoretical priors and performs more consistently in the empirical analysis.

employment growth is equal to the product of the county's initial industry shares s_{ij} and its respective national growth rate G_j for the period 2000–2007 and summed together: $D_i = \sum_j G_j s_{ji}$ where industry employment shares are calculated from the County Business Patterns for each three digit NAICS sector and the BEA-REIS for government.

Human capital is an important factor determining entrepreneurial outcomes (Conroy and Weiler 2015) as well as economic growth at the county level (Beeson et al. 2001) and in labor market areas (Thompson et al. 2006). We use several measures of human capital that incorporate and test the perspective of Florida (2002) on the importance of the creative class. The creative class, those workers engaged in creative thinking and processes, can enhance the productivity in a region by leading innovation and attracting businesses, looking for a talented workforce. The human capital variables in the analysis thus include the share of the population with a bachelor's degree as well as those employed in two particular subsets of the creative class, the arts, and high human capital occupations. Artistic occupations include those in the performing, applied, and fine arts. High human capital occupations are those in highly skilled and creative occupations such as engineering, architecture, and computer science.[6] We also include the median age of the population as older populations are found to be more entrepreneurial, perhaps partly because they have acquired more professional experience.

Metropolitan areas provide many benefits from agglomeration. Access to amenities such as theaters, museums, and universities combined with dense and diverse business centers and a large population provide the ideal circumstances to generate positive externalities. These benefits, however, accrue to communities nearest to metropolitan areas. We include several coordinate-based measures of distance to the nearest MSA centroid to capture these benefits as they diminish with distance. To further control for agglomeration, we include the tract-weighted population density. Scenic locations with moderate climate also tend to host footloose entrepreneurs who values natural amenities (Deller et al. 2001; Rappaport 2007). We include the natural amenity score provided by the United State Department of Agriculture–Economic Research Service. Places that feature mountainous or an otherwise scenic landscape with mild winters and cool summers score the highest (Table 2).

4 Results

We report OLS results in Table 3. For interpretive ease, we center births and deaths for all regressions and use the centered terms to create the interaction. All regressions are employment-weighted and include state fixed effects. The dependent variable is the percent employment growth from 2000 to 2007. Though the table includes

[6] Deconstructing the metric into its high human capital component versus the actual creative arts component as in Bunten et al. (2015), allows us to both use the insights of Florida yet also assess the fundamental critique of McGranahan and Wojan (2007) and others that the broader measure simply captures specialization in high human capital occupations rather than any effect of "creativity."

Table 2 Summary statistics

Variable	Mean	SD	Min	Max
Emp growth, 2000–2007	3.9143	12.4214	− 81.6092	122.2889
Birth rate, 1998	7.7591	3.3240	0.0000	66.6667
Death rate, 1998	6.7664	1.7409	0.0000	66.6667
Female birth rate, 1998	1.4995	0.7253	0.0000	12.2087
Female death rate, 1998	0.5585	0.2763	0.0000	8.4567
Male birth rate, 1998	6.2596	2.6971	0.0000	66.6667
Male death rate, 1998	6.2078	1.6043	0.0000	66.6667
Predicted employment, 2000–2007	6.2285	3.6193	− 20.7134	87.2277
Emp growth, 1990–2000	22.2327	20.5797	− 39.3747	767.2035
Log employment, 2000	12.3657	1.6822	4.5539	15.5126
Log income, 2000	10.5546	0.2798	8.0287	11.3859
Density, 2000	6.4957	15.4140	0.0001	113.5345
BA share, 2000	25.9645	9.8511	4.9205	60.4820
HC share, 2000	24.6112	7.1381	0.0000	52.9723
Arts share, 2000	1.2500	0.8109	0.0000	6.6721
Pop growth 1950–1960	0.3901	0.4795	− 0.4228	3.7112
Median age, 2000	35.2095	3.1995	20.6000	54.3000
Amenity score	1.2963	3.3467	− 6.4000	11.1700
Distance to MSA	0.3040	0.3725	0.0000	4.3409
Marg dist MSA > 250 k	0.2739	0.7735	0.0000	8.9237
Marg dist MSA > 500 k	0.3369	0.8739	0.0000	9.3394
Marg dist MSA > 1 M	0.4018	0.9614	0.0000	8.3617

Values are employment-weighted

the full set of explanatory variables, the discussion to follow focuses on the key variables, namely the establishment birth and death rates and their interaction.

4.1 Results: market scale

The results support the fundamental hypothesis that the frequency of entrepreneurial projects—as measured by establishment births, deaths, and their product—has a positive and significant effect on local employment growth. The coefficients on the establishment birth rate, and perhaps more notably, the death rate are both positive and strongly significant, while the coefficient on the interaction term is negative and significant. As expected, new establishments are linked to employment growth, but the positive link between establishment deaths and employment growth is consistent with a positive informational effect. This positive effect is all the more remarkable because a death directly signifies employment losses with the establishment closure. The fact that deaths nevertheless have a longer-term positive employment effect over and above the direct negative effect of an establishment closure emphasizes the relative strength of the informational role.

Table 3 Employment growth 2000–2007

	Obs = 3072 $R^2 = 0.6459$ FE = State IV = No			Obs = 3072 $R^2 = 0.6426$ FE = State IV = No			Obs = 3072 $R^2 = 0.6283$ FE = State IV = No		
	Coef.	Robust SE	$P>\|t\|$	Coef.	Robust SE	$P>\|t\|$	Coef.	Robust SE	$P>\|t\|$
Birth rate, 1998	1.1489	0.1210	0.000						
Death rate, 1998	1.1565	0.1919	0.000						
B * D, 1998	−0.0930	0.0224	0.000						
Male birth rate, 1998				1.2157	0.1307	0.000			
Male death rate, 1998				1.4124	0.2069	0.000			
Male B * D, 1998				−0.0980	0.0277	0.000			
Female birth rate, 1998							6.1603	0.5691	0.000
Female death rate, 1998							3.3178	0.8183	0.000
Female B * D, 1998							−3.8747	0.4910	0.000
Predicted emp growth, 2000–2007	0.1656	0.0653	0.011	0.1703	0.0655	0.009	0.2114	0.0662	0.001
Emp growth, 1990–2000	0.1517	0.0328	0.000	0.1559	0.0336	0.000	0.1447	0.0335	0.000
Log employment, 2000	0.4560	0.3753	0.224	0.2226	0.3812	0.559	1.1991	0.3749	0.001
Log income, 2000	−14.1845	2.9128	0.000	−15.0376	2.9311	0.000	−16.9575	2.8418	0.000
Density, 2000	0.0596	0.0390	0.127	0.0577	0.0399	0.148	0.1019	0.0331	0.002
BA share, 2000	−0.2468	0.1199	0.040	−0.2646	0.1203	0.028	−0.2317	0.1189	0.051
HC share, 2000	0.5376	0.2123	0.011	0.5737	0.2157	0.008	0.5377	0.2104	0.011
Arts share, 2000	−0.2992	0.8979	0.739	−0.1806	0.9091	0.843	−0.9557	0.7804	0.221
Pop growth 1950–1960	−1.5670	0.7522	0.037	−1.6262	0.7512	0.030	−0.3981	0.7065	0.573
Median age, 2000	−0.3994	0.1055	0.000	−0.3700	0.1056	0.000	−0.3560	0.1062	0.001
Amenity score	−0.0903	0.2087	0.665	−0.0895	0.2120	0.673	−0.0577	0.2084	0.782
Distance to MSA	−0.5706	0.6405	0.373	−0.4808	0.6421	0.454	0.1155	0.6427	0.857

Table 3 (continued)

	Obs = 3072 $R^2 = 0.6459$ FE = State IV = No			Obs = 3072 $R^2 = 0.6426$ FE = State IV = No			Obs = 3072 $R^2 = 0.6283$ FE = State IV = No		
	Coef.	Robust SE	$P>\|t\|$	Coef.	Robust SE	$P>\|t\|$	Coef.	Robust SE	$P>\|t\|$
Marg dist MSA > 250 k	−0.2126	0.3180	0.504	−0.2720	0.3198	0.395	0.0236	0.3231	0.942
Marg dist MSA > 500 k	0.3414	0.2322	0.142	0.3598	0.2336	0.124	0.0558	0.2392	0.816
Marg dist MSA > 1 M	0.5559	0.2888	0.054	0.5112	0.2924	0.081	0.4658	0.2902	0.109
Cons	156.327	28.176	0.000	165.4445	28.8432	0.000	174.4824	27.6074	0.000

Table 4 Marginal effects of the establishment birth rate on employment growth

Establishment death rate	d*y*/d*x*	SE	$P>\|t\|$
− 3 SD	1.63	0.19	0.000
− 2 SD	1.47	0.16	0.000
− 1 SD	1.31	0.14	0.000
Mean	1.15	0.12	0.000
+ 1 SD	0.99	0.12	0.000
+ 2 SD	0.83	0.13	0.000
+ 3 SD	0.66	0.15	0.000

Using the centered birth rate and death rate allows for straightforward interpretation. In a county with a mean death rate, equal to zero after centering, the marginal effect of a one unit increase from the mean birth rate is 1.15 percentage points in employment growth over the subsequent period. Symmetrically, for deaths, in a county with a mean birth rate, the marginal effect of a one unit increase from the mean death rate is 1.16 percentage points in employment growth. Thus, consistent with our theoretical motivation based on a positive information externality, both births *and* deaths alike generate positive employment effects in the typical local economy. To give a sense of magnitude, in a county with the average 50,000 employees in 2000, a one unit increase in the birth rate would correspond to 50 additional businesses. These additional 50 businesses would correspond to just over one percentage point additional employment growth from 2000 to 2007.

In addition to the positive effects of entrepreneurial dynamism, the results also demonstrate the importance of market scale. Given that births are interacted with deaths, effectively squaring our two information components, the marginal effect of the birth rate will vary with the establishment death rate. The negative coefficient on the multiplicative term between births and deaths alongside the positive coefficient on the birth rate is conceptually similar to interpreting a quadratic specification in that it signals a positive but decreasing relationship between entrepreneurial information from establishment births and employment growth. Our result is comparable to Roper et al. (2017) who use levels and squares of their variables measuring local knowledge sources and finds a nonlinear, decreasing returns relationship with innovative outputs by firms.

Table 4 and the accompanying Fig. 1 display the marginal effect of the establishment birth rate across a range of establishment death rates three standard deviation around the mean. The plotted line with a downward slope, equal to the coefficient on the interaction term of − 0.09, demonstrates the importance of entrepreneurial dynamism. On this interval, the effect of an increase in the establishment birth rate on employment growth is largest and positive in economies with a below average death rate and decreases thereafter in more dynamic economies. Similarly, Table 5 and Fig. 2 demonstrate that the marginal effect of the death rate on employment growth is largest in counties with low establishment birth rates and decreases as economies become more actively entrepreneurial. That is, the marginal effects of a birth and death are higher in thinner, less dynamic counties compared with the effects in thick,

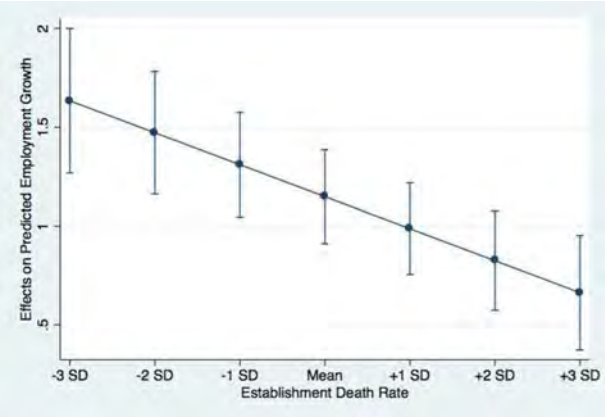

Fig. 1 Marginal effect of establishment birth rate

Table 5 Marginal effects of the establishment death rate on employment growth

Establishment birth rate	d*y*/d*x*	SE	$P>\|t\|$
− 3 SD	2.08	0.31	0.000
− 2 SD	1.77	0.25	0.000
− 1 SD	1.47	0.21	0.000
Mean	1.16	0.19	0.000
+ 1 SD	0.85	0.20	0.000
+ 2 SD	0.54	0.23	0.019
+ 3 SD	0.23	0.28	0.409

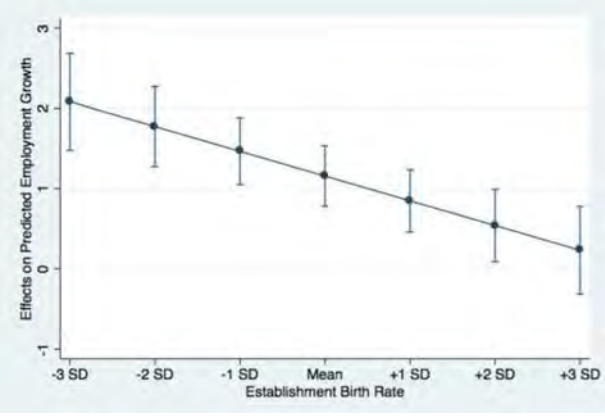

Fig. 2 Marginal effect of establishment death rate

dynamic markets, suggesting that market scale is the key to understanding the incremental informational benefits of entrepreneurship.

Relative changes in entrepreneurial activity generate economically significant changes to regional employment outcomes. The fact that establishment openings generate jobs is not surprising; the fact that closures are equally constructive in creating job growth is remarkable. Furthermore, the impacts of a given opening or closure depend inversely on the thickness of their entrepreneurial environment. A new, pioneering firm exposes a relative wealth of information in thin markets. Comparatively, in a dynamic market with many closings and openings, a new firm adds only a slim margin of information about already well-known market terrain.

5 An empirical extension

Relationships that are the basis of networks can evolve along many dimensions, both economic—such as by sector or industry—and socio-demographic, such as by historic cultural ties like university alumni. In the present case, we focus on gender networks as one such subgroup, an important yet often overlooked system of information-channeling structures (e.g., Weiler and Bernasek 2001) for the segment of the population that has effectively doubled its educational attainment levels in just a single generation (Colorado Innovation Report 2014). The NETS database is particularly advantageous for such an analysis because it is possible to disaggregate the birth rate and death rate for women-owned or managed establishments. Using the establishment level data in NETS, we calculate county-level aggregates for the establishment birth rate and death rate by gender.[7] The following extension explores the network informational asymmetries between male- and female-owned businesses and their impacts on job growth.

5.1 Gendered networks

As a result of long-standing social institutions such as male-dominated professional networks and historical gender norms, women entrepreneurs may find it difficult to integrate themselves into supportive networks. Most entrepreneurs, especially most older, experienced entrepreneurs, are men. As a result, business networks and their better-connected members are predominantly male and women may suffer a less-networked position. As evidence of these gendered networks, past work has shown that working women are less likely than working men to belong to voluntary business organizations. Those organizations in which they do participate are smaller and are less likely to have a significant market presence (McPherson and Smith-Lovin 1982). Thus, the organizational networks that can determine flows of information and access to resources differ considerably in size by gender (ibid).

[7] Please see "Appendix" for details on definitions and methodology.

The gender composition of the workplace and/or occupation, as summarized by McPherson et al. (2001), can also play a powerful role in the gender composition of the networks of men versus women. The minority group, often women, have much more gender-diverse networks than do the majority group. The majority group, typically men, tend to have much more gender-specific networks. The stronger the majority is, the stronger the difference in networks. This pattern is even more pronounced in looking at network ties characterized by advising, mentoring, and respect. Taken together, these findings suggest that among (male-dominated) entrepreneurs, men are primarily networking with other men. Women are networking with other women but must also connect with men in order to gain access to the majority of information flows and social resources. That is, women likely face a network barrier in connecting with the male-dominated network, and this is likely even more limiting when it comes to finding a mentor and valuable advice.

Returning to the model framework, networks can be considered gender-specific, where male and female entrepreneurial networks are characteristically different. These network differences may arise for several reasons such as the previously discussed tendency for network homophily, different preferences, and/or persistent yet subtle sexism in the workplace (see Akerlof and Kranton 2000 for an interesting discussion). As a result, women often perceive a "glass ceiling"-type or "boys' club" effect (e.g., Weiler and Bernasek 2001) where they are less networked with key leaders and role players in the business community. For example, women may have fewer connections in total and in particular, they may suffer fewer key members that connect them to unique sources of information as described by Granovetter (2005).

In addition to the networking challenges just described, there are simply fewer women entrepreneurs (currently and historically), and thereby, women, in aggregate, have less entrepreneurial experience to share. Only in recent decades have women become a significant share of entrepreneurs and business owners. Even now, women own roughly one-third of firms in the USA and account for just 12% of sales (U.S. Small Business Administration 2017). As a consequence of the low level of entrepreneurial activity among women combined with other potential challenges, new women entrepreneurs likely have networks comparatively sparse in entrepreneurial connections, resulting in greater uncertainty for any given potential project. Incoming women entrepreneurs have fewer role models and mentors and thus limited information about the local market that comes from past projects. Even beyond their access to market-based information, weak networks may additionally disadvantage women in their access to finance, supplier networks, and other components of business that benefit from interpersonal relationships. Thus, social networks, which theoretically reduce transactions costs and thereby increase economic efficiency, may actually be a barrier for women entrepreneurs (Weiler 2000).

Thus, women entrepreneurs' networks are likely smaller and less dense and have weaker information flows than their male counterparts. Translated into our framework, the effect is twofold. First, men and women will face different costs to their search for inputs based on the development of their collective networks. We expect that early nodes in the entrepreneurial network provide important foundational connections or social ties, more so than later nodes that add a relatively smaller increment of network value leading to the following variations in Eqs. 23–25.

$$\gamma_{gi} = (\gamma_{gi}(s_i(b_{gi}, d_{gi})) \quad g \in \{m, f\} \tag{23}$$

$$\frac{\partial \gamma_{gi}}{\partial b_{gi}} > 0, \quad \frac{\partial^2 \gamma_{gi}}{\partial^2 b_{gi}} < 0 \tag{24}$$

$$\frac{\partial \gamma_{gi}}{\partial d_{gi}} > 0, \quad \frac{\partial^2 \gamma_{gi}}{\partial^2 d_{gi}} < 0 \tag{25}$$

Female and male networks clearly differ significantly in scale and scope. While female and male networks may have some overlap, the informational channels within each core network are critical to the effectiveness of information transmission. Therefore, even though women entrepreneurs may glean some insight from men's larger informational set, the relative lesser set of connections within women's entrepreneurial network constrains the actual effectiveness of these informational increments. Specifically, we posit $\gamma_f < \gamma_m$ and, as consequence, women face higher search costs, a subsequently smaller search area, and a lower probability of success.

$$c(A_t|\gamma_m) < c(A_t|\gamma_f). \tag{26}$$

Second, as a consequence of the low level of entrepreneurial activity among women, new women entrepreneurs enter a relatively thin informational market, resulting in greater uncertainty for any given potential project. That is $\lambda_m > \lambda_f$. This lack of information likely results in fewer and or lower quality entrepreneurial projects for women entrepreneurs compared to men. It follows that all else equal, the typical female entrepreneur's resource constraint $V^*F\ (A_t \mid K\ (\lambda_f))$ would be lower than the typical male's constraint, indicating that

$$V(V, A_t|K(\lambda_f)) \leq V(V, A_t|K(\lambda_m)).$$

The gender asymmetries could discourage new businesses led by women entrepreneurs, but at the same time, from both an information and network perspective, each of their projects is all the more valuable. That is, with relatively little information available from women entrepreneurs alongside a relatively thin network, pioneering females generate market information in large increments. In addition, each project—even a failure—adds a potential node to the female entrepreneurial network. Even if only the most promising female-led projects overcome the obstacles and succeed in the marketplace, their projects are all the more likely to pioneer the way for future entrepreneurs, both by informing their followers and by creating critical foundational nodes for their network.

The combined effect of such female pioneers should result in larger regional employment effects than entrepreneurial increments to the comparatively information-thick and well-networked male ecosystem. Thus, compared to men, the marginal effect of an additional female-led project generates a large increment of regional growth. In this framework, we thus expect the findings of diminishing returns from the previous section will hold by gender. Specifically, the diminishing

Table 6 Hypotheses and empirical testing

(3a) The marginal effect of male entrepreneurial activity is relatively large in less dynamic economies compared to the marginal effect of male entrepreneurial activity in highly dynamic economies	The marginal effect of a male-owned establishment birth (death) will be decreasing in the interval ± three standard deviations from mean male-owned establishment death (birth) rate
(3b) The marginal effect of female entrepreneurial activity is relatively large in less dynamic economies compared to the marginal effect of female entrepreneurial activity in highly dynamic economies	The marginal effect of a female establishment birth (death) will be decreasing on the interval ± three standard deviations from the mean female-owned establishment death (birth) rate

returns to information based on market scale should also hold in the gendered market segments (Hypotheses 3a and 3b) (Table 6).

5.2 Results: male and female specifications

The first gendered specification uses male-owned establishment dynamics in combination with the remaining control variables. Symmetrically, the second gendered specification uses the birth rate, death rate, and interaction term for only female-owned firms. The gendered results are reported in Table 3.

As in the previous section, before discussing the specific estimates, we consider the appropriateness of the OLS specification based on parallel analysis of an IV approach.[8] The diagnostic results for the separate male and female IV specifications are substantively similar. We find that the OLS regression is more appropriate for this analysis. For reference, IV results are shown in Table 8. With a few exceptions,

[8] The measures of male and female entrepreneurship are likely to each require their own set of instruments, since the surge of women entrepreneurs in recent decades represents a different trend than the long-standing presence of male business owners (Conroy and Weiler 2016). Women likely faced unique barriers to entry based on historical gender roles including a male-dominated business network. The evolution of women's role in the labor force during the last 60 years, alongside a much larger sociocultural shift in women's rights, roles, and opportunities, clearly created the preconditions for women's advancement as business owners. While the cultural shift conceivably lowered barriers to female entrepreneurship, it is likely unrelated to future employment growth—thus suggesting a potentially valuable category of instrumental variables (IV).

The twin developments of women's role in the labor force alongside broader sociocultural shifts indeed prove to be fertile ground for the needed IVs. Growth in female labor force participation (1950–1970) and the divorce rate (1980) show themselves to be particularly good instruments for women's entrepreneurial activity in our model of employment growth (Haines 2010). Increases in female labor force participation may signal growing opportunities in more stable wage and salary positions and also as business owners. Since most entrepreneurial financing is derived through family networks, a higher divorce rate may cut off critical credit, especially during an era when men controlled most assets and women had remarkably little recourse to formal credit channels.

In the final statistical models, we combine the growth in female labor force participation and divorce rate with the proprietor's share of employment in 1979 and the share of employment in small businesses in 1974 for the IV mix. In both cases, the first stage tests of weak identification suggest that our instruments are strong across the establishment birth rate, death rate, and their interaction.

these results largely mirror those in the preferred OLS model, especially in the gender-blind and male models where the instruments are strongest.

Generally, the pattern of results is similar across the male and female specifications and consistent with the gender-blind results from the previous section. The establishment birth rate is positive and strongly significant as is the death rate. The coefficient on the interaction term is negative and strongly significant, again highlighting the second-order effect that creates diminishing returns to entrepreneurial information. In support of the information hypothesis, there is a positive effect from births *and* deaths that contributes to subsequent regional employment growth.

As in the previous section, the marginal effects for each gender help clarify the relationship of our gendered measures of entrepreneurship to growth. The effect of a one unit increase in the male-owned establishment birth rate in the average county is a 1.22 percentage point increase in employment growth over the subsequent period. Again, however, the marginal effect varies with the establishment death rate via the interaction term. The marginal effect is higher in less dynamic counties as indicated by the negative coefficient on the interaction term. Effectively, if we were to compare the effect of a one unit increase in the birth rate across two counties, one with average entrepreneurial dynamism and one relatively less dynamic, the thinner market would benefit from close to additional tenth of a percentage point in employment growth.

Similarly, the marginal effect of an increase in the male-owned establishment death rate is 1.41 percentage points in the average county. As before, the marginal effect is larger in less dynamic counties. The diminishing effect of a death is again determined by the coefficient on the interaction term, which indicates that the informational business failure is larger and is more valuable in counties with below average entrepreneurial activity measured by births. Thus, the marginal effects of the male-owned establishment birth rate and death rate are decreasing in scale in the same way as shown in Figs. 1 and 2.

The marginal effects of the female-owned establishment birth and death rates follow the same pattern, although are larger in magnitude. The marginal effect of the establishment birth rate is 6.16 percentage points in employment growth in the average county, while marginal effect of an increase in the establishment death rate is 3.32 percentage points in employment growth. These effects are substantively larger than the gender-blind and male-owned variations, yet fit with overall trends for female-owned businesses. A one unit increase in the birth rate, which may seem small but is more than one standard deviation, is equivalent to roughly 50 additional businesses in a county with average employment. Further, consider that women-owned businesses are concentrated in rapidly expanding industries like healthcare and education. These additional, potentially high-growth businesses correspond to 6 percentage points, less than half of one standard deviation, of additional employment growth over the period from 2000 to 2007.

Keeping in mind that the marginal effect of the female-owned establishment birth rate varies with the death rate, the birth–growth relationship is determined by the coefficient on the interaction term. If we were to again compare the effect across two counties, one with average entrepreneurial dynamism and one incrementally less dynamic, the marginal effect on employment growth in the latter case would

be 3.9 percentage points higher. A similar effect holds for the marginal effect of the death rate. Relatively large growth effects in less dynamic counties for both male and female entrepreneurial activity is the same pattern observed in the gender-blind results, suggesting again that there are diminishing returns to market information. Informational increments in the form of the revelations provided by openings and closures have substantially more impact in thin market economies, as those successes and failures illuminate a relatively unexplored market terrain.

Because relatively few women business owners have come before, women entrepreneurs are pioneering the market for those that follow. Not only are they illuminating market terrain through the informational mechanism of openings and closings, they are also creating the foundational nodes of a nascent network along gender lines. Incremental male-owned businesses are adding to an already well-developed network; each women-owned business more fundamentally helps build a parallel community system that can allow informational increments to be communicated and leveraged ever more effectively. The building of a women's entrepreneurial network is all the more important given that women—armed with their unique socioeconomic perspective—are capable of identifying opportunities and market niches that may otherwise go unrecognized. Women can bring unique products, processes, services, and management styles to the market, the very definitions of innovation.

6 Conclusion and policy implications

Leveraging the natural experiment contexts of regional economies, we hypothesize that new business openings—even and especially their eventual closures—reveal information about the market and find that these business dynamics have identifiable and substantive effects on economic growth. This type of information reduces the uncertainty for incoming entrepreneurs who are developing their own ventures and evaluating their prospects for success. In markets with thinner information, entrepreneurs face more uncertainty, greater measured risk, likely higher financing and insurance hurdles, all of which may discourage them from pursuing their potentially equally promising project. This underinvestment, a direct result of informational market failure, can lead to suboptimal outcomes, damaging both economic efficiency and equity.

Conceptually, our theoretical model hypothesizes a decreasing returns relationship between information from entrepreneurial projects and economic growth. This diminishing returns relationship between entrepreneurship and the economic payoff has specific implications in terms of both market scale and gender which we test empirically. In thin markets with relatively few new business openings and closures, even just a few additional entrepreneurial projects can expose broad swaths of relatively unknown market terrain and thus generate large incremental payoffs in terms of employment growth. In thick, dynamic markets, well charted by the activity of past entrepreneurs, the marginal entrepreneurial project adds relatively little new detail about the market, thus generating smaller gains in future employment growth. The empirical results and corresponding marginal effects support the hypothesized diminishing returns relationship between entrepreneurial projects and employment

growth. In thin markets, represented by counties with below average establishment birth and death rates, the marginal effect of an additional project (birth or death) on employment growth is larger than the marginal effect in thick markets represented by counties with above average establishment birth and death rates.

Intriguingly, we find that the gender aspect of entrepreneurship also reflects the same diminishing returns relationship between market information from entrepreneurial projects and the gains in employment growth. With women representing a small share of business owners, both currently and historically, there is less market information available based on the female experience or about the market niches where women have been particularly innovative. Male entrepreneurs enter the market with a relative information advantage derived from the long-standing prevalence of men among business leaders. These men have comparatively mature networks that transmit information that is useful to them as entrepreneurs in contrast to the more limited networks of women business owners and weaker information flows. Yet as a consequence of the relatively limited information based on and available to women entrepreneurs, their ventures can be especially valuable for exposing lesser-known aspects of the market compared with male-owned projects. This information, alongside such ventures' implications for developing a supportive network, subsequently can lead to larger employment gains.

Thicker information flows through denser networks will, ceteris paribus, improve local entrepreneurial projects and enhance prospects for success by local establishments. In this sense, the paper's results provide additional evidence for encouraging entrepreneurial ecosystems in communities. Rather than focusing exclusively on start-ups and success stories, as is standard practice in mature clusters such as the Silicon Valley (Saxenian 1994), embracing broader entrepreneurial dynamism and appreciating the value of failures takes encouragement in evolving entrepreneurial communities.

De-isolating particular networks such as those along gender lines may further reveal new market niches, business methods, and consumers' demands that add significant innovative value to products and services from emerging entrepreneurial markets. Altruism and cross-pollination across such traditional lines is again an accepted feature of more established ecosystems, but often requires explicit guidance in the earlier stages of network development. In that sense, fostering social infrastructure through informal and formal networking opportunities is likely to be complementary strategies for entrepreneurship and job creation. Such strategies are likely to be particularly effective in lagging regions which, as underscored by the paper's findings, are in the best position to benefit from informational and network increments.

Appendix: instrumental variable analysis

See Tables 7, 8.

Table 7 Key variable comparison

Variable	Source	Definition	Mean	SD	Min	Max
Births 1998						
Establishment birth rate	Census BITS	An establishment birth is counted when a business transitions from zero to positive employment. The number of births, as defined by the census, is divided by total nonfarm employment (in thousands)	4.29	1.50	0.00	12.62
Establishment birth rate	NETS database	An establishment birth is counted in the year an establishment is first active. The number of births, as defined based on NETS, is divided by total employment (in thousands) from the NETS database	11.63	5.94	0.00	66.67
Women-owned establishment births	NETS database	The establishment birth rate is calculated as above, but for the subset of establishments that are women-owned or managed. Women-owned or managed establishments are those that had a female CEO or a woman holding the controlling interest of the establishment in the most recent year of activity	2.11	1.25	0.00	12.21
Male-owned establishment births	NETS database	The establishment birth rate is calculated as above, but for the subset of establishments that are nonwomen-owned or managed	9.52	5.25	0.00	66.67
Deaths 1998						
Establishment death rate	Census BITS	An establishment death is counted when a business transitions from positive to zero employment. The number of deaths, as defined by the census, is divided by total nonfarm employment (in thousands)	4.18	1.35	0.00	17.20
Establishment death rate	NETS database	An establishment death is counted for establishment that active in previous year but inactive in the year observed. The number of deaths, as defined based on NETS, is divided by total employment (in thousands) from the NETS database	7.15	2.82	0.00	66.67
Women-owned establishment deaths	nets database	The establishment death rate is calculated as above, but for the subset of establishments that are women-owned or managed. Women-owned or managed establishments are those that had a female CEO or a woman holding the controlling interest of the establishment in the most recent year of activity	0.83	0.65	0.00	8.46
Male-owned establishment deaths	NETS database	The establishment death rate is calculated as above, but for the subset of establishments that are nonwomen-owned or managed	6.32	2.55	0.00	66.67
Employment growth 2000–2007						
Employment growth	BEA-REA	Growth in total nonfarm employment	6.58	14.55	− 35.32	168.51

Table 7 (continued)

Variable	Source	Definition	Mean	SD	Min	Max
Employment growth	NETS database	Growth in total employment	7.83	16.73	− 81.61	122.29

Number of Obs = 3072 counties

BITS business information tracking system, *BEA* Bureau of Economic Analysis, *REA* Regional Economic Accounts

Table 8 Employment growth

	Obs = 3072 $R^2 = 0.6405$ FE = State IV = Yes			Obs = 3072 $R^2 = 0.6385$ FE = State IV = Yes			Obs = 3071 $R^2 = 0.5493$ FE = State IV = Yes		
	Coef.	SE	$P>\|t\|$	Coef.	SE	$P>\|t\|$	Coef.	SE	$P>\|t\|$
Birth rate, 1998	0.8676	0.5391	0.108						
Death rate, 1998	1.2567	1.1714	0.283						
B * D, 1998	−0.0238	0.1597	0.882						
Male birth rate, 1998				1.0802	0.5819	0.063			
Male death rate, 1998				1.3126	1.2258	0.284			
Male B * D, 1998				−0.0192	0.2448	0.937			
Female birth rate, 1998							12.9268	3.7934	0.001
Female death rate, 1998							−9.8821	11.7467	0.400
Female B * D, 1998							0.1462	4.2563	0.973
Predicted emp growth, 2000–2007	0.1792	0.0894	0.045	0.1901	0.0887	0.032	0.1862	0.0808	0.021
Emp growth, 1990–2000	0.1546	0.0353	0.000	0.1548	0.0349	0.000	0.1062	0.0364	0.004
Log employment, 2000	0.3454	0.6163	0.575	0.2493	0.6337	0.694	1.3409	0.4843	0.006
Log income, 2000	−16.2492	3.1024	0.000	−16.6465	3.1175	0.000	−13.9039	3.5445	0.000
Density, 2000	0.0658	0.0382	0.085	0.0617	0.0392	0.115	0.0623	0.0391	0.111
BA share, 2000	−0.2909	0.1221	0.017	−0.2963	0.1248	0.018	−0.1898	0.1276	0.137
HC share, 2000	0.6353	0.2169	0.003	0.6480	0.2222	0.004	0.4218	0.2220	0.057
Arts share, 2000	−0.3224	0.8821	0.715	−0.2383	0.8894	0.789	−0.9625	0.8348	0.249
Pop growth 1950–1960	−1.4072	1.0188	0.167	−1.4204	1.0019	0.156	0.1744	0.8393	0.835
Median age, 2000	−0.3716	0.1161	0.001	−0.3465	0.1122	0.002	−0.3494	0.1583	0.027
Amenity score	−0.0869	0.2275	0.702	−0.0793	0.2388	0.740	−0.2347	0.2402	0.328
Distance to MSA	−0.2284	0.6873	0.74	−0.2291	0.6869	0.739	0.0326	0.7186	0.964

Table 8 (continued)

	Obs = 3072 $R^2 = 0.6405$ FE = State IV = Yes			Obs = 3072 $R^2 = 0.6385$ FE = State IV = Yes			Obs = 3071 $R^2 = 0.5493$ FE = State IV = Yes		
	Coef.	SE	$P>\|t\|$	Coef.	SE	$P>\|t\|$	Coef.	SE	$P>\|t\|$
Marg dist MSA > 250 k	− 0.2381	0.3206	0.458	− 0.2832	0.3175	0.372	0.5686	0.4726	0.229
Marg dist MSA > 500 k	0.2929	0.2409	0.224	0.3225	0.2434	0.185	0.2702	0.2823	0.339
Marg dist MSA > 1 M	0.4753	0.2992	0.112	0.4581	0.3001	0.127	0.8403	0.3565	0.018
Cons	175.6762	40.5062	0.000	179.3925	29.7263	0.000	134.7971	34.7294	0.000
	Test stat	*p* value		Test stat	*p* value		Test stat	*p* value	
Test weak ID: births	43.08	0.000							
Test weak ID: deaths	24.61	0.000							
Test weak ID: B * D	21.46	0.000							
Test weak ID: M births				48.70	0.000				
Test weak ID: M deaths				22.20	0.000				
Test weak ID: M B * D				16.74	0.000				
Test weak ID: F births							11.73	0.000	
Test weak ID: F deaths							10.27	0.000	
Test weak ID: F B * D							15.56	0.000	
Cragg Donald	20.92			16.159			5.982		
Hansen J	0.024	0.877		0.058	0.8103		2.1220	0.145	
Endog	3.21	0.360		1.807	0.6134		5.5180	0.1376	

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UNDERSTANDING LOCAL ECONOMIC DEVELOPMENT

EMIL MALIZIA, EDWARD FESER,
HENRY RENSKI, AND JOSHUA DRUCKER

SECOND EDITION

UNDERSTANDING LOCAL ECONOMIC DEVELOPMENT

This book offers insights into the process and the practice of local economic development. Bridging the gap between theory and practice, it demonstrates the relevance of theory to inform local strategic planning in the context of widespread disparities in regional economic performance.

The book summarizes the core theories of economic development, applies each theory to professional practice, and provides detailed commentary on them. This updated second edition includes more recent contributions—regional innovation, agglomeration, and dynamic theories—and presents the major ideas that inform economic development strategic planning, particularly in the United States and Canada. The text offers theoretical insights that help explain why some regions thrive while others languish and why metropolitan economies often rise and fall over time. Without theory, economic developers can only do what is politically feasible. This book, however, provides them with a logical tool for thinking about development and establishing an independent basis on which the local consensus needed for evidence-based action undertaken in the public interest can be built.

Offering valuable perspectives on both the process and the practice of local and regional economic development, this book will be useful for both current and future economic developers to think more profoundly and confidently about their local economy.

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PREFACE TO THE SECOND EDITION

Understanding Local Economic Development, published in 1999, was written as a text for both university courses and in-service training. The book summarized the dominant theories of economic development, applied each of them to professional practice, and presented detailed commentary in the text and endnotes. References cited the most important work in each theoretical area. The book had four audiences: economic development professionals, undergraduate and graduate students of economic development, economic development educators and researchers, and community leaders involved in formulating economic development policies or funding economic development programs. It presented, in systematic fashion, theories, models, concepts, and perspectives needed to understand the essential features of local economic development in the United States and Canada, primarily with possible application to other regions in more developed countries. Designed to span the divide between theory and practice, the book aimed to demonstrate how useful theory could be to these economic development audiences.

Although the second edition still serves as a textbook, the book has two other objectives. The narrower one is to present the major ideas that inform economic development strategy formulation. This focus should make the book relevant to anyone engaged in strategic planning. The broader objective is to offer theoretical insights that help explain why some regions are thriving while others are languishing and relatedly why metro economies often rise and fall over time. These objectives guide the retention of relevant traditional theories and the selective addition of more recent theories of regional economic growth and development. As in the first edition, theories primarily draw from traditional micro- and macro-economics, regional science, and economic geography. Institutional, behavioral, and radical theories are not covered.

Admittedly, our objectives are ambitious. We write this book to give current and future economic developers and community leaders knowledge they can use to understand both the process and the practice of local economic development. With such knowledge, they should have the confidence to think more profoundly about their community. Collectively, the theories covered herein contain the basic concepts that developers need to know in order to analyze their local economies internally as well as relative to other regions, define economic development appropriately, design strategies with promise to be effective, evaluate the outcomes of different development activities, and communicate successfully with stakeholders whose support is needed for implementation. Without theory, economic developers can only do what is politically feasible. With theory, developers have a logical tool for thinking about development and an independent basis on which they can build the local consensus needed for effective action. The virtual world is cluttered with unqualified opinions, fake news, and other misinformation pretending to be factual. In this context, theory offers a safe harbor for reflection on economic development and, if the politics allow, a foundation for evidence-based action undertaken in the public interest.

Many theories of economic development exist within our defined scope. They differ in fundamental ways. They make different behavioral assumptions, use different concepts and categories, explain the development process differently, and suggest different policies. Although they often claim to have little use or patience for theory, economic developers always use some theory, explicitly or implicitly, to understand their regional economy, to ask questions about its past and possible future, to detail the information needed to analyze development, and to formulate the most promising development strategies. Ultimately, theoretical insights strongly influence how economic developers understand the factors affecting their region's relative attractiveness and local competitiveness. Due to the variety of regional economic realities and development paths, however, *there is no single correct theory of economic development*.

The organization of this book is designed to help economic developers grasp these theoretical differences and select the most powerful theories for addressing the economic realities they face. The book is divided into two parts. Part I, Fundamentals, presents an historical sketch of U.S. development practice (Chapter 1) and important definitions and concepts required to understand economic development theories (Chapter 2).

In Part II, Theories of Economic Growth and Development, Chapters 3–9 systematically present relatively self-contained and related theories of regional economic growth and development. Each of these chapters covers three topics: (1) the basic tenets of the theory, (2) the typical applications of the theory that answers the "so what" question, and (3) a more detailed discussion that elaborates on the theory and presents major critiques. The extensive endnotes offer greater depth and theoretical richness that researchers should find useful. The discussion questions in each chapter are primarily intended to help the reader apply the theory to their regional economy to test its relevance and explanatory power. The final chapter synthesizes

various theories in summarizing Wilbur Thompson's contributions and Enrico Moretti's analysis of regional inequality and offers ideas about how to use theory to frame strategies for local practice.

We have written this book assuming that most readers are pressed for time, have limited background in economics, and have little patience for jargon. We hope our book is compelling enough to motivate the readers to cull out and apply the most useful theories to understand and improve their unique regional economy.

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PREFACE TO THE FIRST EDITION 1999 (EXCERPTS)

Economic development encompasses a wide range of concerns. To most economists, economic development is about economic growth. To many business leaders, economic development is the wise application of public policy that will increase U.S. competitiveness. To environmentalists, economic development should be sustainable development that harmonizes natural and social systems. To labor leaders, economic development is a vehicle for increasing wages, benefits, basic education, and worker training. To community-based leaders and professionals, economic development is a way to strengthen inner-city and rural areas to reduce poverty and inequality. To public officials at the state and local levels, economic development embodies the range of job-creation programs, incentives, and other forms of assistance.

Economic development as practiced at the local level is a technique-dominated field concerned with increasing jobs and tax base, primarily by marketing the location to prospective and existing employers. The political culture in which most developers operate emphasizes short-term, quick-fix solutions, as well as the emulation of development strategies and programs in successful communities. Thus, the practice of economic development is strikingly similar across the United States as economic developers try to keep up with the competition. Economic developers endeavor to show that their location is better than any others' on a prospect's short list and that their incentive package is as good as the competitions'. Yet, places are very different, as differences among their firms, labor forces, politics, natural resources, and geography aptly demonstrate.

This book presents one view of how a broad body of ideas fits together. Though the view is not beyond criticism, it has proved useful in over 25 years of teaching development concepts to future practitioners. It also supplements other contributions. Important early edited volumes include Friedmann and Alonso (1964) and Perloff and Wingo (1968). Contributing authors in Bingham and Mier (1993)

summarize economic development theories drawn from various social sciences and apply these ideas to local practice. Several books examine development theories and policy in the United Kingdom and Europe (Chisholm 1990; Armstrong and Taylor 1978, 1985). Gore (1984) provides an excellent critical review of Anglo-American regional theory. Blakely (1994) offers a brief summary of theory in his wide-ranging and elementary introduction to economic development planning. Among the books most comparable to this one are Richardson (1973, 1978), Blair (1991), and Higgins and Savoie (1995). Higgins and Savoie (1995) provide a comprehensive survey of regional development theories and an analysis of regional policy in Canada and the United States. Their analysis suggests that development activity in the United States and Canada holds many similarities. Thus, we hope this book will also prove useful to Canadian development practitioners.

ACKNOWLEDGMENTS

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PART I

Fundamentals

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1

THE PRACTICE OF ECONOMIC DEVELOPMENT

Local economic development in Paterson, New Jersey

The most prominent early intentional development project in the United States designed for economic improvement began when Alexander Hamilton visited Paterson, New Jersey, in 1778. The Great Falls of the Passaic River attracted his interest, the highest falls east of the Mississippi River after Niagara Falls whose elevation and volume of water could generate substantial waterpower. It was later calculated that the Great Falls and the Little Falls farther upstream could drive 325 undershot water wheels. (Undershot wheels were turned by water flowing from below.) With this water resource and energy technology, Hamilton saw that Paterson had the potential to become the young nation's first center of industry (Kenyon 1960, p. 27). In November of 1791, Hamilton helped found the Society for the establishment of Useful Manufactures (SUM). SUM purchased from the state almost 800 acres of land adjacent to the river and the rights to channel some of the river's water into raceways. Two years later, SUM started the first water-powered cotton spinning mill in New Jersey, one that failed after operating for three years (Scranton 1985).

Local economic development is an ongoing process, where problems are resolved, not solved, because current solutions give rise to new problems to tackle as competitive factors change. Industry in Paterson grew through a series of "boom followed by bust" cycles for more than a century. For some time period, the localization economies (Chapter 9) in the industrial district enabled the sequential success of cotton textiles, locomotive production and assembly, silk textiles, and aircraft manufacturing (Kenyon 1960, pp. 24–66). Since the cotton industry required machine shops to keep the mills running, skilled craftsmen increased in number as the industry grew. Machine-shop owners sought patents for ideas they developed. In 1840, the cotton sector peaked, and several cotton mill owners formed new

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companies to build locomotives to support the westward expansion of the railroads. Kenyon (1960, p. 39) identifies that year as the beginning of the "century of silk" when the Paterson area became "a diversified urban industrial complex." Continuing through the 1920s, entrepreneurial companies were founded, grew, became well-established, and in many instances ultimately failed.

Paterson's local economic base evolved and diversified over time. By 1900, the silk textile industry, locomotive manufacturing, and other manufacturing were flourishing. The most important factors leading to success were: (1) proximity to New York City for finance and distribution, but most importantly for early detection of fashion and design changes; (2) reliable power, first from year-round water power and later from coal-produced steam; (3) tariff protection that eliminated duties on raw silk but imposed them on imported manufactured silk products; (4) the influx of unemployed skilled workers who immigrated to Paterson after the silk sector in England was decimated by producers in France; and (5) synergies between the silk and iron industries, including largely female workers in silk and primarily male workers in locomotive production.

From 1870 to 1910, Paterson experienced impressive economic growth due to innovation, agglomeration economies, and proximity to New York City—the fashion capital of the country. The population increased rapidly, primarily from immigrant labor that provided the "hands" that worked in the factories. From 1870 to 1900, the population tripled to over 105,000, reaching 125,600 by 1910. During this time, Paterson became one of the leading silk manufacturers in the world, vying with Lyon, France, for top billing.

During the next 30 years, Paterson's economic growth slowed dramatically. Silk manufacturing remained the dominant industry, accounting for 47 percent of manufacturing value-added projects in 1925. Over the next 15 years, the number of silk establishments decreased from 691 to 147 (Kenyon 1960, p. 62–65). The combination of new synthetic fabrics, the Great Depression, and labor strife took their toll (Scranton 1985).

In 1913, the Industrial Workers of the World (The Wobbles) and local socialists staged the "Paterson Silk Strikes" advocating an eight-hour day and better working conditions. Although unsuccessful, the strikes helped forge the American labor movement and were a precursor of New Deal reforms that brought the eight-hour work day, better wages, improved working conditions, restrictions on the use of child labor, better housing, and overall improvements in public health and living standards. Thus, the period of rapid economic *growth* from 1870 to 1910, when Paterson's industries got bigger and more numerous, was followed by the period from 1910 through World War II when the lives of the workers in Paterson got better, which could be called the period of economic *development* (Chapter 2).

For 20 years after World War II, modest growth continued in Paterson, but subsequently the manufacturing base declined precipitously as companies left for low-wage, non-union locations in the South and outside the United States. Economic decline continued in the central city for many years, while the suburbs

prospered, becoming bedroom communities of New York City. More recently, immigrants arriving from the Middle East, Mexico, Latin America, and other parts of the world have occupied cheap housing and have begun to revitalize Paterson. Over 200 years after Hamilton initiated "top-down" economic growth, Paterson's workers and entrepreneurs will determine whether "bottom-up" actions will have positive economic outcomes. Will Paterson's economy in the 21st century recover its past success or continue its flat trajectory?[1]

Inflection points in local economic development

In this section, we present four major trends that have shaped state and local economic development practice in the United States since 1930. We describe them as inflection points and identify the relevant underlying theories of economic growth and development for each one. This presentation has two purposes: to place current practice in its historical context and to demonstrate the value of theory so that economic developers can better understand and improve their practice.

Industrial recruitment

The *first inflection point* came with the formulation of state-level industrial recruitment as an intentional development strategy to encourage industrial development in the "New South."[2] Southern states initiated industrial recruitment, and their success was largely at the expense of places like Paterson and other cities in the Northeast and Midwest. It began in 1929, when Hugh White was elected mayor of Columbia, Mississippi. The lumber company he owned was in decline, and the local farming sector was weakening. As mayor, he formed the Marion County Chamber of Commerce and hired the Fantus Corporation based in Chicago to recruit companies. When Fantus found an interested prospect—Reliance Manufacturing—the mayor raised enough capital locally to provide the loan guarantee for the factory's construction, including conditions that would now be called "claw back" provisions. The most important one was that the company would own the factory as long as it hired 300 (primarily female) workers and paid one million dollars in wages over the next ten years. The town signed up over 1,400 women interested in working at the factory satisfying the company's questions about labor availability. Mayor White also created customized training for the women who were not paid until they became proficient. Reliance came to Columbia and hired these women at low wages, but the income of their families increased as a result. The new employer provided a buffer for the local economy as the Great Depression gained force.

Hugh White was elected governor on a platform that included "balancing agriculture with industry" (BAWI). From 1936 to 1940, he provided the leadership to pass legislation that allowed localities to finance land and capital for new industry to achieve the newly identified public purpose of providing employment, thus establishing the BAWI program state-wide (Cobb 1982). Thus, hiring workers was no

longer simply a *private* cost that businesses incurred to generate product and profits. "Job creation" had now become a *public* purpose.[3]

By the mid-1950s, almost all of the Southern states had policies favoring industrialization and had established agencies with the mission of industrial recruitment. They unleashed their "industry hunters" on corporate boardrooms to the north. Favorable financing, prepared industrial sites, and customized training programs were often part of the package designed to lure companies to the South. Equally compelling were access to growing product markets, relatively cheap labor, cheap land, low cost of living, low taxes, and virtually no labor unions ("right-to-work states").

Although state-sponsored industrial development for job creation began in the South, the idea spread throughout the country. State development corporations or departments of commerce took on this function partly in reaction to losing companies to Southern states. Counties and cities joined in, creating the infrastructure for industrial recruitment of jobs and tax base that exists to this day.

Industrial recruitment or what became called the "attraction strategy" focused on manufacturing because manufacturers were expected to have the greatest positive impact on local economic growth. Most economic developers know that economic base theory (Chapter 3) is the theory that rationalizes industrial recruitment.[4] Companies that source labor and other inputs locally and sell products outside the area (the export sector) bring money into a region that stimulates employment in local-serving sectors (such as retail and personal services) through successive rounds of buying and selling (the economic base multiplier). In addition to higher multiplier effects, recruited manufacturers offered better wages and benefits in most instances than existing employers. Thus, manufacturing usually contributed to local economic development.

Small business development

The *second inflection point* occurred when small business became viewed as an important source of employment. This focus quickly expanded to important locally-based industries as well as educational, scientific, health-oriented, and financial institutions that could promote economic growth. Interest in small business began in 1979, when David Birch (1979) published a report about job creation. Using Dun & Bradstreet data, he showed that small businesses had created almost all new jobs in the United States during the previous decade. The story reported in the *Wall Street Journal* hit the industrial development community like a bombshell. In one Southern state, the head of the state's industrial development program read the story at breakfast. He called his lieutenants to an emergency meeting as soon as he arrived at work. He asked the question—what are we doing to help small businesses create jobs? The silence was deafening. He instructed his team to come up with concrete ideas about policies and programs and scheduled a meeting to review all ideas later that week. After lunch, he received a call from the governor. The governor noted that he had read an interesting article in the paper that morning

and asked his appointee what their state was doing to help small businesses. The director assured the governor that his agency was on top of this and would brief the governor on their initiatives early in the following week.[5] Similar conversations undoubtedly occurred in economic development offices throughout the country that week. Reflecting this broader focus, the American Industrial Development Association's executive committee made numerous changes to its rules and governance structure in 1980. The most important one was changing its name to the American Economic Development Council.[6]

Today, every state has policies and programs designed to help small businesses and existing industry, usually called "creation and expansion strategies." Yet they continue to devote substantially more resources to industrial recruitment. One reason is that Birch's definitions and results were confusing. It was difficult to sort out exactly which small businesses were generating jobs (Malizia 1981). The lively debate involved assessing the potential of small firms, new firms (startups), young firms, and especially entrepreneurial firms to be important job generators. The evidence eventually became clear that the "small business" which created most new jobs was also responsible for most of the job destruction (what is called job churning).[7]

Regardless of the true sources of job creation, this second inflection point had meaningful effects on economic development practice. Whereas industrial recruitment sought growth from without, small business development and associated expansion strategies directed economic developers to seek growth from within the local economy and find ways to build on local assets. Product cycle, entrepreneurship, innovation, and agglomeration-related theories, covered in Part II, are associated with this broader internally-oriented view of economic development. The emphasis of local development practice shifts from the location's comparative costs to how the region's value can be enhanced to make its economy more viable.[8]

Industrial clusters

The *third inflection point* emerged about a decade later when national competitive advantage was framed in terms of "industrial clusters" (Porter 1990, 1998). Michael Porter was an established expert on business strategy when he was appointed to the President's Commission on Industrial Competitiveness in 1985. He became increasingly interested in applying his findings on competitiveness at the company level to help clarify ongoing debates in the 1980s about "industrial policy." He published *The Competitive Advantage of Nations* in 1990, which presented an industry-based theory of competitiveness and applied it to examine selected internationally competitive industries in ten countries. Porter's strategy is critically discussed in Chapters 8 and 9.

The aspect that had the greatest impact on economic development practice was the observation that most internationally competitive industries formed industrial clusters, which are groups of interrelated companies. Many of the connections in

an industrial cluster were geographic: linked industries often located in the same regions or cities (Porter 1990, pp. 157–159). Subsequently, Porter led case studies of industrial clusters in different regions of the United States and applied his ideas to promote central city revitalization.

Porter's impact on economic development practice was profound. During the 1990s, economic developers referred to "clusters" much more often than "industries" or "companies." Industrial recruitment was now targeted to industrial clusters more than individual industries or specific corporations. Internally focused strategies addressed ways to augment existing clusters. These considerations included buyer-supplier connections (supply chains), specialized pools of talent and skills, associated business and professional services, and local "anchor institutions," such as health facilities, universities, research labs and centers, and major facilities of the federal or state government. This cluster perspective certainly elevated the importance of strategic planning in economic development practice.

Porter observed that internationally competitive clusters were highly specialized in different parts of the world. Regions had experienced prosperity by using and upgrading their assets effectively in these industrial specializations. It follows that economic developers should use limited available resources to deepen the region's existing clusters. However, most state and local development entities have preferred to identify many clusters (ten or more), some existing, others aspirational. This approach may lead to greater industrial diversity, but it disperses limited resources in ways that reduce the chances of success.

The creative class

Urban and regional theory recognizes the mutual relationship between the location of population and the location of employment. One way to sort out this relationship is to assume that employers first decide to locate their company in a specific metropolitan region and households follow, moving there to pursue employment opportunities that these companies provide. The influx of households in turn stimulates business growth and additional employment within the region. The more important dynamic, then, is that workers are attracted to available employment opportunities (people follow jobs).

This logic was first articulated by political economist Sir James Steuart in 1767 (nine years before Adam Smith published *The Wealth of Nations*).

> I now proceed to the other class of inhabitants; the free hands who live upon the surplus of the farmers. These I must subdivide into two conditions.
>
> The first, those to whom this surplus directly belongs, or who . . . can purchase it.
>
> The second, those who purchase it with their daily labour or personal service.

> Those of the first condition may live where they please; those of the second must live where they can [find work].
>
> *(Steuart 1767)*

Most regional theorists would agree with Steuart that population generally follows employment opportunities. Thus, it made sense for economic developers to focus on businesses whether by growing or expanding them or by attracting external business investment. Richard Florida's theory of the creative class posed a different idea. Florida advocated focusing on occupations and places instead of industries or clusters. Places with talent, technology, and tolerance would outperform ones that lacked these attributes (Florida 2002). If places were able to attract and retain enough talented people, employers would follow. This hypothesis represents the *fourth inflection point* in economic development.

Florida's ideas are presented more completely in Chapter 9. Scholarship aside, Florida has had major impacts on economic development policy and practice. To his credit, he has helped broaden the perspective of state and local economic developers by making them more aware of the knowledge economy and the importance of workforce development and other local assets. Economic developers became concerned about the supply side of the labor market for the first time, in addition to their traditional focus on stimulating labor demand (job creation).

Florida's "super" creative class of artists, designers, musicians, writers, and so on prefers urban areas that are also attractive to bohemian subcultures and members of the LGBTQ community. Young professionals trained in engineering, computer science, research, and so on ("techies") seem to like places with "hip" people. The most typical strategies call for urban redevelopment, especially downtown revitalization, that involve compact, connected mixed-use projects with associated public transit. These redeveloped areas provide restaurants, cafes, bars, unique shops, music and performance venues, hip workspaces (coworking), small residential units (co-living and micro apartments), and so on.

Unfortunately, Florida did not carefully qualify many of his recommendations. For example, the creative class includes over 30 percent of the labor force, most of whom prefer to live in suburban residential areas. The "super" creative class is a small subset that seeks to do original work and prefers amenity-rich urban locations. This small subset is much more likely to gravitate to larger denser cities that offer features attractive to them, but Florida failed to discuss directly the influence of city size. In the absence of such qualifications, many local boosters overestimated the importance of the creative class and formulated creative-class strategies for places far too small ever to reach the critical mass needed to attract employers. Furthermore, from a practical standpoint, it takes far more resources to attract 50 individuals than one business with 50 employees.

Whereas Porter's cluster concept has had major direct effects on economic development practice, Florida's influence has been much more diffuse. In some areas, downtown redevelopment organizations are working closely with traditional

economic development entities, and regional and local economic developers have become more involved in urban/downtown redevelopment. In these areas, the strategy of "talent attraction and development" is as important as industrial recruitment and development.

State and local practice in the United States

The array of strategies currently employed by state and local economic developers reflects these four inflection points. Although each one took strategic thinking in a new direction, developers have not abandoned previously established ideas. Indeed, most state, regional, and local economic development organizations devote resources, in some combination, to traditional industrial recruitment, small business development including attention to startups and entrepreneurship, industrial clusters of existing industries, and workforce or talent development.[9]

State and local economic developers agree that the 21st-century economy has become far more complex. They need to understand better the workings of internal processes and external connections to the global economy. Theory helps developers grasp the evolving development process, provides insights about the relative attractiveness of one place compared to other places, currently and in the future, and guides the study of the historical process that generated its current status. The chapters in Part II present theories that economic developers can use to explain interregional and intraregional development and by implication how to promote economic growth and development. They are primarily intended to help state and local practitioners formulate better strategies by understanding their regional economy in more profound ways. Theory should give practitioners more confidence to fashion unique strategies designed for their specific locality instead of simply imitating their peers.

Although local economic development practice has matured, certain confusions and unanswered questions remain.[10] First, the definitions, goals, and strategies of economic development are usually discussed without explicitly recognizing the relevant theory of economic development on which they are based. Even the goal of job creation remains unclear without an explicit model of development (Malizia 1987). For example, should all permanent, full-time jobs be considered equivalent or should differences in job quality or average salaries be factored in? Should developers count all jobs or only net new jobs? Should jobs that reduce unemployment or accrue to existing local workers be valued more highly? Is the profile of jobs anticipated over time from a project important or just the initial number of jobs? Should developers focus exclusively on local benefits or also on benefits accruing to the larger economic system? As discussed in Chapter 2, each economic development theory provides both an explanation of the development process and a definition of development.

Second, economic development thinking often reveals weak economic principles. Modern economics notwithstanding, some developers still confuse "making money" in terms of a favorable balance of trade generated by manufacturing and export services with creating wealth from innovation or productivity improvements.

(This "mercantile bias" is explained in the Appendix on Economic Thought after Chapter 10.) The concepts presented in this book should help resolve confusions and strengthen economic thinking in the field generally.

Furthermore, because developers need to be concerned about the future, they often ignore the past. Yet ahistorical thinking has led to gross blunders in formulating development strategies for the future. Economic developers ignore the economic history of the region in which they work at their peril. For example, in the late 1960s, the Appalachian Regional Commission (ARC) neglected to examine the previous 100 years of Appalachian economic history in devising its development strategy. The new strategy was based on the assumption that Appalachia was poor because it was isolated and therefore needed to be linked to the rest of the United States. ARC used growth centers, development highways, and social service programs to integrate the region into the larger economy. Yet substantial evidence indicates that the historical linkages between the region and the rest of the country had impoverished Appalachia. In another example, Porter (1997) called for the private sector to assist new and existing inner-city businesses as a way to reverse central city decline. Yet he failed to explain how these areas became poor, dangerous, deteriorating places, or why private investors shunned them over the past 50 years. Answers informed by the region's economic history could help identify the strategies more likely to succeed. The importance of history and human agency is underscored in Chapter 2.

Finally, practitioners tend to emphasize economic growth more than economic development or fail to recognize that growth and development are neither synonymous concepts nor identical processes. Jeep (1993) contends that the inability to distinguish growth from development has led developers astray. Growth and development are carefully distinguished and contrasted in Chapter 2.

The theories included in this book pertain to labor market areas, which are functional economic regions best approximated by metropolitan areas. Since these labor markets function as local economies, it makes sense to analyze them as whole units. Yet most economic developers are employed by states, counties, or municipalities—political entities that constitute only a part of the labor market/metropolitan area. They should apply each theory to the region in which they are located and formulate relevant region-wide strategies. Then, they can figure out how to adapt these strategies to the jurisdiction for which they work.[11]

Economic developers need strong leadership, patience, persistence, and good planning to have a chance to succeed. They may decide to put their faith in good timing and luck to bring about regional economic development and accept the old a-theoretical adage: shoot anything that flies; claim anything that falls. As William Alonso (1990) once said, somewhat in jest: we believe that a "silver bird" (manufacturing facility) will land on our island (local industrial park) and bring us development or that, through "spontaneous combustion" (local creativity and innovation), new local businesses will transform poverty into plenty. This book encourages developers to promote economic development by using their wits rather than depending on luck.[12]

Discussion questions

The questions that follow are for economic development professionals. The questions are designed to address the orientation of local practice that bears on the definitions of economic development and the theories meaningful to developers. Other readers may use these questions to interview a practicing economic developer. Please refer to these answers as you read subsequent chapters.

1 Briefly describe the activities that take most of your work time over a calendar year. Who are the clients and major beneficiaries of these activities?
2 Identify the major strategies or policies that justify these activities. Who are the primary beneficiaries of each of these strategies or policies?
3 Is job creation or investment for tax base expansion the primary goal of these strategies or policies? Do you have other primary or secondary economic development goals?
4 If job creation is an important goal, are you simply trying to stimulate the local demand for labor or are you also trying to provide jobs for local residents or unemployed residents?
5 Economic developers have been criticized for engaging in constant-sum activity by increasing local growth but not overall national growth. Do you think this criticism applies to your activities? What is your view on this issue?
6 The four outcomes listed below could occur hypothetically as the result of your activities. Assume that each outcome generates the same number of jobs or amount of economic growth. Figure out the alternative for each outcome that you would view as the best improvement to the local economy.

    a New branch facility/expansion of existing business/new locally based business.
    b Manufacturing company/retail company/business or professional service company.
    c More small businesses/more self-employment.
    d Larger export base/cheaper products for local consumers.

7 Do you address environmental quality, community development, or other broader topics in your practice? How are these topics dealt with?

Notes

1 In addition to the references cited, this brief history of Paterson draws from Wikipedia, the New Jersey Community Development website: www.njcdc.org, and Malizia's knowledge of his home town.
2 Advocacy for the "New South" often references journalist Henry Grady, an effective early proponent of industry replacing sharecropping, which became the post-bellum version of plantation agriculture. During the 1880s, he gave many speeches on this topic, including an oft-quoted one about a funeral he attended in his home county of Pickens, Georgia, where only the body and the hole in the ground were locally produced. The most accessible source of Grady's famous speech is Wikipedia under Henry W. Grady.

3 "Job creators" are now respected as public benefactors, although they are rarely demonized as "job destroyers" when they eliminate jobs or move them to more profitable locations.

4 Economic base theory also provides the rationale for the economic growth coalition that supports industrial development in most localities. Coalition representatives are in declining-cost industries such as railroads, trucking, utilities, banking, construction, and real estate that serve the local market and benefit from its growth.

5 The economic development director told this story to Malizia, who believes it is factual and accurate but prefers not to disclose specific identifying information.

6 In 2001, AEDC merged with the Council for Urban Economic Development, which became the International Economic Development Council.

7 Subsequent research helped resolve the debate. See Freear and Sohl (2013), pp. 224–225 and Kane 2010. Chapter 7 explores entrepreneurship theories and strategies in detail.

8 The Corporation for Enterprise Development began publishing a state-level "report card" designed to balance the state rankings of site selection consultants like Fantus Corporation, which were accused of measuring the "cost of everything but the value of nothing." The report card assessed both quality and cost factors.

9 The American Economic Development Council (AEDC) described practice as pursuing "ACRE" in order to achieve more local jobs, investment, and tax base: attraction of new investment or facilities, creation of new businesses, retention of existing businesses, and expansion of existing businesses. Detailed descriptions of these activities are in Smith and Ferguson (1995). Note that workforce or talent development was not included.

10 Jeep (1993) and Rubin (1988) offer critical assessments of economic development practice, while Sternberg (1987) presents a detailed classification scheme for organizing economic development policy instruments. Smith and Fox (1991) describe the major tools used in industrial recruitment, namely infrastructure provision, preferred financing of capital facilities, customized training, and tax breaks or financial incentives. They call for additional strategies to promote business development, including small business development centers, research and development (R&D) partnerships, technology transfer through the manufacturing extension service, and new venture financing through venture funds. Now, these strategies are often included in state and local practice.

11 Each jurisdiction within the labor market area can identify its economic development strategies compared to others based on within-region differences in factor costs, accessibility, amenity levels, business climate, economic base, and other structural attributes. Many jurisdictions in the region may specialize in residential development or may want to limit growth. We discuss appropriate within-region strategies in Chapter 10.

12 These comments ignore the reality that confronts many local economic developers who spend much of their time on two tactical activities. First, developers must continually improve and update their locality's website. Without a strong presence in the virtual world, a locality's existence in the real world is hardly relevant. Second, they must be responsive to demands for financial incentives whether from prospects and their consultants or existing companies threatening to leave. Economic developers who want to transcend this practice are encouraged to read further.

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2

DEFINITIONS AND CONCEPTS OF DEVELOPMENT

Definitions

Ideally, the review of various theories of local economic development would be informed by a clear definition of the economic development and the regional processes we seek to understand. Yet an appropriate *a priori* definition of economic development is not possible. Definitions do not precede theory. Each definition contains its own implicit theory, just as each theory supports a unique definition.

Development practice in the United States accepts economic growth as a positive force and attempts to facilitate the growth process.[1] In 1990, the American Economic Development Council (one of two major professional associations representing U.S. economic developers at that time) commissioned a report from the profession titled *Economic Development Tomorrow* (AEDC 1991). A Delphi process involving the profession's leadership as well as other experts accepted the definition presented in a similar 1984 report:

> Economic Development is the process of creating wealth through the mobilization of human, financial, capital, physical and natural resources to generate marketable goods and services. The economic developer's role is to influence the process for the benefit of the community through expanding job opportunities and the tax base.
>
> *(AEDC 1984, p. 18)*

The definition offered by the International Economic Development Council in 2006 was weaker in that it only focused on practice and outcomes:

> Economic development can be defined as a program, group of policies, or activity that seeks to improve the economic well-being and quality of life

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> for a community by creating and/or retaining jobs that facilitate growth and provide a stable tax base.
>
> *(IEDC 2006, p. 4)*

The older AEDC definition captures the two aspects of the term "economic development": it refers to both a process and a practice. As a growth process, economic development is the mobilization of resources to produce marketable products. However, the definition itself is static. It fails to indicate that economic development, as a process and a practice, is a long-term, ongoing enterprise. As illustrated in Chapter 1, new development problems continue to emerge as former ones are resolved. Although flawed, the definition is nonetheless powerful because it justifies much of what practitioners presently do in the name of economic development in the United States and Canada.

Development organizations have referenced the AEDC definition for many years without addressing the fact that it is inconsistent. The second sentence contradicts the first one. The first sentence is a politically astute description of the market system, with which we are all familiar. Resources are mobilized and used to produce commodities for which market demand exists. Such a development process increases wealth because aggregate consumption increases. The second sentence instructs the economic developer to facilitate the development process through the creation of additional jobs and the expansion of the tax base. Yet while wealth and jobs/tax bases may grow in tandem, they are fundamentally different. Wealth creation results from the production and sale of commodities that benefit consumers. Job and tax base creation make available the human and physical resources needed to produce commodities; labor and government services are means to the end of more production and consumption. The critical omission in the definition is the notion of scarcity, the existence of which suggests that jobs/tax base creation may be inefficient and erode, rather than generate, wealth. Wealth creation and jobs/tax base expansion do not necessarily go hand in hand.

The existence of scarcity is a fundamental part of the economic process; scarce resources are used to satisfy competing ends. The economical use of resources is valued because it achieves efficient, least cost production. Therefore, more consumption produced by less labor and fewer government services benefits the community, whereas more employment or tax revenues without more consumption imposes costs.

Furthermore, while being clear and easy to understand, AEDC's definition obscures important questions about contemporary economic development practice. It does not address the serious criticism that developers frequently use scarce public resources to move jobs from one place to another without contributing to national competitiveness (the constant-sum recruitment game). In addition, it does not address whether developers should attempt to retain companies that want to close or relocate.

Moreover, wealth creation benefits corporate shareholders and other owners of capital, whereas job creation benefits local workers and community residents. While both are legitimate political objectives, they are also potentially conflicting.

Conflicts often arise between shareholder value and the interests of consumers and employees. These conflicts relate to the long-standing debate between equity (stable and plentiful employment in many communities) and efficiency (national productivity growth). The American Economic Development Council's consensus definition is politically acceptable in part because it ignores these trade-offs. It optimistically implies that the engine of economic growth will create jobs and wealth where developers want them. The dual realities of significant social inequality and regional inequality make this optimism seem opportunistically ignorant. Many would agree that social and regional inequalities are serious problems that economic developers need to address.

In most jurisdictions, economic developers have been more comfortable facilitating the economic growth process and working to improve the local business climate. They have been less comfortable trying to increase per capita income or wage rates. Nor have the problems of low wealth residents been a priority. The idea of *inclusive prosperity* responds to the challenge of growing income and wealth inequality in the United States, but mainstream economic development practice has not yet embraced the concept.

A more logical definition of economic development, consistent with mainstream (neoclassical) economics, would consider wealth creation as more important than job creation or, alternatively, job growth as a means to creating wealth. Local economic developers would only facilitate jobs and tax base expansion locally when productivity was not reduced in the larger economic system. If taken seriously, this revised definition could significantly influence the practice of economic development.[2] Yet, the more fundamental point is that each theory provides the basis for posing a defensible definition of economic development.

Concepts

Economic developers need to grasp four fundamental concepts to learn how to use theory effectively in economic development practice. Developers face an apparent contradiction given the conventional views of theory and practice, as follows: theory is considered abstract thinking that simplifies reality, whereas practice involves human action that changes reality in particular ways. Economics and other social sciences generally ignore individual action to explain reality. Theories are essentially deterministic in that posited causes should lead to expected outcomes. Economic developers, as well as other individual actors, exercise free will when they try to influence the development process. The four concepts of power, theory, interests, and mediation can resolve the apparent contradiction between deterministic theory and voluntary practice, as explained in Appendix 2.1.

Basic assumptions

The assumptions described in this section provide the conceptual basis for the economic development theories presented in this book. We assume that the local

economy is best understood in the context of the larger economic system. The evolution of the local economy can be grasped by understanding its relative attractiveness compared to other local economies. The relative attractiveness of each area depends on its *economic location*—the economic role it plays in the larger system.

To create and build linkages between the local economy and the external economic system is one viable path to economic development. To do so, it must find a useful role to play in the global economy. Successful local economies will specialize, trade, grow, diversify, and develop over time. The other path calls for strengthening internal linkages and minimizing external trade, what is called autarky. In this case, the local economy must develop through local self-reliance.[3] For many developing regions and countries, both paths deserve consideration. For most localities in the United States and Canada, however, building linkages to the global economy is more feasible and desirable (if not unavoidable) than separation and autarky. This book's audiences and its U.S. and Canadian regional focus suggest an emphasis on *competitiveness* as the primary objective by which to evaluate the relative success of linkages to the global economy and the relative attractiveness of the locality to firms and households.

We view the global economy as the system that consists of mutually exclusive metropolitan areas or local labor market areas that are functionally linked through the economic exchange of goods, services, money, credit, information, and people. Metropolitan areas are the most appropriate units of analysis with which to study relative attractiveness, because they represent the closest approximation to meaningful economic entities and functional economic units for which data are available. In this book, the terms "locality," "area," "region," "location," "place," or "community" generally refer to local labor market areas. Importantly, metropolitan areas contain multiple political jurisdictions that greatly complicate effective local economic development practice.

Because the United States and Canada are rather mature economies, our coverage of regional development theory selectively includes macro-oriented theories that emphasize the diffusion of development. The focus of Part II of this book is on the continued diffusion of development across local economies rather than on the initiation or early stages of development.[4] Furthermore, micro-oriented theories of spatial development, such as migration theory and location theory, which pertain to individual location decisions, are generally ignored.

Growth-development distinctions

Understanding local economic development can be sharpened considerably by examining the distinctions between economic growth and economic development. Robert Flammang (1979) does an impressive job identifying nine different implicit or explicit conceptions of economic growth and development adopted by researchers and practitioners. They are summarized as follows:

1 No definitions are offered. Economic growth and development are reduced to other concepts such as urbanization and industrialization.

2 Growth is the same as development. Growth or development is measured as increases in aggregate or per capita income.
3 The distinctions depend on geography. Growth occurs in rich countries, while development occurs in poor ones.
4 The distinctions depend on the origin of development. Change that comes from internal sources is identified as development; change that is externally imposed is considered growth. Yet sometimes the argument is reversed.
5 Growth and development are complements because one makes the other possible.
6 Growth and development are alternating processes that occur in sequential time periods.
7 Growth is an increase in output; development is structural change—technical, behavioral, attitudinal, or legal.
8 Growth expands the economy; development must lead to more equal distributions of income and wealth.
9 Growth and development both lead to a greater range of economic choices.

Flammang presents an ecological model to synthesize and describe long-term change. Populations organize into societies in order to adapt to their environments more successfully. Development is instigated when a population begins to crowd its environment. Out of necessity, the society attempts to increase the means of sustenance from the environment. Adaption involves seeking a new ecological niche. From the ecological perspective, development involves niche finding; growth is niche filling. Organized populations (communities) introduce adaptive technology to solve economic problems.[5] This adaption may or may not become adopted by the ecological system. With adoption, the population will increase. Otherwise, the population will stagnate or decline or out-migration will occur.

Using this context, Flammang argues that growth is best defined as simple, quantitative increase, while development is qualitative and involves structural change.[6] Growth and development may be competitors in the near term but are usually complements in the long term. Over the long term, growth provides the resources needed for development. In response, development generates new technical, organizational, behavioral, or legal structures that facilitate growth. Growth increases output by mobilizing more resources and utilizing them more productively; development changes the output mix by devoting local resources to doing different kinds of work. In the near term, however, growth or development may proceed without the other. Growth may retard development, or development may engender decline. Moreover, development can occur in one place by draining resources from another location, thereby limiting growth and development elsewhere. Regional disparities in growth rates and development levels are common features of the growth-development process.[7]

The growth-development distinction also suggests contrasting economic growth to *sustainable* development. Indeed, sustainability is a widely discussed principle in the economic development and city planning fields. The concept is

attractive because of its generality; it would appear to encompass issues of competitiveness, social inequality, and environmental quality. Some of the literature presents normative statements outlining sustainability principles particularly for developing countries. The basic idea of this viewpoint is to evaluate economic growth in terms of its impacts on people and nature with a bias to conserve resources and to prefer economic growth with the following features: (1) limited utilization of natural resources and, in general, respect for eco-systems, (2) efficient utilization of material resources through energy conservation, recycling, and so on (3) full use of existing capital stock and reuse of sites and buildings, (4) less pollution from production and consumption activities, and (5) reasonable levels of living with less income and wealth inequality.[8] Blakely and Green Leigh (2010) have brought together these ideas in the definition they offer to local economic developers:

> Local economic development is achieved when a community's standard of living can be preserved and increased through a process of human and physical development that is based on principles of equity and sustainability. . . . Economic development establishes a minimum standard of living for all and increases the standard over time. . . . reduces inequality . . . [and] promotes and encourages sustainable resource use and production.
>
> *(p. 75)*

A related viewpoint based on the work of Karl Polanyi deserves attention. Polanyi (1944) developed a unique perspective on economic development that was drawn from careful historical and anthropological analysis. He argues that traditional (pre-capitalist) societies subordinate the economy to their politics and culture. Capitalist development represents a historical anomaly. Under capitalism, the economy becomes the dominant societal force. In essence, the competitive market, which is a highly effective mechanism for allocating produced commodities, becomes an ultimately destructive mechanism because human beings and the natural world are reduced to the "fictional commodities" of labor and land.[9]

From the outset of capitalist development in the 19th century, people have tried to avoid the wrath of the free market. Businessmen continually try to circumvent the market through price fixing and other forms of collusion in seeking monopolistic harbors that would protect their sources of income and wealth. Workers have formed labor unions "in restraint of trade." Environmentalists fight against the treatment of nature as a resource that provides material production inputs. Government intervention attempts to balance the needs of the market economy that treats people and nature as commodities with the political reaction voters have against such treatment.

Polanyi would ask economic developers to find the balance. Developers can be decidedly "pro-business" and advocate measures to improve the local business climate because private investment is needed to sustain the local economy. Yet developers should also recognize the need for interventions that reasonably protect

workers and the natural environment from market forces. Although much more difficult than one-sided advocacy, developers should address the costs of growth as well as its benefits.

Feldman et al. (2016) present a definition of economic development that builds on Polanyi's institutional perspective. Feldman and Storper (2018) argue that economic development is "the development of capacities that expand economic actors' capabilities". This apparently simple definition actually represents a significant departure from traditional thinking about economic growth and development. Their "innovative place-based development policy approach" focuses on building the basic capacities of people, expanding the "sources of creativity and satisfaction that are good . . . on human grounds," and developing innovative practices of all kinds to increase capacities in the regional economy on a continual basis. Feldman and Storper elaborate on ways to foster widely distributed place-based innovation capacities, which are associated with more numerous agglomerations, industry-building entrepreneurship, economic and social networks, coordination, and responsiveness to demand. This institutional and policy-based definition is not a way to improve economic development practice. This definition represents a radical departure from current practice.

Overview of theories

The economic developer must understand the language of theories in order to apply them skillfully. This section summarizes each theory in terms of five fundamental elements (see Table 2.1):

1 Basic categories—the fundamental classification or distinctions used to lay out the theory.
2 Definition of development—what economic development is or should be according to the theory.
3 Essential dynamic—the key variable or relationship that drives the logic of the theory.
4 Strengths and weaknesses—how well the theory enables one to understand economic development.
5 Applications—the ways in which the theory can be used in economic development practice.

Economic base theory

The basic categories of economic base theory are the industrial sectors of the regional economy that are assigned either to the basic or export sector or to the non-basic or local sector. The definition of local economic development is equivalent to the rate of local economic growth, measured in terms of changes in the local levels of output, income, or employment. The essential dynamic of the theory is the response of the basic sector to external demand for local exports, which, in

TABLE 2.1 Summary of economic development theories

Theory	*Basic Categories*	*Definition of development*	*Essential dynamic*	*Strengths and weaknesses*	*Applications*
Economic Base Theory	Export/basic sectors and non-basic, local (or residentiary) sectors	Increasing the rate of growth in output, income, or employment	Responses to external changes in demand Subsequent economic base multiplier effects	Most popular understanding of economic development in the United States and a simple tool for short-term prediction or forecasting Inadequate theory for understanding long-term development	Industrial recruitment and promotion for export expansion and diversification, expansion of existing basic industries, import substitution by strengthening connections between basic and non-basic industries, and infrastructure development for export expansion
Staple Theory	Exporting industries	Export-led economic growth	Successful production and marketing of the export staple in global markets External investment in and continued demand for the export staple	Historical perspective on economic development Descriptive theory difficult to apply	Build on export specializations State does everything possible to increase competitive advantage Character of economic base shapes political and cultural superstructure
Sector Theory	Primary, secondary, and tertiary sectors	Greater sectoral diversity and higher productivity per worker	Income elasticity of demand Labor productivity in primary and secondary sectors	Empirical analysis possible Categories are too aggregated	Attract and retain producers of income elastic products Facilitate adjustments to sectoral change

Theory	*Basic Categories*	*Definition of development*	*Essential dynamic*	*Strengths and weaknesses*	*Applications*
Interregional Trade Theory	Prices and quantities of commodities and factors	Economic growth that leads to greater consumer welfare	Price-quantity effects that result in equilibrium terms of trade Price-quantity-effects	Unique emphasis on consumer welfare and price effects Ignores many economic realities	Government intervention should promote free trade, infrastructure development, and efficient local government
Neoclassical Growth Theory	Aggregate macro model or two-sector regional model	Increasing rate of economic growth per capita	Rate of saving that supports investment and capital formation	Supply-side model	Government should promote free trade and economic integration and allow market forces to resolve social and spatial inequality
Growth Pole Theory	Industries	Propulsive industry growth leads to positive structural change	Propulsive industries are the growth poles Diffuse growth via the domination effect	General theory of initiation and diffusion of development Difficult to apply	Government pursues strategies to promote growth centers
Regional Concentration and Diffusion Theories	Commodities and factors (Myrdal) Industries (Hirschman)	Higher income per capita	Spread and backwash effects (Myrdal) Trickle-down and polarization effects (Hirschman)	Theories address the dynamics of development	Coordinated investments and active government to mitigate backwash effects and reduce inequalities, growth through balanced investments (Myrdal) Strategic public investments to spur development, growth through unbalanced investments (Hirschman)

(*Continued*)

TABLE 2.1 (Continued)

Theory	*Basic Categories*	*Definition of development*	*Essential dynamic*	*Strengths and weaknesses*	*Applications*
Product Cycle Theory	Products: new, maturing, or standardized	Continual creation and diffusion of new products	New product development	Most applicable in large metro areas	Development strategies to promote new product creation and subsequent diffusion
Entrepreneurship Theories	Entrepreneurs The entrepreneurial function	Resilience and adaptability	Innovation process New combinations	Mediated theory	Support entrepreneurial ecosystem and innovation districts
Regional Innovation Theories	Actors, networks, institutions Knowledge bases	Continuous innovation Path development Evolutionary economic change	Interactive learning among actors within networks Changes in the nature of demand	Focus on rich and complex production dynamics among actors Innovation can underpin any industry, not just technology-intensive Reliance on typologies and taxonomies of regions and systems	Redress system failures limiting innovation, strengthen networks and institutions, modernize manufacturing, facilitate new development paths, develop clusters
Theories of Agglomeration	Regionally co-located firms, workers, and other economic actors	Import replacement leads to new types of work (Jacobs) Linked firms and industries enhance regional competitiveness (industrial clusters)	Geographic proximity generates benefits that improve economic performance	Broad framework underpinning other theories Direct empirical observation difficult Implications vary widely across definitions	Support and advertise agglomeration benefits Facilitate agglomeration benefits to support clusters, creative class, etc
Marxist Theory	Relations of production	Reduction of alienation	Human action through social classes	Thought-provoking but easily misapplied	Assess business influence in local governance

turn, stimulates local growth. The economic base multiplier transmits changes in output, income, and employment from the basic sector to the entire regional economy. The theory's major strengths are its popularity as a basis for understanding economic development in North America and its simplicity as a theory or tool for prediction. Its major weakness is its inadequacy for understanding economic development as a long-term process. Economic base theory strongly supports attracting industry through recruitment and place marketing.[10]

Staple theory

Staple theory begins with the category of exporting industrial sectors. It defines economic development as sustained growth over the long term. The essential dynamic is the external investment in and demand for the export staple that leads to the successful production and marketing of the export staple in world markets. The theory's major strengths are its historical relevance to North American economic development experience and its emphasis on understanding the region's economic history. Its major weakness is that it describes, more than explains, the development process. Staple theory provides a general strategy of development by recognizing the connections of the economic base to the political superstructure. Economic developers should continue to build on and improve the export staple as long as it remains competitive in the global economic system. Strengthening the existing specialization may be more sensible than attempting to diversify the economic base. Eventually, footloose economic activities will be attracted to the area if its market achieves sufficient size and offers agglomeration economies that can be exploited by other exporters.

Sector theory

Sector theory uses three aggregate sectors as its basic categories. The level of development depends on sectoral diversity, which emphasized a prominent tertiary sector, and labor productivity. The essential dynamic involves the income elasticity of demand and labor productivity in primary and secondary sectors: as incomes rise, the demand for income-elastic products grows and output increases, as labor released from primary and secondary sectors is employed in tertiary sectors. Although sector theory is attractive because it can be empirically applied and tested, the primary, secondary, and tertiary categories are far too aggregated to be very useful in practice. The overriding application is the need to attend to industries producing income-elastic commodities in order to achieve sustained growth as incomes rise.

Interregional trade theory

The basic categories of interregional trade theory are prices and quantities of commodities and factors of production, just as in microeconomics. Its implicit definition

of development is economic growth that leads to greater consumer welfare. The essential dynamic is the price mechanism (price-quantity effects) operating to eliminate price differentials and establish equilibrium prices (the terms of trade). The theory has two unique strengths. First, increased consumer welfare (aggregate consumption benefits), not job creation, is the goal of development. Second, the price/cost-based theory is very precise. Yet its precision is achieved with numerous restrictive assumptions that largely ignore realities such as transportation and technology diffusion costs.

Neoclassical growth theory

The basic categories of neoclassical growth theory are sectors or regions that comprise the macro economy. It identifies economic development as an increase in the rate of economic growth measured in terms of changes in output or income per capita. The theory has two essential dynamics: (1) in aggregate models, the rate of saving which supports investment and capital formation drives the growth process; (2) in regional models, factor prices, specifically the relative returns on investment and relative wage rates, stimulate factor flows that result in regional growth. Neoclassical growth theory suggests that economic developers respect the free market and do what is necessary to support the efficient allocation of resources and the operation of the price mechanism. The simplest growth models imply that economic developers are unnecessary, but formulations with greater complexity would support growth-enhancing development activities.

Economists use growth theory and trade theory to advocate less government intervention and freer international trade, more open regions and, generally, more competitive markets. The theories give strong support for local infrastructure development, improvement in government efficiency, and other measures that could increase local productivity and lower input costs for all producers. Local developers, on the other hand, often ignore the implications of growth and trade theory and support protectionist measures and growth strategies that impose costs on local consumers.

Growth pole theory

Growth pole theory treats industries as the basic units of analysis, which exist in an abstract economic space. Economic development is the structural change caused by the growth of new propulsive industries. Propulsive industries are the poles of growth, which represent the essential dynamic of the theory. These industries first initiate then diffuse development becoming the dominant economic actors. Growth pole theory attempts to be a general theory of the initiation and diffusion of development. Although insights drawn from the theory are useful, it has failed as a general theory of development. Growth center strategies are based on this theory. Also summarized in Table 2.1 are regional concentration and diffusion theories, which are broadly similar to growth pole theory.

Product cycle theory

Product cycle theory treats the developmental stage of the product as its basic category. Products are classified as new, mature, or standardized. At any point in time, the space economy can be divided into regions where new products tend to arise and regions devoted to the production of already established, standardized commodities. The essential dynamic of product cycle theory is new product development. From locations where new product innovation takes place, the product is eventually standardized and diffused to other locations in the space economy, stimulating economic growth and development in both types of location. However, the character of development is different in each. These differences help explain why levels of development vary from place to place and why differences can persist. The economic developer who wants to apply product cycle theory in its most literal form must try to identify and work with companies that can create new products. Alternatively, the developer may be able to mobilize the resources needed to improve the local business infrastructure in ways that would support new product development.

Entrepreneurship theories

Entrepreneurship theories identify entrepreneurs or, more precisely, the entrepreneurial function as the basic category of economic development. With this theory, development proceeds as changes in firms and industries result in more resilient and diverse local economies. The essential dynamic driving this development process is innovation. Innovation is conceptualized in different theories as new combinations, improvisation, or creative risk taking. To its credit, entrepreneurship theory is mediated theory, which means that people make development happen. This strength leads to the weakness that entrepreneurship theory is not easy to apply consistently. The most general application is to support an industrial environment favorable to entrepreneurs, which is called an entrepreneurial ecosystem.

Regional innovation theories

Regional innovation theories consider networks of firms and other actors influenced by institutions as their basic categories. These local-to-global networks and institutions shape the flow of codified and tacit knowledge among all actors. Development is a process of long-term evolutionary change realized along emergent paths achieved through innovation, resulting in qualitative changes in firm structures, regional industrial mix, clusters, the organization of local and global value chains, and sources of competitiveness (e.g., from least-cost or price-focused competition to that based on innovation, product differentiation, and niche marketing). The essential dynamics are interactive learning that occurs among actors functioning within networks and changes in the nature of demand that influence the adoption of more flexible production modes and forms of industrial organization.

Among the principal strengths of regional innovation theories are a focus on rich and complex production dynamics within firms, among firms, and among firms and other organizations and actors (universities, government labs, producer services, and labor), and the characterization of innovation as a general process that can underpin any industry, not just technology-intensive ones. A weakness shared by most regional innovation theories is a reliance on descriptive typologies and taxonomies of regions that make research implications difficult to apply. The applications are clear: reduce factors limiting innovation, strengthen interfirm networks and basic institutions, modernize manufacturing by encouraging the adoption of new technologies and practices, and support cluster-based development.

Theories of agglomeration

Agglomeration theories underscore the importance of spatial relationships, especially the co-location of firms, workers, and other economic actors. The definition of development varies. Jacobs emphasized the process of import replacement that leads to new products and new types of work. Cluster theory points to linkages among firms and industries that enhance regional competitiveness. Florida argued that the attraction of creative workers would subsequently attract new businesses. The essential dynamic that connect these different ideas is geographic proximity that generates benefits for households and firms and improves economic performance. The major strength is the broad framework that underpins other theories. The weaknesses pertain to difficulties in direct empirical observation of effects. In addition, the implications vary widely across different definitions and formulations. One obvious application is that economic developers should help specific groups enjoy the benefits of agglomeration. Relatedly, developers should support and advertise agglomeration benefits.

Other theories

Marxist theory discussed in the Appendix at the end of the book is included for comparative purposes.[11]

Summary

The theories discussed in this book describe the economic development process quite differently. Some are primarily concerned with the near-term expansion of the local economy. These are theories of economic growth. Economic base theory, neoclassical growth theory, and interregional trade theory are essentially economic growth theories. Other theories deal with evolutionary and structural change occurring over longer time horizons. These attempts to explain development as a long-term process may be treated as economic development theories. Staple theory, sector theory, growth pole theory, entrepreneurship, agglomeration, and innovation theories consider economic structure in detail, rather than focus on

one or two regional sectors, and focus on structural change occurring over the long term. Product cycle theory has one foot in each camp. As an extension of trade and location theory, it represents a contribution to growth theory. When used to examine new product development, organizational structure, and the technology of firms, product cycle theory becomes more like a development theory.[12]

Not surprisingly, no single theory explains the economic development process adequately. Theories draw different paradigms or schools of economic thought: classical, neoclassical, Keynesian, institutional, and Austrian. Each paradigm uses a different language; the rules of grammar as well as vocabulary are different. Because of these differences, we present each body of theory in its own terms rather than defining and criticizing concepts from a single point of view. This approach is consistent with the notion that no one theory or paradigm can be expected to help the practitioner understand every development situation or solve every development problem. Several theories taken together will usually offer more useful insights. This book, then, is written to help economic developers with two vital tasks: first, to understand the reality of local economic development more clearly in order to achieve greater material well-being in their community; and second, to understand the consciousness and interests of other actors thinking about economic development in order to win powerful supporters of the developer's program as well as communicate strategies effectively to other stakeholders. In the first instance, the developer gains insights about *what* to do; in the second, he or she begins to figure out *how* and *with whom* to do it. Embedded in every theory is a specific definition of economic development, implicit goals and strategies, and implications for the wealth and income of various actors.

APPENDIX 2.1

Key concepts explained

Power

Power is the ability to do work that enables you to get something accomplished. Power is exercised by using (1) money, (2) force, (3) persuasion, or (4) information. With money, people can buy what they want or hire other people to get what they want done. Force can be used legally by the state or illegally by individuals to further their ambitions. Obviously, people do certain things because they are threatened with the use of force. Persuasion is a gift some people have that gets others to help them accomplish their objectives. Historically, some individuals with great charisma have mobilized many people to work in their service for noble or evil ends.

These forms of power clearly have little to offer economic developers. Developers' access to money and the government's police power will depend on the organization and jurisdiction where they work. Charisma varies with personality. However, developers can use *information* in the form of sound ideas, facts, and knowledge, to accomplish development objectives. Although the weakest form of power, information can be used by practitioners to counter its misuse and distortion that has become prevalent.

Theory is the most powerful form of information, and developers can use it to increase their power. With theory, they will not only be better able to convince others to help them carry out their strategies but also have the ability to think independently and creatively about the local economy in the face of political pressures favoring particular development strategies. Of course, these advantages assume that the developer has an audience that is interested and able to listen. The greatest challenge developers now face is finding effective ways to reach their constituents who are overwhelmed with information, much of which has limited factual basis.

Theory

Contemplation and speculation are mental activities that help prepare us to get something done. Theory is a systematic form of thinking that sets forth propositions positing cause-effect relationships that can be placed on a continuum from hypothesis to law. Theory is usually distinguished from practice, which is action oriented, not reflective. Yet the more basic idea is that theory offers the underlying principles that explain the relationships we observe and thereby motivates and informs our actions.

The concepts of theory and power can be brought together by picturing people taking action, thereby exercising their power. They can use theory to guide their actions in two ways. First, theory as an abstract, static system of causes and effects can be treated as data or information that is given. Second, theory that people put to use in practice results in facts. The Latin roots of the words "data" and fact" make this distinction. Facts are made, usually the result of human action. In other words, facts are mediated by human agency and informed by theory.

Developers, like other professionals and businesspeople concerned with practical affairs, often scoff at theory as useless abstraction. Yet, to paraphrase Lord Keynes, such practical minds are usually preoccupied with the ideas espoused by some dead and largely discredited economist. Everyone operates with a theory or model of reality whether they recognize it or not (Boulding 1956).

Interests

Theory uses information to generate questions that lead to learning. Yet no theory or model of reality is politically neutral. People tend to accept theories that support their economic and political interests and ignore conflicting evidence. In other words, they are opportunistically informed and opportunistically ignorant. Will Rogers was said to have observed that the problem of ignorance is not caused by people who don't know anything. The problem is caused by "people who know things that just ain't so." Effective communication with ideologues is difficult because ideology provides all relevant answers and therefore raises no questions.

In a democratic, market-oriented society, economic developers have neither the authority nor the funding to dictate development strategies; they must rely on persuasion to accomplish their strategic objectives. As a result, development practitioners must listen to and understand the actors who have the responsibility to formulate and implement development strategies in order to communicate with them effectively and motivate them to support their program. Therefore, developers need to understand the theories and models used by these participants in the development process. To attain this understanding is one primary justification for studying theory.[13]

One convenient way to identify economic interests in development more broadly is to recognize the four general impacts that the development process has on different actors: price, quantity, income, and wealth effects. Theories that refer

to the economic growth process focus on income effects and quantity effects (such as changes in employment or output). Yet local actors often feel price and wealth effects more immediately and acutely. For example, consider the large discount retailer coming into an area that provides employment and earnings opportunities (quantity and income effects). Several local businesses are forced to lower their prices (price effects) and become less profitable. Landowners near the new retailer may realize capital gains on their property, whereas retail property owners in other parts of the community may experience capital losses (wealth effects). All such effects deserve attention if the costs and benefits of growth are to be understood in a comprehensive manner. In considering the applications of each theory, the developer should explicitly consider the relationship of the theory to local political and economic interests by outlining the likely price, quantity, income, and wealth effects.[14]

Mediation

We expect that the sun will rise in the east tomorrow morning. This predicted outcome is unmediated because it will happen without the involvement of people (without human agency). On the other hand, economic development outcomes are mediated because they cannot occur without human action; the activities of people are required to give life to these relationships. Unfortunately, economic development theories ignore human agency. They are deterministic, that is, cause-effect explanations of human behavior; otherwise, they would not be simple, concise, logical explanations of reality. In such abstract causal models, inanimate objects often appear to have human traits and abilities. For example, economists speak of "the market" as if it has a life of its own and the ability to do things. They ignore the human agency required for markets to function.[15] Therefore, the development practitioner must remember that all theoretical propositions are mediated by human agency, but this mediation is usually ignored in the interest of conciseness.[16] The full picture will remain somewhat obscure without "reading between the lines." Developers should use theory to understand reality in order to avoid the trap identified by Keynes. Developers, like other men and women of action, believe in their power to change future reality. They know that economic development does not just happen; people make development happen. To "develop," then, is a transitive, not an intransitive, verb (Arndt 1981). To overcome the apparent contradiction between trying to understand the world deterministically and exercising free will when trying to change it, developers must remember that earlier human activity has led to the facts they observe.

We turn to history to find accounts of human agency. Historical studies describe who did what, when, where, why, under which circumstances, and to what results. For example, historical accounts reveal the tremendous impact Robert Moses had on the growth and development of New York and its environs. Yet development theory when applied to New York effectively ignores his role for the sake of simplification and conciseness. Thus, historians are the researchers who document human agency with all of its messiness in their scholarly work. Historical analysis

is not theory, but it provides the indispensable background and context that leads to the wise and informed application of theory. Our understanding of economic development, then, is incomplete without both theoretical explanation and historical analysis. Local economic developers who have this perspective should be able to grasp the relationships between theory and practice in historical context.

Although we focus on theory and its application to practice, developers should remember the other three concepts when considering each theory presented in Part II. Power raises questions about how practical the theory is and how easily and usefully it can be applied. We expect developers to be drawn to theories that are both insightful and appropriate given the local context. Interests motivate the developer to gauge the benefits and costs of development and to identify the winners and losers from the perspective of each theory. Mediation requires careful study of the place's economic and political history as necessary preparation for any serious attempt to use theory to influence future development.

Discussion questions

1 Do you agree that everyone operates with a theory of reality?
2 Do you think it is important to understand interests in economic development?
3 Why is it necessary to supplement economic development theory with historical analysis?
4 At this point, how would you define economic development? What does your definition imply for both the process and practice of economic development?
5 Compare and contrast the definition of "economic development" you favor to the IEDC's definition.
6 How does the definition of "economic development" you favor address the following trade-offs?

   a Attracting or growing successful companies versus providing infrastructure useful to all companies.
   b Wealth creation for corporate shareholders/business owners versus benefits for local workers and community residents.
   c Stable and plentiful local employment versus increasing national productivity growth.

Notes

1 More formally, information on alternative locations for production facilities is imperfect. Developers help perfect the market by improving the quality of information used in investment decision making. They provide this information by marketing the locality and its sites. Economic development practice as a form of place marketing is well described by Kotler et al. (1993).
2 A more detailed version of this section is in Malizia (1994), whose revised definition of economic development states:

> [T]he on-going process of creating wealth in which producers deploy scarce human, financial, capital, physical and natural resources to produce goods and services that

> consumers want and are willing to pay for. The economic developer's role is to participate in the process of national wealth creation for the benefit of local consumers and producers by facilitating either the expansion of job opportunities and tax base or the efficient redeployment of local resources.
>
> *(p. 84)*

This critique and revised definition apply neoclassical economics. As noted, other definitions of development are drawn from other theories and paradigms. The definitions from theories covered in subsequent chapters are summarized in Table 2.1.

3 Agropolitan development, parallel economy, and basic needs approaches have been proposed to build self-reliance and are discussed more fully in Friedmann and Weaver (1979). This path requires that political and legal institutions regulate economic forces in order to protect people and the natural environment.

4 An excellent comparative treatment of the origins of capitalist development in various nation-states is in Moore (1993).

5 Flammang's ideas about development have much in common with Thorstein Veblen's. Both view technological progress as a common property resource that is used to increase the society's survival potential. This idea may be counterposed to Schumpeter's individualistic conception of the entrepreneur who leads the development process (Chapter 7). Veblen advanced a critique of capitalist development rooted in cultural and historical analysis of modern societies. He viewed economic progress as driven by "instincts" that were conditioned by culture: a desire to be productive (workmanship), responsibility for friends and family, and a concern for the next generation (parental bent), which respectively lead to regard for quality, community, and the future. With the rise of corporate enterprise, however, business (or commercial/finance) principles come to dominate industry (production) principles. Corporate financiers, absentee-owners and top managers gain power at the expense of engineers, technicians and lower managers. Salesmanship becomes more important than workmanship. As a result, productive capacity is not fully used, and prices and profits are increased at the expense of greater production at lower cost. Veblen's contributions as well as Myrdal's (Chapter 6) are used in an argument that challenges the convergence assumption in neoclassical theory. See Hall and Ludwig 2010.

6 The analogy of human growth and development is appropriate. We all grow, and eventually shrink, as we age. We also develop as we mature from infant to toddler, to youngster, to teenager, to adult, and to elder. These terms refer to qualitatively different developmental stages.

7 In a later article, Flammang (1990) skillfully contrasts growth to development with the idea of static efficiency (growth) versus dynamic efficiency (development). He argues that development "softens" economic and social structures, which leads to more flexibility, while growth "hardens" structures in order to realize efficiencies. For any local economy, growth involves decreasing internal differences, increasing structure, accumulating rewards, and expanding to fill existing opportunities. Development involves increasing internal differences, increasing flexibility, increasing adaptive capacity, and searching to find new opportunities, which respond to external change. These distinctions can also be applied to local companies that exemplify the following differences. A growing company concentrates resources on several promising product lines or services, organizes production to increase margins, and gains a greater share of existing markets. A developing company establishes new profit centers, decentralizes control, experiments with new business approaches, and pursues new markets or different marketing channels.

8 A long tradition of posing strong critiques of capitalist development exists in response to its deleterious environmental and social impacts (e.g., Kropotkin, Geddes, and Mumford). Economic theory has been reformulated in biological terms. For example, see Daly (1991). Concern for development that is "sustainable" has become more widely embraced and has prompted calls for a "post carbon" economy with growing recognition of climate change.

9 The two questions that concerned Polanyi are: (1) how did the free market become so dominant? and (2) how have people and governments responded to its dominance? The short-hand answer to both questions is presented in the epigraph of an article about Polanyi: laissez faire was planned; planning was not (Sternberg 1993). The self-regulating market remained dominant for about 100 years, rising to prominence from 1832, with repeal of the England's Elizabethan poor laws and passage of laws supporting the market, until 1870, and then declining until the repeal of the gold standard and the trade wars of the 1930s. In the early 19th century, national governments created the institutional framework to support laissez faire. The framework included the legal system to defend property rights and enforce contracts, the production of money and regulation of the money supply, the provision of necessary public goods, and so on.

Polanyi reviews the series of social reform movements that arose spontaneously to protest laissez faire and call for the protection of labor and land from the self-regulating market. His interpretation of capitalist development and the need for social intervention represents a middle ground, less extreme than Marxists who want to replace the market system yet much more interventionist than the defenders of laissez faire would tolerate.

10 Dynamic economic base theory, discussed in Chapter 3, is not treated as a distinct theory. Rather it can be considered as an extension of economic base theory that addresses structural change over time. In this sense, it combines the logic of economic base theory, stages theory, and sector theory.

11 Pike et al. (2017) devote Chapter 3 to the presentation of concepts and theories relevant to local and regional economic development. In laying out these divergent theories, they draw out their policy applications and limitations. They cover a much broader range of theories than those in Table 2.1. Their additions include the following: long-wave theory, regulation theory, institutionalism, sustainable development, and a set of critiques they call "post-developmentism."

12 Although the industry, occupation, enterprise, and product dimensions of regional economies are all relevant, development theories tend to introduce or emphasize just one or two of these categories. Growth theories emphasize industry mix, especially the leading export industries. Product cycle theory focuses on the product dimension, while entrepreneurship theories introduce the enterprise and company dimension. In general, growth theories tend to be more macro level and deterministic, while development theories are more micro level and mediated. Theories of innovation focus attention on the locality's economic ecosystem: its diversity and connectivity, as well as its business climate and quality of life.

13 Joan Robinson and John Eatwell relate theory to interests in an interesting way, which previews the discussion in Appendix at the end of this book:

> As we have seen, the Mercantilists were the champions of the overseas trader; the Physiocrats supported the landlords' interest; Adam Smith and Ricardo put their faith in the capitalist who makes profits in order to reinvest them and expand production. Marx turned their argument round to defend the workers. Now, Marshall came forward as the champion of the rentier—the owner of wealth who lends to the businessman and draws his income from interest on loans.
>
> *(1973, p. 39)*

By extension, John Maynard Keynes appreciated the consumer and government as major forces influencing the business cycle, while Joseph Schumpeter emphasized the power of the entrepreneur as producer. All theories have their champions, as we will demonstrate in Part II.

14 The connections between theory and the interests of various actors in the development process are discussed in Malizia (1985, pp. 35–36). The reader should make these connections with every theory presented in Part II. Each theory would impose different benefits and costs on local interests. Price, quantity, income, and wealth effects are likely to impact local interest groups differentially.

15 How many people do economists think are needed to change a light bulb? None; they expect that the market will do it.

16 It may be useful to practice the application of this admonishment here by analyzing the unmediated statement—costs increased, thereby causing prices to rise—and writing down the actions of workers, unions, suppliers, business executives, and influential groups (such as OPEC) that would be required to realize this simple causal statement. After sufficient practice, one will better understand that all of the causal relationships postulated by any particular theory are mediated. One can also see why the specific activities of economics actors are too cumbersome to be fully described in behavioral models.

PART II

Theories of economic growth and development

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3

ECONOMIC BASE THEORY AND RELATED EXTENSIONS

Economic base (or export base) theory is widely used to understand local economic development in the United States and Canada. Its underlying premise, that the external demand for a region's products is the primary determinant of regional prosperity, is widely accepted. Learning economic base theory thoroughly should be a top priority for economic developers because this knowledge will facilitate better communication with economic development colleagues, political leaders, and others interested in promoting the regional economy. As a basis for understanding the regional economy, economic base theory offers useful insights. In the form of a quantitative comparative static model, it is the basis for economic impact analysis, which is used to make near-term predictions of economic growth or decline. For long-term analysis of economic development, economic base theory needs to be modified, because key export sectors and local economic structure change over time, often significantly. Dynamic economic base theory addresses this limitation to some extent (see section "Extension" of the chapter).

When applying economic base theory, the economic activities of a labor market or metropolitan area are divided into those that produce for the export market (termed *basic industries*) and those that produce for the local market (termed *non-basic, service or residentiary industries*). The two sectors are linked in two important ways. First, the basic sector directly purchases goods and services from the non-basic sector. Second, workers employed in the basic sector purchase food, clothing, shelter, public services, and other commodities from the non-basic sector. These two linkages give rise to *the multiplier effect*.

How does the economic base multiplier work? Demand for the region's exports generates sales that return income to the basic sector. Basic sector purchases provide income to the non-basic sector. Spending by basic sector workers also generates income to the non-basic sector. With this income, non-basic firms and non-basic workers engage in additional rounds of spending. These rounds of spending

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generate the multiplier effect such that an initial increase in basic-industry income generates an even greater amount of total income for the area. In parallel fashion, a decrease in basic-industry income leads to a greater decrease in total area income.

Given multiplier effects, the economic developer's most important tasks are to recruit any promising export-oriented company (industrial recruitment) and to try to foster a suitable proportion of industries whose products are in heavy demand outside of the region. Thus, industrial recruitment which remains the most popular economic development strategy finds its rationale squarely in economic base theory because the attraction of promising manufacturing or service-export industries generates growth in non-basic or local-serving industries that naturally follows.

Economic base theory

Economic base theory was originally developed as a practical technique to evaluate the local economy for mortgage underwriting and was subsequently used by urban planners to predict metropolitan population growth.[1] Urban land use planners still use the economic base model to forecast growth that will require additional land and building space.

Economic base theory represents the simplest formulation of what may be called a Keynesian theory of regional income determination. It is a demand-driven model used to estimate metropolitan growth. As noted previously, the economic base model divides the regional economy into two sectors. The export sector includes all economic activities that produce commodities that are sold to nonlocal households, businesses, or governments. The non-basic sector includes all remaining economic activities that are assumed to produce for the local market.

In relation to North American Industrial Classification System (NAICS) codes, primary sectors (11 agriculture, forestry, fishing and hunting) and secondary sectors (21 mining, quarrying, and oil and gas extraction, and 31–33 manufacturing) are often assumed to be in the basic sector, while construction (23), utilities (22), and tertiary sectors (distribution, trade, and business and personal services—codes from 42 to 92) are non-basic. Making assignments to the proper sector can be refined by using more disaggregated industries or by relying on local expertise. (Appendix 3.1 describes various ways to define basic and non-basic industries and calibrate the economic base multiplier.)

The economic base multiplier model is measured in terms of employment, earnings, or output and may be written as follows:

$$b + r = n \tag{3.1}$$

where b, r, and n denote basic, non-basic (residentiary or local), and total regional economic activity, respectively. Non-basic economic activity is a function of total activity, where a is a parameter that must be estimated.

$$r = \mathrm{f}(n) = an \tag{3.2}$$

The multiplier is derived by substituting *an* for *r* in (3.1) and rearranging terms to get the following equation[2]:

$$\left(\frac{1}{1-a}\right)b = n \tag{3.3}$$

The term pre-multiplying *b* is the economic or export base multiplier; *a* denotes the average (and, in this case, also the marginal) propensity to spend locally. The model can be used to estimate the change in total regional employment, earnings, or output when demand for regional exports stimulates or depresses basic sector activity.

Thus, the economic base model provides a means of estimating the employment, earnings, or output multiplier effects of external changes in demand for the region's exports. The linkage between the basic and non-basic sectors is represented by the multiplier $(1-a)^{-1}$, which transmits changes in external demand for basic sector products or services to the entire regional economy. If we assume that the multiplier remains constant over time, estimated changes in the export sector alone generate projections of employment, earnings, or output. The IMPLAN (IMpact analysis for PLANning) model is a regional input-output model that extends economic base analysis from two sectors to many sectors. It is widely used to analyze the economic impacts of growth or decline. Appendix 3.2 shows the derivation of input-output multipliers used in the IMPLAN model.

Exclusive focus on external demand as the determinant of regional growth while ignoring internal demand is a weakness of economic base theory. The theory does not consider supply-side features of the regional economy, including its endowment of natural resources, the rate of capital investment, or the quality and quantity of the labor force. The theory also assumes that there are no significant production capacity constraints, and, therefore, local factor prices will not increase when demand increases. Excess capacity means that there are unemployed resources (capital, labor, and land) in the region or that these resources may easily be acquired from outside the region via labor migration or capital inflows.[3]

Due to its simplicity, economic base theory has been subjected to significant criticism, the most important of which is summarized in section "Elaboration and criticisms" of the chapter. Yet simplicity gives economic base theory its continued appeal. Its intuitive appeal is strong because it is difficult to imagine that output or employment in a region could grow over time if regional industries only traded with each other. The postulate that metropolitan growth in employment and output is determined by external demand for the region's exports yields clear implications for economic development practice.[4]

Applications

Industrial recruitment and promotional efforts by Chambers of Commerce and public utility allies are clearly aimed at expanding the region's basic sector. These economic development organizations have websites that contain great quantities of statistical and marketing information. They contact prospects regularly, host visits

of site-selection consultants and corporate officers, and facilitate the location of companies they attract. Thus, the recruitment strategy, which is supported by economic base theory, stands as one pillar of local practice. Economic base theory also provides a common language for local advocates of economic growth.

Industrial recruiters do not focus only on companies that would generate strong linkages and high multiplier effects. They have interest in any company that wants to make a sizable investment or locate many jobs. But they would not want to promote aggressive expansion of the non-basic sector. The size of the local market limits demand for the non-basic sector. Thus, attempts to grow the non-basic sector would probably result in business failures.

Although local economic developers cannot influence external demand for basic sector goods directly, they can try to expand the existing economic base in three ways. First, they can facilitate the expansion of export industries that are already part of the basic sector. Providing adequate space and infrastructure is especially important in this regard. Second, they can engage in industrial recruitment and promotion to diversify the export base. This requires careful assessment of the region's competitive position vis-á-vis other areas to target growth industries. Attractive industries would be those that offer forward or backward linkages (i.e., interindustry connections) and, therefore, generate high multipliers. Third, they can reduce the cost of doing business locally if they can convince local politicians to fund public facility and service improvements. Development practitioners can draw on economic base theory to support three other strategies.[5] First, developers can anticipate potential capacity constraints that would retard or delay growth. They could work to ensure adequate supplies of trained labor, industrial land and facilities, public infrastructure, affordable housing, and so forth. Second, developers should recognize that, due to interindustry linkages, all connected industries influence multiplier effects. Therefore, the most rapid rate of growth is not necessarily achieved by concentrating development efforts solely on the obvious exporters. Careful study of export companies and their linkages within the regional economy could open up other paths for stimulating growth. Third, strengthened linkages between industries in the basic sector and the non-basic sector would increase the multiplier by reducing leakages. This strategy is essentially one of import substitution.[6]

What impact do imports have on the multiplier? To the extent that local workers or suppliers purchase from non-local sources, the multiplier will decrease. Furthermore, some local exporters may not purchase inputs locally but rather import them in the first place. This situation is common in the wholesale/distribution sector engaged in transshipments. In these sectors, the only local input is labor. Other local firms, especially retailers, hire locally but otherwise import the goods they sell. These situations would lower multiplier effects.

Elaboration and criticisms

The economic base model can be used as a tool for near-term predictions of economic growth and for impact analysis as long as (1) the industrial composition of

the basic sector does not experience substantial change, (2) non-basic industries retain their competitive position in the local economy, and (3) the demand for export products is an important factor causing local change. The model has limited applications for long-term analysis of regional economic development precisely because these conditions are not likely to remain constant for very long.

Is the objective of economic development employment growth or increased consumer welfare? The economic base model clearly focuses on growth and assumes that increased consumer welfare will follow. Companies in the basic sector compete for market share. Therefore, they must remain competitive to survive. The situation in the non-basic sector is more complex. Since local consumers prefer inexpensive commodities regardless of source, local monopolies could burden them with higher cost or inferior products. Yet local monopolies may not be easily replaced. Although more competition in the non-basic sector should increase consumer welfare, excessive competition and business failures impose costs on the public due to the inefficient use of expensive infrastructure.[7]

Economic base theory can be used to anticipate the local interests that would favor growth or oppose it since growth benefits some members of the community and imposes costs on others. Firms in the local sector that enjoyed economies of scale (i.e., lower unit cost as production increased) would benefit. Owners and managers of these firms would tend to be growth boosters because bigger would be better for their returns. Such firms may well include local internet providers, other communications firms, electric/gas/water utilities, banks and other financial institutions, and possibly construction contractors and companies providing local business services. Furthermore, the value of urban land should increase as growth occurs. Thus, landowners, including farmers with property on the urban fringe, real estate firms, and other transaction-oriented firms whose commissions are tied to asset values, should expect to realize capital gains as values increase. On the other hand, growth could generate congestion, crime, higher tax rates, higher rents, or higher prices for local commodities. Local residents who experience these outcomes may well oppose continued growth. However, residents who got better jobs or earned more income would be less likely to oppose growth. Since economic base theory helps identify the expected costs and benefits of growth, it helps developers understand the pro- and anti-growth forces found in most U.S. localities.

Three more profound problems with economic base theory exist. First, economic developers should clearly understand the region's balance-of-trade position and its competitive position. But economic base theory tends to confuse two objectives: maintaining a favorable regional balance of trade (commodity exports being worth more than commodity imports) and supporting "critical" industries (those industries that are vulnerable to outside competition) that impact the region's competitive position.[8] Trade deals with all current flows entering or leaving the region. Competitive position reflects the ability of firms in the region to export their commodities. With regard to balance of trade, regions must export in order to bring in money to pay for needed imports; export base theory advises practitioners to focus on basic industries in order to ensure an adequate level of

export earnings. However, an emphasis on balance of trade should necessarily treat the import side of the ledger as well as the export side to be most effective. Developers may also focus on reducing imports, which requires attention to the fortunes of local-serving (non-basic) industries. Suddenly the priorities of economic base theory are not so clear: the developer must ensure the healthy growth of both the basic and the non-basic sectors, which together include every firm in the region!

Application of economic base theory should not be carried to this extreme, however, because of the critical-industries objective. Economic base theory puts proper emphasis on those industries, which, if lost, would constitute the greatest loss to the region. Moreover, through industrial recruitment, it identifies those industries, which, if gained, would constitute the greatest benefit to the region. However, this focus is too narrow because not every critical industry is in the basic sector.[9]

A second problem with economic base theory is the somewhat arbitrary division of the regional economy into basic and non-basic sectors. Although the issue is ultimately conceptual rather than empirical, clearly basic sectors often sell to the local market and non-basic sectors at times export. There are many related problems, including the lack of explicit regional export data, the use of employment or earnings instead of output information, and the financial and operational infeasibility of census surveys.[10] Ultimately, the difference between basic and non-basic activity is a function of the organization of industry and not the criteria identified in the theory. If a local exporting firm, for example, buys $200 worth of intermediate inputs from local suppliers, and then exports the product at a price of $500, only the value added to the product by the firm ($300) is considered an export. If the firm were fully vertically integrated, thus supplying its own inputs, the entire value added ($500) would be considered an export. In the first case, the input suppliers sold their product to a local industry. In the second case, they sold directly to the exporting industry, and no intermediate sales of any part of the product would be considered non-basic; here the basic-nonbasic distinction begins to lose its meaning.[11] The distinction becomes more problematic as the local economy under consideration becomes larger because the specialization and differentiation of the regional economy are likely to increase as the metropolitan area grows. In other words, the multiplier is sensitive to the size of the region. Moreover, by reducing the economy to two sectors, the two-sector model suppresses both interindustry relations and the multiplier effects of different export industries. Input-output analysis can overcome most of the difficulties. Indeed, given the greater availability of IMPLAN data at the county level, there is very little justification for using the simple economic base multiplier. See Appendix 3.2.

The third and related fundamental problem with economic base theory is that, by focusing on exports and the basic sector, the theory neglects the reality of the regional economy as an "integrated whole of mutually interdependent activities" (Blumenfeld 1955, p. 121). It ignores autonomous investment and the role of the non-basic sector in stimulating economic growth.[12] Since all export firms require local services to produce, all local services are basic, in this sense, and constitute

the foundation upon which further regional growth can take place. According to Blumenfeld:

> It is thus the secondary, non-basic industries, both business and personal services, as well as ancillary manufacturing, which constitute the real and lasting strength of the metropolitan economy. As long as they continue to function efficiently, the metropolis will always be able to substitute new export industries for any which may be destroyed by the vicissitudes of economic life.
>
> *(1955, p. 131)*

The true economic base of the region over the long term is comprised by the large size of the local market, the availability of skilled and talented labor, and the array of business services, including public infrastructure. It is business services and other "secondary" industries which, together with the availability of labor of all kinds, enable the metropolis to sustain, expand, and replace its "primary" industries. Local industries may be more permanent and stable than export industries. While the existence of a sufficient number of export industries is indispensable for the continued existence of the metropolis, each individual "export" industry is expendable and replaceable. Blumenfeld's arguments, which constitute a reversal of the causal direction of the original model, were picked up later by Wilbur Thompson (Chapter 10).[13]

The criticisms related to size of region and reversal of sectoral importance raise the relationship between specialization and size. The economic base model would appear to work best in smaller regions or "one horse" towns, where the division of labor is indeed severely restricted by small market size. External demand would surely enhance the prospects of local economic growth. At the other extreme, large metropolitan areas are inherently more diverse because of their ability to support multiple specializations. Export industries may well be less important than "secondary" industries. Although still smaller than the external market, the large local market offers a generous source of demand for local production.

Extensions

These criticisms and theoretical limitations can be partly addressed by introducing related theories that offer local economic developers additional insights. These theories present different ways to overcome the most limiting aspects of economic base theory, namely its near-term orientation, its exclusive emphasis on external demand, and its context of one open region interacting with an undifferentiated rest-of-the-world. First, *staple theory* extends economic base logic to address the historical evolution of an undeveloped region over the long term. Second, *sector theory* assumes a mature region that has attained sufficient size to make internal demand more important than external demand as a source of growth. Third, *dynamic economic base theory* focuses on the evolution of economic structure over the long term.

Staple theory

In his 1955 book, Douglas North uses export staple theory to examine the evolution of regions over time. His concern is to explain the causes and consequences of long-term secular change, as measured by regional product or per capita income, more than cyclical change.[14] He emphasizes the need to understand a region in terms of its evolving export specialization. According to North, although other sources of growth may exist, the export staple is usually the predominant source. Therefore, long-term growth is a function of the quantity and quality of productive factors, which are shaped by the export staple and, in turn, generate competitive staple exports.

North makes a twofold contribution in writing about economic development in the 1950s. He first explains and applies staple theory, which was originally formulated by Harold Innis (1920, 1933, 1940) as a model of the Canadian economy, and he cogently criticizes Hoover and Fisher's (1949) stages theory of development.[15] His application is most appropriate to the economic history of the United States or Canada, which contained undeveloped regions that never experienced feudalism.[16]

Staple theory addresses economic growth and structural change in the long term. The staple is an internationally marketable commodity generated by agriculture, forestry, fishing, or mining activities and processed in varying degrees by local manufacturing. North attempts to extend the staple concept to apply to a region's entire export base, but the theory works best when applied to export staples only rather than to the entire economic base. As Innis observed, the status of the export staple will determine and dominate the development of a region newly integrated into the larger market system.

To exploit an undeveloped region, capitalists determine what is exportable by gauging comparative advantage and transfer costs. Since demand is exogenous while costs are endogenous, government intervention is focused on reducing transfer costs and driving down production costs to help expand the market for the export staple. With the development of infrastructure and needed services, firms begin to benefit from external spatial economies (Chapter 9). Infrastructure investment, especially in transportation, is needed to improve the competitive position of developing regions. Research and development (R&D) is designed to improve the export staple's technology, thereby reducing costs and deferring diminishing returns. External economies grow up around the export base, specifically through trained labor, complementary industries, and business services, including credit and transport services that are oriented to the export sector. Capital coming to the region is invested in the established competitive advantage which reinforces the region's specialization. Therefore, the export staple shapes the entire character of the regional economy.[17]

North describes both the urbanization and the transportation effects of staple-led growth. Unlike the central place pattern that emerges in densely settled regions, where numerous market towns serve local markets, large cities arise in the newly developed region. For example, most major U.S. port cities have grown as physical

and commercial interruptions or breaks in transportation. Extensive transactions occur in these locations, spurring the growth of both financial services and legal services.

North posits that growth of the successful export staple will lead to related manufacturing growth. First, material-oriented industries (e.g., sugar refining) result in vertical integration (e.g., sugar canes or beets are processed crudely at first into sugar and molasses and subsequently into more sophisticated sugar products). Second, non-basic industries serve the growing local market. Third, industries arise to supply the staple-related manufacturing and primary sectors. Finally, footloose industries, although not directly tied to the export staple, are attracted to the region because of the growing size of its market. They can serve as an outlet for locally accumulated capital. Thus, industrialization occurs naturally, and government intervention is not necessary to spur local private investment. In the long term, growth gradually reduces differences among regions specialized in different staples. Over time, regional economic structures should become more similar.

Applications

Staple theory provides a general strategy of development by recognizing the connections between the economic base and the political superstructure. Economic developers should continue to build on and improve the export staple as long as it remains competitive in the larger economic system. Strengthening the existing specialization should be more sensible than attempting to diversify the economic base. Footloose economic activities will be attracted to the area when its market achieves sufficient size and offers urbanization economies that can be exploited by these new exporters.

Government intervention is rationalized as a means to improve the competitiveness of the export staple. Public investments in R&D, infrastructure, training, and so on are justified as long as they lead to lower staple production costs. The concern about greater diversity should be deferred until a strong industrial complex and the related infrastructure are created to support the staple export. Instead of engaging in generic business development strategies, economic developers should help government fulfill its traditional roles designed to support capitalist development. To sustain the export-staple industrial complex, government should provide public infrastructure, education and training, new scientific information, and other public goods that should increase the efficiency of local firms.

The theory is quite helpful in understanding the economic history of many port cities and other major cities in North America that grew by serving as physical and commercial interruptions in transportation for an expanding inland economy. Although this application is limited, staple theory is important and compelling in that it orients economic developers to the economic history of their regional economy. Developers should study and comprehend local economic history for three basic reasons. First, knowledge of economic history provides the grounding needed to apply appropriately and skillfully more abstract, ahistorical models of

economic growth. Second, this understanding will help them work more successfully within the constraints imposed by established local values, politics, and wealth. Third, this perspective raises the useful concept of path dependence. Each region's unique history limits to some extent its future possibilities. Economic developers may be able to learn from the experiences of regions that have similar pasts. On the other hand, they should avoid trying to imitate successful regions with different industrial legacies. Your regional economy is not likely to become the next version of Silicon Valley. Path dependence is further discussed in the following and in Chapter 10.

Sector theory

Sector theory argues that the relative share of production in each major sector will change in the region over time. Thus, sector theory presents a relatively simple and testable way to understand regional economic development. The economy is divided into three highly aggregated sectors: primary (agriculture, forestry, fisheries), secondary (manufacturing and mining), and tertiary (trade and services). The region becomes specialized sequentially in primary, then secondary, and then tertiary products due to two forces: differences in the income elasticity of demand for primary, secondary, and tertiary products and technological change that leads to productivity improvements in primary and secondary sectors more than in the tertiary sector. Economic base theory and staple theory emphasize external economic relationships. Their logic would argue that funds earned from trade are fundamental and necessary to bring about internal development. On the other hand, sector theory focuses on the internal structure of the economy. Internal development through specialization and division of labor paves the way for favorable external trading relationships. The structural relationships between the three sectors evolve as income per capita increases in the economy over time.[18]

Sector theory is attributed to Clark and Fisher, whose writings were published in the mid- 1930s and early 1940s. In *The Conditions of Economic Progress*, Clark (1940) observes that high levels of real income per capita are associated with high proportions of the labor force in tertiary industries. Fisher (1933), examining national economic structure, makes the same observation. They formulated sector theory to explain this empirical phenomenon. The economy is supposed to shift from "lower order" to "higher order" economic activities as economic growth proceeds. Based on their empirical research, Clark and Fisher expect shifts to occur from primary sectors through secondary sectors and on to tertiary sectors.

The income elasticity of demand for the products of different sectors drives the sectoral shifts in production. Increases in labor productivity support the changing sectoral allocation of the labor force. As per capita income increases, the demand for manufactured goods will exceed the demand for agricultural and other primary products. Subsequently, the demand for services continues to grow, and the service sector becomes the largest regional sector.

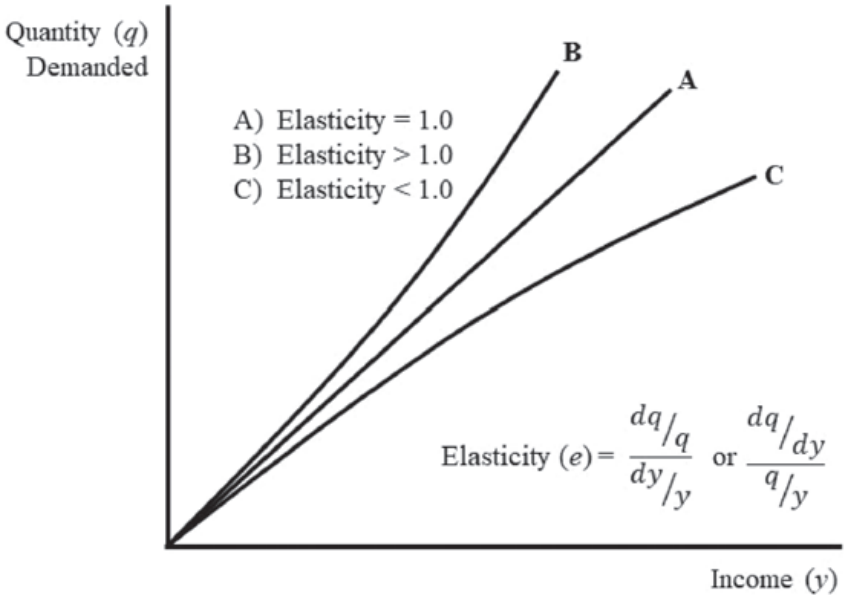

FIGURE 3.1 Income elasticity of demand: constant, increasing, decreasing

At the same time, growth-creating investment introduces better technology, which allows factor substitution. Generally, technological progress will be labor saving in the primary and secondary sectors. Primary sectors and mining industries are expected to experience diminishing returns, while manufacturing is expected to experience constant or increasing returns to scale. Production relationships encourage expansion of manufacturing relative to producers of primary products. Producers continue to introduce labor-saving technology in order to respond to shifts in demand. These productivity improvements are more likely to displace labor from primary and secondary sectors, making labor available to the tertiary sector. As a result, the share of total employment becomes lowest in primary sectors and highest in tertiary sectors.

Income elasticity of demand (compared to price elasticity, where change in quantity demanded results in change in price) relates the demand for a commodity to income, as shown in Figure 3.1. Except for inferior goods, the quantity demanded should increase with aggregate income. If the rate at which demand increases with income is constant, income elasticity equals one. Increasing and decreasing rates of change in demand refer to elasticities of greater than or less than one, respectively.[19] Figure 3.2 shows how income elasticity may affect the demand for commodities of each sector. Starting at the origin, the demand for agricultural goods peaks quickly then levels out; manufacturing goods increase in level but at a declining rate; services show an increasing level at a constant or increasing rate.

Although sector theory was sharply criticized by economists in the 1950s who were using developmental models that stressed external growth, it remains credible as an explanation of economic progress for several reasons.[20] First, it focuses the

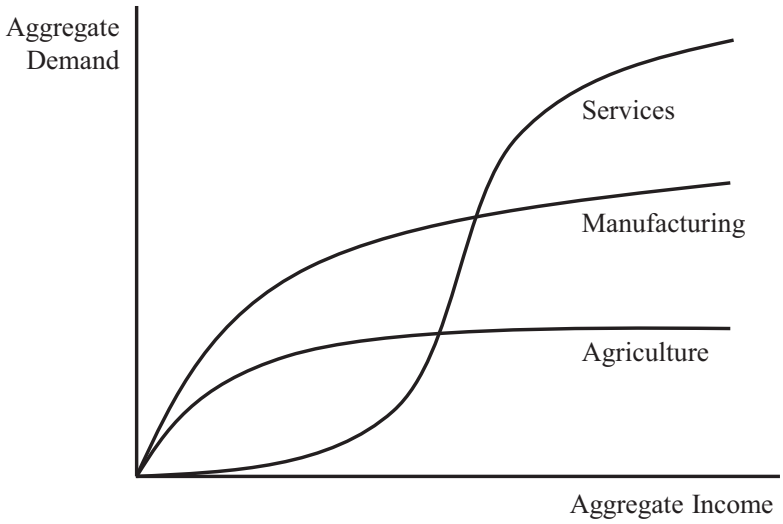

FIGURE 3.2 The effect of income elasticity on commodity demand

analysis on economic structure and structural change, not simply the income or production flows of an existing economic structure. Second, the theory deals with both demand and supply.

On the demand side, the sectoral hierarchy reflects the evolution of the regional economy. The primary sector is initially dominant because its products are necessities like food and shelter. As an economy becomes more efficient in the production of the basic goods needed to sustain life, surplus labor becomes available for other pursuits and is put to work in the secondary sector manufacturing goods. With innovation and productivity increases in the secondary sector, surplus labor again becomes available and moves to provide services for those employed in the primary and secondary sectors. As an economy evolves, employment is increasingly provided by the higher-order services. As a result, the service sector enhances the range of economic opportunities in the region. A large service sector can support more diverse economic activities and attract, retain, or improve manufacturing.

On the supply side, both Clark and Fisher see productivity gains to be the direct result of increased specialization. These gains are qualitative as well as quantitative. With increased specialization comes greater expertise, higher rates of innovation, and more creative uses of labor and capital. Internal structural development that occurs with greater specialization increases the number of activities that the economy can simultaneously support. The diversity of economic opportunities gives all members of society more choice to pursue the work for which they are most capable. The internal development of economic structure is a mark of the economy's growing sophistication (Fisher 1933). Sector theory, then, may be used for predictive and prescriptive purposes, if one is willing to assume that less developed economies will follow the path of more developed economies. The size of the tertiary sector is a crude indicator of the level of development, and the growth rate of the tertiary sector may be a dynamic indicator of development.[21]

Applications

Economic developers tend to consider export sector expansion and import substitution as attractive strategies to encourage economic growth. Sector theory reminds us that furthering the internal evolution of the local economy is an equally sound path to economic development. Internally focused development strategies can lead to progress over the long term; external development strategies may promise more rapid economic growth but also higher risk of failure and instability.

In today's economy, sector theory is too crude in its original three-sector form to be useful as a basis for understanding and encouraging economic development. The secondary and tertiary sectors are far too diverse to be treated as single categories. In particular, many new service industries have been created, and services are now consumed on a mass scale. New service industries range from information services to internet-based apps to new ways to sell and deliver products (e-commerce). The motivating forces behind service sector growth are as diverse as the new services themselves, such as productivity enhancements, outsourcing, esoteric consumer services for the wealthy, and so on. Because the spectrum of today's service sector is very broad, its specific role in shaping the internal structure of an economy varies from region to region.

One way to apply sector theory currently is to focus on its "essential dynamic" elements, namely the income elasticity of demand and productivity improvements (see Table 2.1). The local economic developers could conduct detailed analysis of the productivity trends in the major industries and the income elasticity of major products. Sectors with relatively high income elasticity should have more promising growth prospects, and thus assistance to these sectors may have better results. Sectors experiencing productivity improvements are likely to displace labor. The growing importance of artificial intelligence makes this analysis especially important. Anticipating the displacement of workers who have specific skills may help generate better retraining options for them.

Another application is to consider the importance of service-sector industries in the regional economy. Certainly, many metropolitan areas in the United States now count services as constituting the region's economic base. The most important are usually in business-oriented sectors. Based on NAICS codes, these sectors include information (51), finance and insurance (52), professional, scientific, and technical services (54), and higher-level services within the education (61) and health care (62) sectors.

These business services can be important, especially for newer businesses, because they can reduce overhead costs and allow greater flexibility. These services have grown rapidly, partly the result of information technology and outsourcing. Education, health, and state governmental services serve as anchor institutions and shape the essential character of university districts, medical centers, and state capitals.

The third and final application of sector theory is to examine all sectors in order to anticipate growth and decline of local industries and plan for ways to respond to expected change. Comprehensive scope requires detailed structural analysis of

the metropolitan economy. Input-output analysis is one vehicle for conducting this structural analysis.[22] For U.S. metropolitan areas with different industry mixes, aggregate income growth will have differential effects on local production since income elasticity stimulates some sectors more than others. Productivity gains will also depend on industry mix. The local labor freed for new activities may find new employment locally or may migrate to other areas.

The perspective of sector theory would support providing services to existing businesses and industries. These efforts typically include visits to important employers, assistance in dealing with government agencies, advocacy for public improvements that benefit existing companies, business appreciation days and awards, and many other services supportive of existing businesses. These activities are often justified on recruitment grounds; the existing industries in one locality are the recruitment targets of other areas. Thus, it makes sense to care for important local companies for fear of losing them.

In conclusion, sectoral analysis offers powerful insights about the relative prospects of existing industries. These insights would help local economic developers ration scarce resources in order to assist the most strategically important sectors. However, such applications are not very common; the productivity of local industries and the well-being of local consumers take a back seat in economic development practice to industrial recruitment and the expansion of exports.

Dynamic economic base theory

Economic base theory is an example of comparative static theory; we examine a local economy before and after the export sector generates more or fewer exports to assess the economic impacts. Like staple and sector theory, *dynamic* economic base theory considers the evolution of the economic base over the long term. It builds on the proposition that the dynamic, competitive global economy demands adaption and adoption to achieve successful economic outcomes at the regional level. The central proposition is that regional economies able to deepen their existing economic base or spawn new specializations will perform better than the ones that remain relatively stagnant.

Dynamic economic base theory calls attention to factors that generate local economic change. The most fundamental is human agency (people taking action). Entrepreneurs are important change agents, and their role is examined in Chapter 7. Also important are actions of existing company leaders, especially leaders of companies in the export sector. They may instigate forms of "intrapreneurship" that enable their company to evolve successfully through innovation. Such change may be based on opportunities afforded by new technology, new sources of demand, new communication channels, and so on. Localities may be blessed with nimble forward-looking business leaders or burdened by ones concerned only with earnings per share in the next quarter.

Another factor previously mentioned is path dependence. Often, economic success can be traced to an event at one point in time that initiated economic growth

and subsequent development. The dynamic becomes established and continues over time, leading to more and more successful economic outcomes (Moretti 2012; Storper 2013).

Dynamic economic base theory pertains to periods of 30 to 50 years. Over such time periods, change in the regional economy can be measured absolutely, relatively, or directly. Greater absolute change indicates more dynamism. Relative change introduces a reference region as the comparative standard. More relative change occurs when the locality's economic base deviates more from the overall average represented by the reference region's economic base. Although absolute and relative differentiation are useful indicators of dynamism, direct measures of structural change over time are even more informative. Direct, relative, and absolute measures of economic base are presented and applied in Appendix 3.3.

Applications

Industrial targeting is a very popular aspect of industrial recruitment. Industries become targeted typically because they pay relatively high wages, have minimal negative impacts on the environment, and are expected to grow nationally. Determinations of growth prospects are made at the national level, for example, by economists in the U.S. Department of Commerce who provide forecasts of industries and occupations. Local economic developers who understand the dynamics of their region's economic base should be able to use this information more effectively to anticipate and facilitate structural change.

A useful way to target critical regional sectors is to use location quotients to examine changes in export/traded sectors over time. Again, the analysis at the metropolitan level should use at least 30 years as the time frame. Conducting this analysis successfully requires solving two problems. First, Census Bureau definitions of metro areas change over time. Second, the change from the SIC (Standard Industrial Classification) system to NAICS (North American Industry Classification System) occurred around the year 2000, making it difficult to have consistent data from 1970 or 1980 to the year 2000 and beyond. The United States Bureau of Labor Statistics (BLS) provides information that shows how SICs were converted to NAICS. Woods & Poole is a good source that maintains consistent metropolitan-area definitions and consistent sectoral definitions. Their data for two-digit NAICS sectors are sufficiently detailed for the initial analysis.

To conduct the analysis, the first step is to calculate location quotients in order to identify export sectors. Ones with values over 1.20 for a recent year are very likely to be exporting. The next step is to repeat the calculations for an earlier year, say 1970 or 1980. Intervening years may also be examined. Earnings data are preferable to employment data since they reflect the quality of labor, not just the quantity.

Two criteria are relevant for evaluating changes in economic base: deepening and broadening. Deepening may arise from improvements in productivity, whereas broadening may reflect successful innovation. Deepening occurs when *individual* location quotients over 1.20 increase in value over time. The economic

base becomes shallower when the opposite occurs. Broadening is examined by considering *all* export sectors. When the number of sectors with high location quotients increases over time, the region's economic base has become broader. A decrease in the number of high location quotients over time reveals a narrowing of the economic base.

Local economic developers can use these results to guide practice. In regions where the economic base has deepened and/or broadened, the task is to find ways to sustain this positive momentum. In regions where the economic base has become shallower and/or narrower, the task is more formidable. The most feasible option may be to focus various forms of assistance to the remaining export sectors.

In conclusion, economic developers should not limit their theoretical insights about the local economy to those provided by economic base theory. Developers can gain much ground by mastering extensions of that theory. Staple theory demands attention to the historical evolution of local economic structure. Sector theory emphasizes internal economic relationships and potential development paths. Dynamic economic base analysis suggests that examining change in economic structure over many years can yield valuable insights about long-term change. Familiarization with all of these theories offers developers more tools to better understand their regional economy.

Discussion questions

Economic base theory

1 How would you gauge your local economy's competitive advantage from the perspective of economic base theory? From Blumenfeld's perspective?
2 Do you think your local economy has a favorable balance of trade (exports greater than imports)? Does its balance-of-trade position matter? How has it changed over time?
3 In which direction do regional (input-output or economic base) multipliers change when:

   a The region grows larger?
   b The regional economy becomes more interdependent?

4 Why is the economic base model potentially more accurate for understanding contractions rather than expansions?
5 Why is economic base theory more useful for analyzing economic growth than for understanding economic development?

Extensions of Economic Base Theory

1 Why would popular strategies to increase investment and employment attraction, creation, retention, and expansion (ACRE) not find support from the perspective of staple theory?

2 In general, which economic development strategies are recommended from the staple theory perspective?
3 List important insights that can be gained about your area from an understanding of its economic history.
4 Is the service sector diverse and sophisticated in your area? Will its development lead to increases in local economic growth and development?
5 Is your area dominated by one functional specialization or by many? How do you define and measure functional specialization?
6 Are important industries relatively independent or are they part of one or two industrial complexes?
7 How should you treat your metropolitan area's functional specialization? Is it a given such that the basic strategy is to compete successfully with comparable areas? Is the basic strategy to change/improve the existing functional specialization? If so, how?
8 How has the economic base of your economy changed over the past 30–50 years? What have been the major consequences of this evolution?
9 Is achieving more economic diversity an important economic development objective in your area? How can you pursue that goal given the existing functional specializations and industry mix?

APPENDIX 3.1

Calibration of economic base multipliers

In order to calculate the economic base multiplier, the regional economy must be divided into basic activity that serves the export market and non-basic activity that serves the local market. The fundamental problem facing the practitioner interested in conducting an economic base analysis, however, is the lack of available data on regional imports and exports. As a result, several relatively simple and inexpensive methods have been developed to estimate the multiplier. The most commonly used approaches are the assignment method, the use of location quotients, and the minimum requirements technique.[23]

The assumption or assignment method

The simplest way to subdivide the regional economy is to determine, simply on the basis of expert judgment, which sectors are basic and which ones are non-basic. In fact, few regional industries produce entirely for export (or to satisfy local demand). This difficulty either is assumed away with the hope that overestimates of export activity in some industries will be canceled out by underestimates of export activity in other industries, or with supplementary information from surveys used to determine the proportion of export activity in any industry. Although a survey of area employers would provide the best information, surveys are usually prohibitively expensive.[24]

The use of location quotients

One of the simplest and most commonly used methods of determining regional export activity involves the use of location quotients. A location quotient measures the proportion of employment, earnings, or output in one regional sector compared to that sector's proportion in a reference region, usually the nation.

Although any relevant measure of economic activity may be used to calculate location quotients, regional data constraints frequently make employment the variable of choice. The use of employment as a proxy for output requires acceptance of strict, and not particularly realistic, assumptions.[25] Earnings data are available and a better proxy for output since productivity is better reflected in earnings than employment.

With employment or earnings data, location quotients for each regional industry are calculated. If regional employment in one industry as a proportion of total regional employment is 0.2 and national employment in the same industry as a proportion of total national employment is 0.1, the location quotient for that industry will be 2 (0.2/0.1). When the proportion of regional employment in a given industry exceeds the proportion of employment in the same industry nationwide, the location quotient will exceed one. When this is the case, the regional economy is said to be more specialized in that industry than the nation as a whole. Likewise, when the location quotient is less than one, the regional economy is considered less specialized in the given industry than the nation. A location quotient equal to one indicates that the region and the nation are equally specialized in the study sector.

The basic premise underlying the use of the location quotient to calculate regional export activity by industry is that exports equal the amount by which any regional industry's share in total regional production exceeds that national industry's share in total national production. Similarly, it is assumed that the regional industry's proportion of regional production used to satisfy local demand is equivalent to that national industry's proportion for the nation. Any production level below this amount must be satisfied by imports. See Isserman (1980).

Consider a two-region, two-industry national economy as indicated in Table 3.1. Employment in industry *i* in region A represents 50 percent of total national employment in industry *i*. Total employment in the region represents only 37.5 percent of total national employment. Given these figures, what can be said about export employment in industry *i* in region A?

The location quotient approach to the determination of regional export employment rests on two critical assumptions (Isserman 1980, pp. 157–158). First, productivity per employee in industry *i* is equal in the region and the nation, and thus the region's share of national industry *i* employment indicates its share of output in industry *i*. Using this assumption in the above example, we conclude that region A produces one half of the nation's output of industry *i* (100/200 = .5).

TABLE 3.1 Two-region, two-industry national economy

	Region A Employment	*Region B Employment*	*National Employment*
Industry *i*	100	100	200
Industry *j*	500	900	1,400
Total	600	1,000	1,600

Second, if per-employee consumption of industry *i* output is the same in the region and the nation, then the region's share of total national employment represents its share of consumption (600/1,600 = 0.375). Given these assumptions, since region A produces exactly one half of national industry *i* output but consumes less than half of total national output, it cannot be consuming all of its industry *i* output. Carrying out the calculations, we find that 25 out of 100 industry *i* employees in region A produce for export, and the other 75 produce for local consumption, which is the same as the national proportion (75/600 = 200/1,600 = 0.125).

Two additional theoretical implications follow from the two primary assumptions. First, there is no *cross-hauling*: the region cannot import, for its own consumption, the same product that it exports. If cross-hauling does in fact occur, the method estimates net, rather than gross, exports. Although the underestimation of exports can be reduced by using highly disaggregated industrial data, the problem can never be eliminated completely.[26] Second, there are no net national exports or imports for either industry. Following the example in Table 3.1, region A satisfies its own demand for *i* while also exporting part of its output of *i* to region B. Likewise, region B is able to fully satisfy its internal demand for *j* while also exporting to region A.

The minimum requirements technique

The minimum requirements technique is also a popular method of estimating regional export activity (Ullman and Dacey 1960). The method is nearly identical with the location quotient approach except that the regional economy is compared to other similar sized regions rather than to the nation. Application of the technique involves three steps: (1) assembly of a sample of regions of comparable size; (2) for each industry *i*, identification of the region that has the minimum share of total regional employment in industry *i*; (3) estimation of regional export activity for each industry.

The minimum requirements approach assumes that all production of *i* in the minimum region is used entirely for local consumption. Then, consumption per employee in the study region from *local production* of *i* is assumed to be equivalent to consumption per employee in the minimum region (which we assume neither imports nor exports the products of industry *i*). The consumption term indicates that the study region is assumed to consume a regional output share identical to the minimum region's share of national *i* output, scaled by the relative size of the study and minimum regions.[27]

Other bifurcation techniques

The three methods of dividing the regional economy discussed earlier are the simplest and most common of a wide variety of alternative approaches. Isserman, for example, proposes using regional/national labor productivity and consumption ratios by industry, as well as the ratio of net national exports of industry *i* to national

output of *i*, in order to relax three of the assumptions underlying the location quotient approach (Isserman 1977). Richardson (1985) briefly reviews this method, as well as Norcliffe's (1983) consumption-based location quotient method, Moore's (1975) simple regression application of the minimum requirements technique, and the Mathur and Rosen's (1972, 1974, 1975) regression method. Finally, Stabler and St. Louis (1990) describe a means of using input-output analysis to classify regional economic activity. Their method also attempts to distinguish between direct and embodied exports.[28]

APPENDIX 3.2

Input-output multipliers

The rather arbitrary splitting of the economy into two sectors can be avoided by using an input-output model. With the availability of input-output multipliers through the widely used IMPLAN model, developers now have sectoral information and industry-specific multiplier estimates for states and metro areas. In addition, many empirical problems with economic base models can be overcome by substituting input-output models and using the latter for multiplier analysis and prediction. Billings (1969) and Garnick (1970) demonstrate the mathematical identity between the economic base multiplier and an aggregate (weighted) input-output multiplier when the final demand sectors of the input-output model are identical to the exogenous sectors of the economic base model.

Input-output equations are shown in the following in matrix form and are comparable to the economic base formulation shown in equations 3.1–3.3 in the text:

$$\mathbf{AX} + \mathbf{Y} = \mathbf{X} \quad (3.4)$$

$$\mathbf{Y} = \mathbf{X} - \mathbf{AX} \quad (3.5)$$

$$\mathbf{Y} = (\mathbf{I} - \mathbf{A})\,\mathbf{X} \quad (3.6)$$

$$(\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{Y} = \mathbf{X} \quad (3.7)$$

where **I** is an identity matrix, **X** is a vector of total output, **Y** denotes a vector of final demand, **A** is a matrix of national technological coefficients or more usually trade coefficients in regional tables, **AX** is a matrix of intermediate demand, $(\mathbf{I} - \mathbf{A})$ is called the Leontief matrix, and $(\mathbf{I} - \mathbf{A})^{-1}$ is the matrix of interindustry multipliers and is called the Leontief inverse.

Equation (3.4) is an accounting identity which says that output used by industries to produce commodities in the current period (**AX**) plus output used by households, governments, and businesses as capital investment (**Y**) equals total output (**X**). Final demand (**Y**) includes sales to local entities as well as exports to

entities located outside of the region. The table of coefficients (**A**) shows the value of inputs from any industry needed to produce one dollar's worth of output from each industry. In national input-output tables, these interindustry coefficients are estimated to reflect the average technology in each industry. In other words, certain amounts of inputs from other industries, plus certain amounts of labor, are needed to produce industry outputs. In regional input-output tables, interindustry coefficients are usually estimated as trade coefficients. In other words, inputs from local industries per dollar of output are shown in the **A** matrix; imports, which are supplied by any nonlocal source, and labor are treated as separate inputs.

Equation (3.7) connects final demand (**Y**), premultiplied by the Leontief inverse matrix, to total output (**X**). The equation says that to satisfy final demand by industry (**Y**), the economy must produce a larger amount of total output (**X**). The interindustry multiplier effects contained in the Leontief inverse matrix determine the industry-specific ratios of total output to final demand.

The fact that the Leontief inverse contains multipliers can be grasped by recognizing that one can invert a matrix by solving a power series. In this case, the power series contains the unit amount of final demand (**I**) plus the first round of inputs needed to produce one unit of output for all industries (**A**), plus the second-round effects inputs needed to produce the first-round inputs (**A*A**), plus the third-round inputs needed to satisfy second-round inputs (**A*A*A**), and so on. The consecutive rounds of inputs and outputs are represented by the sum of the power series and equal the multipliers for each industry.

In most input-output applications, the impact of changes in final demand is analyzed. Therefore, one can modify equation (3.7) to relate a change in **Y** to a change in **X**. The Leontief inverse matrix is not changed; as with the economic base multiplier, the interindustry multipliers are assumed to remain the same. With this input-output model, the economic developer can see changes in each industry that stem from a change in the final demand of one particular industry or ascertain the overall effects on output of projected changes in final demand. Thus, the input-output model can be used for both near-term forecasting and impact analysis.

APPENDIX 3.3

Measures of economic structure

Hirschman-Herfindahl Index (HHI)

$$HHI = \sum x_i^a$$

Where: $\sum$ = sum over all sectors
x = share of earnings for the region
i = one of 18 two-digit sectors
a = coefficient (usually 2—squared)

Note: the higher the coefficient value, the more weight given to sectors with a higher share of earnings.

Krugman Specialization Index (KSI)

$$KSI = \sum |x_i - X_i|$$

Where: $\sum$, x, and i are the same as above
X = average share of earnings in a sector for all metropolitan areas

Modified Lilien Index (MLI)

$$MLI = \sqrt{W_i * \left[\ln\left(x_{i,t} / x_{i,\,t-1}\right) - \ln\left(X_{i,t} / X_{i,\,t-1}\right) \right]^2}$$

Where: $\sum$, x, and i are same as above
t = time period (e.g., 2020)
$t - 1$ = previous time period (e.g., 2010)
W = average share of total earnings for sector i in t and $t - 1$

To calculate the MLI: (1) compute the ratio of metro earnings in sector, *i*, in time, *t*, by earnings in that sector in time period, $t - 1$, and the ratio of total earnings for those two time periods; (2) take the natural log of each ratio; (3) for all i sectors, subtract the sector-specific log from the log for all sectors; (4) square this difference to eliminate negative values; (5) weight each difference by the average share of sector earnings for the two time periods; (6) sum over all sectors; and (7) take the square root of this sum.

These three indexes were examined in an empirical analysis of 102 metro areas in the continental United States. Almost all metropolitan areas with more than 500,000 population in 2010 were included as well as smaller ones to achieve better geographic representation. Dynamic economic base theory calls for examining changes in these indexes over time. In this illustrative analysis, HHI, KSI, and MLI were measured using sectoral earnings in ten-year intervals from 1970 to 2010. Earnings (in 2005 dollars) were considered superior to sectoral employment because using earnings mitigates sectoral differences in productivity to some extent. Changes in the indexes were associated with economic outcomes after 2010, namely household income levels and employment growth.

As the formula shows, the Hirschman-Herfindahl Index (HHI) is an *absolute* measure in that it calculates how unequal the distribution of earnings is in each metropolitan area without reference to any other place (Hirschman 1964). With 18 potentially tradable sectors, the HHI would have a value of 5.55 percent if all sectors generated the same level of earnings. In this context, more evenly distributed earnings indicate less organized economic activities; an economic structure with less organization has higher entropy. As earnings become more concentrated and the HHI increases, economic structure becomes more organized and deeper sectoral specializations evolve. Thus, metropolitan economies with higher ratios are considered more dynamic over time and are expected to experience better economic outcomes. HHI values for 2010 ranged from 7.60 to 31.18 for the 102 metropolitan areas.

The Krugman Specialization Index (KSI) is a *relative* index (Krugman 1991b), where the economic structure of each of the 102 metropolitan areas was compared to the economic structure of all 366 MSAs according to the 2009 Census Bureau definitions. The KSI is the sum of the absolute differences between the earnings share in each sector compared to the average share in that sector for all metropolitan areas. KSI values increase as the metropolitan area's economic structure diverges from the average of all metro areas, reflecting either more or less sectoral concentration of earnings. When KSI values in 2000 and in 1970 were similar, the differences between them indicate less divergence from the all-MSA norms. As the KSI values became more different, the divergence compared to all metropolitan areas had increased. Larger differences in two time periods indicate more dynamic economic structures compared to the average. Therefore, greater *absolute* differences between the KSIs indicated more relative structural change regardless of the direction of change. The KSI values for 2010 in the 102 metropolitan areas ranged from 15.21 to 88.22.

The third structural measure is the Lilien Index applied in its modified form (Ansari et al. 2013). For each metropolitan area, the Modified Lilien Index (MLI)

computes the absolute difference between change in earnings in one sector and earnings change in all sectors for some time-period. Unlike the HHI or KSI, the MLI *directly* measures structural change over time. Higher MLI values mean greater structural change for the time period and therefore more potential dynamism in the metropolitan economy.

Simple regression models were run associating these three indexes with change in employment from 2010 to 2016 and average household income in 2016 as dependent variables. The change measures for HHI, KSI, and MLI were the independent variables adding total employment in 2010 as a control for area size. The analysis indicated that the MLI was best able to "back-cast" outcomes beyond 2010. The HHI ratio performed somewhat better than the KSI. Although suggestive rather than definitive, these results illustrate that having a regional economy with a more dynamic economic base that continues to evolve over decades appears to result in better economic outcomes.

These empirical results have practical implications. In general, long-term strategies designed to facilitate change in a metropolitan area's economic base over many years are expected to have positive results and may turn out to be superior to near-term strategies. Furthermore, development strategies designed to deepen or broaden economic specializations should be more effective when applied consistently over time and coordinated across jurisdictions within the region.

Notes

1 Hoyt and Weimer (1939) developed the economic base model as a means of estimating the prospects of local economies. Their work was used to gauge the economic risk of purchasing residential mortgage loans from various markets in the period when secondary markets were being established in the United States.

In "Homer Hoyt on the Concept of the Economic Base" (1954), Hoyt outlines the microeconomic foundations of the theory. Since industries are subject to price competition, production costs in one metropolitan area compared to others will determine the future trends in basic employment. Furthermore, exports are needed in order to pay for imports. He notes that the base-service ratio will vary in one city over time as well as by city size and level of income. Later, in "Utility of the Economic Base Method in Calculating Urban Growth" (1961), Hoyt takes issue with Blumenfeld's (1955) critique. Regardless of other influences on growth, Hoyt argues that his empirical analysis suggests a "causal" relationship between growth of the economic base and overall growth. Therefore, urban planners can use the model to forecast employment and population growth:

> In short, it has not yet been demonstrated that an urban region can grow substantially in population by an increase in its non-basic industries only. It may reduce its reliance on imports by greater diversification, but a new impetus to growth must come primarily from basic employment.
>
> *(Hoyt 1961, p. 56)*

2 The derivation of (3.3) follows:

$$b = n - an = \ 1 - a \ \ n, \left(\frac{1}{1-a} \right) b = n.$$

The model can also be estimated using *changes* in employment, income, or output. In this instance, the multiplier estimates the marginal impacts and marginal propensity to spend locally rather than the average values.

3 Another way to state this is that supply is assumed perfectly elastic at fixed prices. Elasticity of supply describes the degree to which the quantity supplied of a given commodity increases or decreases with changes in its price. Perfect or near-perfect elasticity implies that producers are extremely responsive to small price changes; capacity constraints do not limit production and therefore do not lead to price increases.

4 Researchers have also examined economic base theory. See, for example, LeSage and Reed (1989, 1990) on the short- and long-run utility of the theory; an application of LeSage and Reed's methodology by Kraybill and Dorfman (1992); research on the derivation of multipliers in the presence of local income leakages (Frey 1989; Farness 1989); and work on an input-output-based methodology for classifying regional economic activity into basic and non-basic sectors (Stabler and St. Louis 1990).

5 The three strategies for export expansion described in this paragraph are illustrated in two issues of *Economic Development Review: The Journal for the Economic Development Practitioner*. The Winter 1991 and Summer 1996 issues focus on existing industry development; the Spring 1991 issue addresses the recruitment of investment. One article in the latter issue explicitly relates economic base theory to the targeting and recruitment of economic activity. See Miller et al. (1991) "Location Quotient: A Basic Tool for Economic Development." New business development in a rural context is considered in the Fall 1992 issue.

6 Import substitution can be developmental provided that the city is large enough to support enterprises at an efficient scale of operation. Import enhancement through product improvements is even more important as growth proceeds and the division of labor deepens (Jacobs 1984 and Chapter 9).

7 Because the theory focuses on one open region rather than on the larger system, the issue of constant-sum or zero-sum growth is ignored. Industrial recruitment efforts in a given community may increase basic employment at the expense of employment in other regions and cities. When plants relocate, there is the very real possibility that one community's gain is simply another's loss. The nation receives no aggregate benefit; hence the term "zero-sum" growth. Blumenfeld's (1955) concern for welfare as the focus of economic development deserves emphasis in this respect. The narrow pursuit of jobs puts developers squarely in the business camp concerned about sales. The welfare orientation keeps the focus on the well-being of local consumers.

8 See Blumenfeld (1955). Blumenfeld presents a readable description of the model and the most trenchant critique of its many weaknesses. The tenacity of economic base theory should be admired when one considers that his criticisms were published in 1955. He argues that the model works best when considering a small city with a clearly defined export sector and a totally dependent service sector.

Blumenfeld also notes the theory's physiocratic and the mercantile overtones. The former relate to the primacy of agriculture, mining, and manufacturing over other sectors and to the idea that all wealth originates in the basic sector. The mercantile overtones are more significant. Since economic base theory reduces wealth creation to the growth of export earnings, the important service-provision role of the city is trivialized. But, money is not the wealth of nations, as Adam Smith pointed out. Rather, the expansion of productive capacity that leads to greater competitiveness results in real national wealth. Mercantile thinking as reflected in the economic base model may be attractive to economic developers because it describes how a place can make money. The pro-business bias of the model becomes clear when considering its implications for consumer welfare.

9 Blumenfeld, in a somewhat apocalyptic example, illustrates the rationale: if General Motors closes shop at Flint, no efforts to promote the development of department stores will save the town. On the other hand, if a Flint department store closes down, but the General

Motors plant continues to operate as before, it will soon be replaced by other stores. Therefore, the thing to worry about, the "base" of the Flint economy, is the automobile industry; once that works, the "services" will take care of themselves (1955, p. 121).

The difference between the department store and the automobile plant is that the latter must compete with firms outside of the region and country, while the former competes only with those within the community. The definition of a "critical" industry, then, is not whether or not it exports but whether or not its area of potential competition extends beyond the region. Even if available bifurcation methods can accurately measure basic activities (see Appendix 3.1), a "criticality" approach to economic base theory suggests that efforts to refine these methods to measure export activity ever more precisely will result in little useful information regarding which industries may require assistance to ensure the continued presence in the community.

In a similar vein, Hoover and Giarratani argue that a region's export activities are not exclusively in the basic (export) sector as it is typically measured.

> It would be more appropriate to identify as basic activities those that are *interregionally footloose* (in the sense of not being tightly oriented to the local market). This definition would admit all activities engaging in any substantial amount of interregional trade, regardless of whether the region we are considering happens to be a net exporter or a net importer. Truly basic industries would be those for which regional location quotients are either much greater than 1 or much less than 1.
>
> *(1984, p. 319)*

10 The use of censuses is extremely rare. In 1937, *Fortune* magazine conducted an economic base analysis of Oskaloosa, Iowa (*Oskaloosa vs. the United States*, *Fortune*, April, pp. 54–62). The study involved a complete census of the city's population to determine the origin and destination of income flows and thus remains one of the most complete applications of the economic base concept to date.

11 This issue raises a simple practical difficulty: should some intermediate inputs, called indirect primary inputs by Blumenfeld (1955) and embodied exports by Tiebout (1962), be considered basic even though the exporting firm purchased them locally? Exporting firms purchase a variety of inputs, including water, police, fire protection, and labor. Indirect primary inputs could, logically, include the entire non-basic sector.

Tiebout provided important insights by forging connections between economic base theory and Keynesian theory. *The Community Economic Base Study*, published in 1962, remains one of the most theoretically complete and practically useful references in the field. In his critique, Tiebout notes weaknesses of the economic base concept: the multiplier is not constant, exports are not the sole source of growth, their importance declines with the region's size, and regions are poorly defined. Tiebout also argues that the comparative cost of region's production will depend partly on the efficiency of local industries. As a result, the rate of growth is neither strictly exogenous nor solely dependent on export base growth.

12 Hoover has also criticized economic base theory from the perspective of linkages—the connections between industries. Vertical linkages, which exist when one industry uses another's output, can be summarized with the help of the table of interindustry coefficients (see Appendix 3.2). Growth can be stimulated by backward linkages, connections that move from demand to supply back to suppliers of that supply, or by forward linkages, from resources that are turned into products that are then sold in the market. These linkages tend to become complementary. A new basic firm, therefore, can attract not only those businesses which supply it but also those which it supplies. Since local services offer important inputs to basic industries, the efficiency of the local sector is critical to export firms. As a result, the primary industry often becomes as dependent on the suppliers, as a group, as the suppliers are dependent on their primary customer.

Such linkages among firms located in close proximity result in cost savings, generating *external economies* or more precisely (external) *agglomeration economies*. Hoover argues that

the big city is the natural habitat of the small plant because it is most strongly dependent on the services of other plants. These service firms enable small firms to be narrowly specialized and presumably more efficient. Small plants concentrate in cities to experience external economies, which often depend on the availability of increasingly specialized auxiliary and service firms that, in turn, received their impetus from supplying some main (export) industry. Large metropolitan areas exist, survive, and grow because their business and consumer services enable them to substitute new "export" industries for any that decline or disappear.

13 Five less serious weaknesses beset economic base theory. First, the model ignores specific linkages to other areas by treating all areas outside the region as one undifferentiated rest-of-the-world sector. Second, since price effects are absent, the microeconomic forces influencing comparative costs are not addressed. Third, the model does not accord with the reality of regional development in the sense that fast growing regions would be expected to import rather than export capital (Richardson 1973). Fourth, the theory neglects the role of payments received for reasons other than the performance of work (e.g., transfer payments). Finally, while the basic-nonbasic ratio will not necessarily remain stable over time, the model has no means of explaining either the length of the period over which a given external change in demand is expected to influence local economic activity or the internal structural changes that occur as regions grow.

14 Tiebout (1956a, 1956b) criticizes North's argument. His criticisms reiterate the general criticisms of economic base theory, rather than directly address export staple theory. Therefore, Tiebout misses North's essential point, which is to explain growth as a long-term historical process. Tiebout is primarily concerned with near-term cyclical stability.

15 Hoover and Fisher (1949) present an idealized version of capitalist development based on the economic history of Western Europe. In their theory, sectors and stages interact. This growth model describes an economy moving through specializations from agriculture to manufacturing to services. Industrialization overcomes diminishing returns in agriculture and propels the economy forward.

Hoover and Fisher (1949) segment the development process into five distinct, sequential stages: (1) the self-sufficient subsistence economy based on agriculture, (2) local specialization based on trade and facilitated by transport improvements, (3) cash-crop farming, mining, and manufacturing to exploit opportunities in interregional trade, (4) 'forced' industrialization as regional population increases and agriculture reaches diminishing returns, and (5) development of exporting tertiary sectors which involves outflows of capital and skilled personnel. As population increases and transportation and communications improve, division of labor based on comparative advantage leads to increasing specialization and trade. One unique feature of this model is its attention to the space economy. Hoover and Fisher are regional economists who think through the spatial structure implications of various economic stages.

North (1955) begins his article with a broadly based critique of the Hoover-Fisher model of development, which he portrays as a descriptive theory that lacks explicit causal mechanisms. First, the Hoover-Fisher theory is not general; it applies only to parts of Western Europe. Undeveloped regions with low population and no feudal institutions are fundamentally different than populated, feudal economies. In the United States and in Canada, long-distance trade in world markets was the sustained stimulus for growth, much more than opportunities for local trade. Second, regions need not industrialize to progress. Progress depends on the export staple and on capital flows that seek their highest reward. Hoover and Fisher incorrectly suggest the need to force industrialization or to balance economic growth.

16 Before 1800, regions in the United States and Canada were undeveloped where land and natural resources were available for capitalist development. No established economies existed at high densities. Underdeveloped regions, such as colonial territories, contained well-established societies before capitalist development was initiated. Neoclassical

economists argue that underdevelopment results from the imperfect and partial introduction of capitalism in such areas. Neo-Marxists argue that underdevelopment is the direct result of capitalist development.

17 North notes that high income elasticity of demand for the staple can lead to rather violent cyclical fluctuations. In contrast, sector theory advocates pursuing sectors with high income elasticity in order to maximize growth. North stresses the risk side, while sector theory, presented next, emphasizes the reward.

18 Development occurs when internal changes in the economy lead to increased specialization. Perloff states that "sector theory focuses on internal rather than external development; economic growth is seen as primarily an internal evolution of specialization and division of labor, although external shifts in demand are not ruled out as of no importance" (1960, p. 59).

19 We express these elasticities as derivatives in Figure 3.1 because we include only two variables: quantity demanded and income. If we introduce prices, which also influence the quantity demanded, we would express the income elasticities as partial derivatives.

20 On the negative side, one could make four points. First, both Clark's (1940) and Fisher's (1933) explanation is based on the apparent relationship between service sector size and the wealth of more developed countries. This relationship may be one effect of development rather than its cause. Second, the division of economic activity into three highly aggregated sectors begs the question of what is going on within these sectors. Bauer and Yamey (1951), for example, referring to less developed economies, question the hierarchical organization of the three sectors. They note that many impoverished nations have a large percentage of the labor force involved in service sector distribution activities. This employment is largely a result of the failure of secondary sector growth. Service sector growth may occur when women enter the labor force at higher participation rates. Services formerly provided within households—child care, cooking, and cleaning, for example—may now have to be provided in the informal sector. More paid employment may not result in higher levels of well-being. Third, sectoral classification is difficult. Classifications based on returns to scale may be reasonable, but income elasticities for any sector are not constant over time or space. Elasticities can vary from region to region and from year to year. Finally, sector theory takes nation-states as units of analysis. The theory must be modified to explain the evolution of metropolitan areas. It becomes more applicable as the area becomes more self-sufficient and closed.

21 Miernyk's (1977) empirical study suggests the limited utility of the three-sector model. He tests the relationship between economic structure and the growth of per capita income with data for Southern states in 1940 and 1975. He finds no correlation between relative income level and manufacturing employment.

Miernyk's study is limited for two reasons. The theory refers to longitudinal changes in nodal regions; Miernyk looks at states in cross-section. He uses employment data, which measures the quantity of one input, rather than the value of sectoral output. Productivity gains within sectors may increase the aggregate value of labor, although the number employed may decrease or remain the same. Employment growth may reflect the substitution of cheap labor for another input rather than aggregate growth.

22 Structural input-output analysis can suggest ways to encourage interindustry linkages based on technology or spatial proximity and support the strategy of building industrial complexes. Input-output has also been used by large corporations and national governments as a powerful economic planning tool.

23 Interested readers should consult Isserman (1980), who provides an excellent and more detailed discussion of the theoretical foundation of each technique than we provide here.

24 Of course, the utility of surveys depends on their level of accuracy as well as their ability to obtain all of the information necessary to calculate the economic base. The economic base of many regions will consist partially of output consumed within the region by nonresidents; surveys of firms cannot measure this element of the base since retailers do not generally know the place of residence of their customers. Farness (1989) also

discusses the reliability of indirect bifurcation techniques when local output is consumed by residents spending externally derived funds.

25 Note that the use of employment data poses a number of conceptual problems. Employment data place equal weight on part-time and full-time employment, cannot distinguish between productivity and wage differences across workers in different industries, and do not account for the role of unearned income, including transfer payments, rents, interest payments, and profits (Krikelas 1992).

26 Isserman (1980) shows the greatest improvements in estimates of export activity from using disaggregated data come from the shift from division to two-digit level SIC data. More modest improvements occur as more detailed three- and four-digit data are used.

27 In Ullman and Dacey's (1960) original discussion of the method, their intended treatment of the regional consumption term was sufficiently ambiguous to generate what in retrospect appears to have been unwarranted criticism. In particular, Pratt (1968) showed that if the consumption term represented a region's total consumption of good *i*, then every region except the minimum must export, while the minimum is assumed to fully satisfy its own internal demand. Therefore, the nation must have net exports. In a subsequent publication, however, Ullman et al. (1969) made clear that the consumption term is an estimate of regional consumption from its own production; there can be regional imports, exports, and cross hauling. See Isserman (1980) for a more complete discussion of this debate.

28 As noted in section "Elaboration and criticisms" of this chapter, embodied exports are intermediate products embodied in direct exports.

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4

TRADE THEORY

Understanding trade and its benefits and ramifications for market economies is imperative for local developers and development officials. Major trends in the international economic environment since World War II, including falling transportation and communication costs and reduced tariff and non-tariff barriers, have led to continued increases in the volume of trade between nation-states. Trade among developing nations, for example, more than tripled in the period 1980–2011.[1] Between 1970 and 2015, the average annual real rate of growth in world exports significantly exceeded the rate of growth in world output at 5.1 percent versus 3.1 percent.[2] In 1970, world exports stood at $2.4 trillion compared with over $23 trillion in 2016 (both figures in constant 2010 dollars). The United States typically exports a relatively modest 13 percent of its GDP, a share considerably below that of other industrialized countries. However, the sheer size of the U.S. economy means that it still accounts for roughly 9.1 percent of total world exports and 13.9 percent of total world imports, according to the World Trade Organization.[3]

Globalization and international trade are clearly important aspects of the national and regional economic picture in the United States and Canada.[4] Moreover, the emphasis on export promotion in the pantheon of state and local economic development strategies demonstrates the importance of trade to local economic developers (Erickson 1992). It is not surprising that trade has captured the attention of city and state officials. The reduction of trade barriers through bilateral and multilateral agreements, advances in information technology, and the subsequent steady increase in international economic linkages have led some analysts to assert that cities and regions—not nation-states—are the relevant geographical economic units on the world stage (e.g., Porter 1990; Hayward 1995).

In his book *The End of the Nation State*, Kenichi Ohmae (1995) presents the following argument. The global economy has undergone a transition from an industrial age to an information age such that the need for, and effectiveness of,

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mechanisms of centralized government control are being reduced. Through the new systems of communication and information transfer, multinational companies already regularly (and legally) subvert attempts to regulate and channel their activities to the benefit of their home countries. In the information age, the major players will not and should not be nations but instead dynamic regional economies, many of which span national borders (e.g., San Diego-Tijuana and Seattle-Vancouver). National governments should abandon traditional redistributive programs and industrial policies that favor specific industries and prop up declining rural areas. In the process, they should

> cede meaningful operational autonomy to the wealth-generating region states that lie within or across their borders, to catalyze the efforts of those region states to seek out global solutions, and to harness their distinctive ability to put global logic first and to function as ports of entry to the global economy.
>
> *(p. 142)*

While not beyond dispute, Ohmae's ideas highlight the global-local dynamic that characterizes important work on international trade and its geographic implications (Moss Kanter 1995).

Trade theory constitutes a diverse body of work that attempts to provide answers to four fundamental questions regarding cross-border economic transactions (Krugman 1990). Why do countries or regions engage in trade? What determines the international (and interregional) pattern of specialization? What are the effects of protectionist measures? What is the optimal trade policy? Neoclassical theories of comparative advantage and factor proportions still constitute the fundamental core of trade theory. However, other work examines trade in the context of increasing returns and imperfect competition. Unlike traditional theory, which makes a strong case in favor of free trade and minimal government interference, the "new trade theory" suggests that a degree of managed trade can generate gains in some cases. Indeed, models of trade in a world of increasing returns can yield results strikingly consistent with those of the cumulative causation theorists. (Endogenous growth ideas are discussed in chapters 5 and 6.) They suggest that some nations or regions may be left permanently behind without some intervention to stem their decline. Even so, most neoclassical economists remain pessimistic about the likely effectiveness of government attempts to influence trade given the complexity of the international economic environment. Paul Krugman (1996) describes new trade theorists as "cautious non-activists" willing to do research on strategic trade policy but reluctant to propose action (p. 110).

In this chapter, we outline the basic principles of trade, including comparative advantage, factor proportions theory, and trade with increasing returns first in the international case and then in the regional case. The interregional and international cases are quite different because key assumptions underlying international trade theory do not hold in the regional case. For example, the degree of mobility of labor and capital is typically much stronger between regions of the same country

than across national borders. Moreover, state and local governments do not have at their disposal many of the policy levers used to manage international trade, including tariffs, quantity restrictions, and currency revaluations.

Trade theory, like economic base and other theories covered in subsequent chapters, provides a means of understanding regional specialization as well as the equilibrating (or non-equilibrating) tendencies of factor migration. Since trade takes place between subnational units (states, counties, metropolitan areas) as well as between those units and other countries, local developers and development officials must understand trade theory in different contexts to form a more complete picture of their economy's position vis-á-vis both the national and the global economy.

Overview

The first question trade theory attempts to answer is why countries engage in trade. What do they gain from trade that they would lose if they simply attempted to produce all of the commodities they require internally? Perhaps this question presupposes too much. If countries engage in trade, can we necessarily assume that they benefit from it? Such an assumption ignores the fact that countries are comprised of consumers and producers that make economic decisions based on their own individual preferences. It is not necessarily true that the nation as a whole will be better off just because some individual firms and consumers benefit from the import of some products and the export of others. Greater aggregate welfare might be achieved without trade (autarky), or at least with some restrictions on free trade. Arguments in favor of tariffs and other barriers to trade often take this position.

Given a set of reasonably plausible assumptions, it is the principle of comparative advantage that firmly establishes the benefits associated with international trade. In the early 19th century, David Ricardo was the first political economist to outline comparative advantage in a rigorous manner. Factor proportions theory, which emerged in the 1930s, explains both the causes and consequences of comparative advantage. Together these concepts remain the central tenets of international trade theory.

Ricardian trade theory

Prior to Ricardo, the basis for trade was unclear. Adam Smith had argued that countries engage in trade only when each of the partners has an *absolute advantage* in the production of at least one good. A country has an absolute cost advantage in a particular commodity when it can produce it at lower cost than any other country. It is this conception of trade based on absolute advantage that is invoked by many critics of open trade policies that pit U.S. companies against competitors overseas that enjoy, say, dramatically lower labor costs.[5]

Smith argued that international trade may provide a nation's industries with sufficient demand to fully exploit the efficiencies associated with larger size of plant and equipment. For a firm to grow and reap internal economies of scale, consumers

must purchase large quantities of goods. International markets can provide these consumers when national markets are limited. By leading countries to specialize in those goods they make at lowest cost, trade promotes an efficient international division of labor. Actually, new trade theorists have taken up this line of reasoning using more modern analytical tools.

Ricardo's analysis overcame confusion about the question of whether nations would engage in trade even if one country has an absolute cost advantage in the production of *all* tradable goods and services. When outlining his theory, he made a number of assumptions: (1) transporting goods between countries is costless; (2) no artificial barriers to trade exist (e.g., government quotas or tariffs); (3) labor is homogenous of comparable skill per unit; (4) the market is characterized by perfect competition (e.g., there are no increasing returns); (5) production technologies are identical in each country; and (6) labor, the only factor of production he considered, is immobile between countries. The labor mobility assumption is critical. If workers (and, in multifactor models, other factors of production) can freely move wherever they choose, all production would take place in the lowest cost country. Ricardo assumed labor is mobile within countries but not between them.

Employing the classical labor theory of value, where all production costs (or the value of goods) can ultimately be reduced to units of homogenous labor, Ricardo showed that even if one country has an absolute cost advantage in the production of all goods, it may still engage in trade with other nations due to differences in relative internal economic capabilities. This is a powerful and arguably non-intuitive finding because it suggests that a firm in a given country may still find an international market for its goods even if it produces at a higher absolute cost than similar firms overseas. A country has a comparative advantage for the purposes of trade in those commodities that its industry produces most cost-effectively relative to other commodities (see the example in Appendix 4.1, which also discusses prices and currency exchange rates).

Nations and the regions within them have limited resources (natural resources, workers, capital stock), at least in the short run. In an economy operating at its highest potential rate of output, each good that is produced means some other good cannot be produced. Otherwise, where could the necessary workers be found? There is an opportunity cost associated with specializing in particular goods and industries. For example, if you choose to produce *more* automobiles, it means you have chosen to produce *less* of something else. Given two countries (say, the United States and Mexico) and two goods (computers and apparel), assume the United States is able to produce one computer by reducing its production of apparel by two dozen units, while Mexico must reduce apparel output by three dozen to produce one computer. The United States, in this hypothetical case, produces computers at a lower relative cost. However, there is a flip-side. Mexico is more efficient in the production of apparel since by making one less computer, it can make three dozen apparel units as compared to two dozen in the United States. The comparative advantage in the United States is computers and is apparel in Mexico. Both countries benefit if the United States ships computers to Mexico in return for apparel,

that is, if they engage in trade.[6] In fact, in this simple model, the maximum benefits are achieved if the United States specializes entirely in computer production, while Mexico produces only apparel.[7]

Factor proportions theory

Why would one country be able to produce a given good at a lower relative cost than another country? Ricardo's explanation is simply that labor is less productive in some countries than others. (Remember that labor is the only factor of production in the Ricardian theory.) But, then, what determines differences in labor productivity? *Factor proportions theory*, developed initially by Eli Heckscher (1919) and Bertil Ohlin (1933) and further refined by Paul Samuelson (1948), postulates a more sophisticated framework for understanding the causes of comparative advantage. Factor proportions theory essentially states that countries trade because they "are different," in terms of their endowments of the equipment, materials, personnel, and expertise that go in to producing goods (Krugman 1990). Countries like Canada that have more land relative to workers will find their comparative advantage in land-intensive goods, such as wheat. Countries like Mexico that have more low-skilled workers relative to high-skilled workers will export lower-technology products such as apparel. Countries well-endowed in capital and skilled workers like the United States or Germany will find their comparative advantage in goods like electronics, computers, and laboratory instruments.

Given a set of restrictive assumptions, factor proportions theory also demonstrates that international trade will tend to equalize factor and commodity prices between regions even in the absence of factor migration. Samuelson (1948) provided the seminal exposition of this result, termed the *factor price equalization theorem*, which states that under factor proportions theory, differences in the relative costs of production of goods across countries are due to differences in the relative scarcity (and therefore price) of factors. We can imagine, however, that once trade ensues (on the basis of those differences), factor prices across trading partners will eventually converge. In other words, although factor prices in the absence of trade first establish the basis for trade, they are not likely to remain stable once trade ensues.

Consider the United States and Mexico again, which, in our hypothetical example, engage in the trade of capital-intensive computers from the United States and labor-intensive Mexican apparel consistent with the comparative advantage each enjoys. In order to satisfy the U.S. demand for imported apparel, Mexico gradually transfers resources from its own home computer industry to specialize in apparel. Since computer production is capital-intensive, relatively more capital than labor is released for use in apparel production, which makes capital relatively easier to secure. At the same time, it becomes harder to find workers in Mexico as the apparel industry grows, so each worker can command a higher wage. The limited quantity of capital needed by apparel manufacturers stimulates a decrease in the price of the scarce factor, capital, and an increase in the price of the labor.

The opposite process occurs in the United States. Resources are shifted from the apparel to the computers industry as the United States specializes in its export good. Then, the price of the relatively scarce factor, labor, decreases because labor is being released from apparel production. The subsequent increase in the labor supply brings down the wage in the computer industry (former apparel workers are now seeking jobs making computers). Note that these processes change the distribution of income between labor and capital. The introduction of trade creates both winners and losers. Factor proportions theory holds that free trade leads to an *overall* increase in welfare, where the gains to the winners outweigh the losses to the losers.[8] Eventually, if we assume that industries produce with constant returns to scale, the price of capital and the wage rate will converge to equality between the United States and Mexico.

New trade theory

The assumptions made by Heckscher, Ohlin, and Samuelson are highly restrictive, and, therefore, the theory's predictions are open to question. The assumptions follow. First, two factors of production, capital and labor, exist, both of which are mobile between industries but immobile between regions. This important interregional immobility assumption means that while the price of each factor must be identical in each industry within a region, they may differ between regions. Second, factor and commodity markets are characterized by perfect competition, where no trade barriers exist and transport costs are negligible. Third, the technological methods of production (production functions) for each industry are identical across regions so that, when faced with the same factor prices, industries in each region will select the same combination of capital and labor (or identical capital-labor ratios). Production functions are also assumed to exhibit constant returns to scale, which rules out possible agglomeration economies (Chapter 9). Finally, computer production is capital-intensive (relative to apparel), while apparel production is labor-intensive (relative to computers), at all possible sets of factor prices. This assumption of *strong factor intensity* is critical to the unambiguous results generated from the model. Capital-intensive commodities could become labor-intensive once the ratio capital to labor prices becomes very high. This means that some commodities could be produced using a labor-intensive process in labor-rich regions and capital-intensive process in capital-rich regions. Given this situation, the Heckscher-Ohlin theorem would predict no distinct pattern of trade (Armstrong and Taylor 1985).

The new trade theory introduces another explanation for why countries (and regions) trade: because there are economies of scale in specialization. For some goods, say satellite-launching rockets, large passenger aircraft, ocean liners, deep-sea oil drilling equipment, and so on, economies of scale are so significant that the world market can only bear a few centers of production (Krugman 1990). Regions producing and consuming such goods would tend to be at similar levels of development. The theory thus helps explain why trade is most common between countries that are arguably the most similar in their factor endowments.

The theory also places much emphasis on the role of chance in determining the pattern of specialization. Some countries and regions get lucky; by virtual serendipity, they start producing a particular good at first. Then, by virtue of economies of scale (internal to the plants plus external economies of agglomeration), the region extends its advantage vis-á-vis other competitors. Production of certain goods may become "locked-in" in particular regions.[9] Although new trade theorists recognize that it is theoretically possible that trade with external economies may be detrimental to some regions and countries, they argue that very few regions would fall behind permanently. As noted by Krugman and Obstfeld (1997):

> Canada might be better off if Silicon Valley were near Toronto instead of San Francisco; Germany might be better off if the City (London's financial district, which, along with Wall Street, dominates world financial markets) could be moved to Frankfurt. The world as a whole is, however, more efficient and thus richer because international trade allows nations to specialize in different industries and thus reap the gains from external economies as well as the gains from comparative advantage.
>
> *(p. 152)*

Applications

In many countries of the world, especially those where multilateral aid organizations are active, neoclassical trade and growth theories are the mainstays of development planning. Benefit-cost analysis, which is widely used to evaluate investment projects in developing countries, is based squarely upon neoclassical trade theory.[10] In the United States, economists use trade theory to advocate less government intervention in order to promote freer international (and interregional) trade. Local economic developers, on the other hand, often ignore the implications of trade theory and end up supporting protectionist measures and growth strategies in the name of job creation, which may sacrifice the economic well-being of the community.

Trade theory narrows the economic developer's attention to tradable commodities, both goods and services; the larger group of commodities that neither are exchanged nor minimally traded may be ignored. For traded commodities, the developer may try to determine whether absolute advantage or comparative advantage exists by comparing the relative prices of traded commodities to world prices or to prices in those places with which the region trades.[11] Typically, however, the number of traded commodities will be too numerous to examine individually. For simplicity, the developer may want to assume that local comparative advantage exists for internationally traded goods and that absolute advantage exists for interregionally traded goods.[12] Given these assumptions, local developers should challenge policies that threaten regional specializations because they may reduce the region's comparative or absolute advantage.

In general, developers would work toward greater efficiency and productivity in the local economy if they opposed trade barriers. They should advocate

export diversification only after carefully assessing the competitive exports of other regions.[13] Similarly, they should compare import substitution carefully when wanting to further export sector specialization. More productivity gains may result when export earnings are used to purchase imports than when the imports are produced locally. Trade theory gives strong support for local infrastructure development, improvement in government efficiency, and other measures that could increase the productivity and lower input costs for all local producers. For example, improvements in intraregional transportation can reduce costs to local companies, while interregional transportation improvements (or lower freight rates) can expand trade (market) areas for basic sector companies.

Many metropolitan economies, with thousands of traded commodities to consider, are far too large and complex to examine each traded commodity. Working at the NAICS two- or three-digit industry level is more practical. The applications of trade theory at this level lead to the recommended strategies similar to those supported by neoclassical growth theory (see Chapter 5): opposing barriers to trade; promoting greater efficiency and productivity in the economy, including efficient government, which would benefit all local producers; and supporting local infrastructure development, especially improvements in intraregional and interregional transportation. This consistency is not surprising since both theories are drawn from the same set of basic assumptions.

Trade theory would encourage local economic developers to analyze closely an export promotion strategy. Local developers interested in growing existing specializations in manufacturing or in financial, business, and professional services would only be able to support these specializations by helping exporting companies produce more efficiently. Export expansion led by these efficient local companies would probably generate greater benefits than an import substitution strategy. As previously noted, local consumers are better off buying relatively cheap imports than buying more expensive local products that were substituted for imports.

Developers face an important strategic decision when applying trade theory: is it better to specialize or diversify? Much research supports the virtues of each, and local politicians usually seek the benefits of both. The basic tenet of trade theory is that a region (or an individual or a firm for that matter) can best achieve welfare gains if it specializes and trades. Yet economically diverse regions tend to experience greater stability and at times more sustained growth. The diversity-specialization dichotomy is actually a false one. Diversity is not the absence of specialization but rather the presence of *multiple* specializations.

Elaboration

Trade between regions may be described as a sequence of trade-based regional growth: (1) closed economy or self-sufficiency without trade; (2) open economy without factor mobility—the international case; (3) open economy with factor mobility—the interregional case; and (4) regional autarky. Given two self-sufficient regions at pre-trade equilibria, the potential for trade between them exists if

equilibrium prices in the two regions are unequal. The different equilibria may reflect unequal factor endowments, unequal tastes, or both. In the short run, commodities are traded until a new equilibrium price is reached. This price represents the terms of trade, and, at this price, a balance of trade exists; that is, exports equal imports for both regions. In the long run, specialization towards the commodity in which the region has a comparative advantage further changes the mix of commodities produced compared to the mix that is consumed in each region. Specialization will continue until all increases in welfare are realized through trade. Thus, both regions gain by engaging in trade based on comparative advantage.

As described in the "Overview" section earlier, under very restrictive assumptions, free trade can lead to factor price equalization between the two regions. Wages and profit rates may tend toward equality even without factor mobility between the regions (the international case). As a result of commodity-based trade, workers with similar jobs would earn about the same real income in both regions. But in the interregional case, the two economies are open to the migration of labor and capital. Factor mobility can equalize factor prices more directly than commodity trade. With labor migration and capital flows, wage and profit rate differentials should disappear eventually.[14] Ultimately, equal factor prices eliminate the potential for trade. The regions cease trading because further welfare gains are not possible. Therefore, the regions end where they began—in a state of regional autarky. After trade, the level of development in the regions should be much more similar.

Interregional trade theory, then, offers a strong rationale for open economies. Although the assumptions are restrictive, the regional economy that experiences labor and capital mobility, specializes in its comparative advantage, and engages in trade not only increases consumer well-being but also impacts factor costs such that returns become more equal compared to other areas. Although trade theory suggests that per capita income levels in trading regions should converge over time, growing inequality among metropolitan areas in the United States contradicts this speculation.

Heckscher and Ohlin argue that comparative advantage is determined by factor endowments, but exactly what constitutes them is not very clear. Ohlin implies that factor endowments consist of land (and other natural resources), labor, and capital; that these factors are homogeneous across regions; and that relative quantities of each determines comparative advantage. However, since factors are clearly not homogeneous across regions and therefore not strictly comparable, it may not be possible to ascertain whether a country is able to compete on the basis of comparative or absolute advantage. In spite of trade theory assumptions, actual regions have deep cultural, historical, and political differences. At any point in time, regions may experience very different levels of development and offer very different, immobile types of infrastructure.

The ambiguous nature of the notion of endowments is evident when one tries to determine when a particular combination of inputs that is unique to a country should determine an absolute rather than comparative advantage.[15] It may be clearer to argue that cultural, historical, and institutional factors shape a region's

factor endowment. However, if a certain region is the only one with a particular factor, then trade based on that factor can only be due to absolute rather than comparative advantage. Moreover, regions are often defined in terms of some unique factor endowment, making it nearly impossible to ever find a case in which trade will be based solely on comparative rather than absolute advantage.

Even if a distinction between comparative and absolute advantage makes sense, nations trade on the basis of comparative advantage if and only if exchange rates can be adjusted to ensure balance-of-payments equilibrium.[16] (See Appendix 4.1.) But regions possess no mechanisms that can achieve exchange rate adjustments. Furthermore, demand or institutional factors may generate prices that do not reflect regional productivity differentials (McCrone 1969). Do regions experience significant balance-of-payments problems? With data shortages, empirical work on this issue is limited, while theorists remain divided (Armstrong and Taylor 1978).[17]

According to neoclassical theory, because factors are perfectly mobile between regions, wage and profit rates should be approximately equal and no unemployment should exist. In this situation trade should be based only on absolute advantage. However, if one region is more productive than another across all industries, the inefficient region will be unable to establish competitive prices. As a result, production in this region must contract, and surplus labor and capital will tend to out-migrate rather than become unemployed:

> Thus, there is a contrast between international trade where differences in productivity can be matched by differences in factor earnings, where exchange rates can be adjusted to ensure trade can take place on the basis of comparative advantage, and where all participants in trade no matter what their level of efficiency or their endowments may enjoy economic growth. And, on the other hand, inter-regional trade with complete factor mobility which implies equality of factor earnings, trade only on the basis of absolute advantage, no regional unemployment, but a tendency for regions with below average efficiency to decline while others expand.
>
> *(McCrone 1969, p. 79)*

Declining demand for local products may further the unproductive region's decline via the economic base multiplier, while a negative balance of trade can also encourage a downward spiral. If labor fails to migrate, surplus resident labor may force down wage rates, or unemployment may persist.[18] There may be too much factor mobility for comparative advantage-based trade but too little mobility to avoid unemployment.

In short, if a region tends to trade on the basis of absolute advantage and it has no such advantage in any commodity, its economy will contract. This raises the hypothetical question of whether a less developed region would be better off as a less developed country (LDC). With the status of a nation-state, the region could pursue an independent economic policy more suitable to its needs by setting exchange rates given the balance-of-payments situation, establishing protective

tariffs, and implementing monetary and fiscal policy. At the same time, national boundaries would limit the factor movements that act as an automatic economic adjustment mechanism. On the other hand, the new nation would forfeit the benefits of cross-subsidization from other regions although it may gain transfers from international aid organizations. Moreover, as a nation, the region would have to face world prices, which would require a painful readjustment for any industries accustomed to price subsidies. The point of analyzing the differences between a sovereign region and one within a country is not to advocate secession. Rather, it is to illuminate export-oriented growth policies for declining regions, such as assisting regions to gain greater economic sovereignty and comparative advantage, perhaps through regionally specific taxes or subsidies.

Ultimately, McCrone's (1969) argument concerning the benefit of exchange rates in assuring balance-of payments equilibrium is not particularly compelling, since income transfers enable a region to have a continually deteriorating balance-of-payments position. For example, if income were not being sent into the region, then there would be no "foreign exchange" to purchase commodities from outside the region.[19]

One of the most powerful conclusions in trade theory—that gains from trade are mutually beneficial—is also questionable. Certainly, specialization caused by trade increases aggregate production, but the distribution of these gains may not benefit both trading partners. To illustrate, consider once again two countries, the United States and Mexico, which produce two commodities: computers and apparel. Assume that computers and similar advanced electronic products are income elastic, while essential, basic apparel is income inelastic. Relative price differences lead to trade, with the United States buying basic apparel from Mexico and the latter importing U.S. computers and sophisticated electronics. In the short run, trade continues until an equilibrium price level is reached and both countries are better off. In the long run, the two countries specialize, expanding aggregate output as described in the "Overview" section of the chapter.

As output expands, the prices of the two commodities fall, causing real incomes to rise. However, as incomes rise, a greater proportion of income is being spent on computers and sophisticated electronics than on basic apparel. Although consumers may still consume a greater quantity of basic apparel, the amount that they spend on this lower-priced commodity may actually fall. Moreover, any further increases in basic apparel production by Mexico may lower apparel prices further. Thirlwall (1980) identified this problem related to the export of income inelastic goods. At this point, it might be very difficult for Mexico to shift back into the production of computers if the United States successfully developed its resources to become even more efficient in computer production. Thus, the net gains from trade in the long run may be more beneficial to the United States than to Mexico.

That trade may not be mutually beneficial represents a fundamental challenge to the notion of equilibrium and regional convergence that underlies neoclassical theory. Labor, capital, and trade tend to favor rich regions to the detriment of poor regions so that market forces reinforce the concentration of growth in

prosperous metropolitan centers and regions. Skilled labor migrates from poor areas; capital seeks locations where demand is highest. Although wealthy regions needing goods from other regions for expansion may diffuse benefits to poorer areas, such trade will generally be more beneficial to the more prosperous regions, because they are likely to be experiencing higher productivity that reduces poorer regions' gains from trade. Lagging regions experience price inelastic demand for their exports, capital inflows to industries that function as economic enclaves, and the suppression of their industrial bases, which are unable to compete with imported products. With surplus labor, productivity improvements tend to lower prices, while inelastic demand restricts the expansion of markets. As a result, interregional trade can negatively affect poor regions.[20] This argument is consistent with cumulative causation theory (Chapter 6): economic systems are inherently unstable due to forces that tend to reinforce regional income differences rather than mitigate them.

One could argue that the diseconomies of excessive growth in prosperous regions, such as congestion, environmental problems, strains on public services, and housing shortages at some point, should outweigh the economies of scale and agglomeration economies that often accompany growth and lead to slower growth rates (Chapter 9). However, since individual producers do not internalize these social costs, they are not reflected in prices. Thus growth may well continue where social costs are greater than the private benefits of increased production yet bypass lagging regions where underutilized labor and infrastructure are available.[21] Thus although the state has often functioned to introduce and support free trade, a legitimate state role may be to modify and mitigate the negative results of interregional exchange by developing programs to reduce growing regional inequality that has become a serious problem in the United States.

These criticisms yield two important implications for economic developers seeking to apply trade theory in order to develop an export base that can help a region benefit from trade. First, comparative advantage is appealing in theory, but it is difficult to determine in practice and thus may not be particularly useful for guiding regional policy. A region may be better off focusing on the development of industries in which it possesses an absolute advantage. Second, to the degree they can be identified, there may be reasons to discriminate between industries in which a region has a comparative advantage, as opposed to simply promoting all sectors. In particular, the production of income-elastic commodities for export should probably be encouraged more than those that are income inelastic.

Discussion questions

1 What is the difference between comparative and absolute advantage?
2 Are possible sources of externalities in your region that has led to specialization in particular goods?
3 In what ways might trade theory help you explain the observed spatial distribution of industries in your area?

4 How have free trade agreements such as the North American Free Trade Agreement (NAFTA) impacted your region?
5 A number of cities and states have set up programs designed to promote international exports. Based on the theory of comparative advantage, what role should state or local officials take in encouraging export activity by local producers? What types of assistance (from information provision to financial aid) would be most effective in sustaining or growing regional employment and income?
6 In spite of factor proportions theory, some countries and regions are still able export goods which utilize factors in which they are comparatively less well-endowed. How are some U.S. apparel producers able to compete with manufacturers in countries with much lower capital-to-labor ratios? (Apparel production is traditionally a labor-intensive process relative to the production of other goods.)

APPENDIX 4.1

Excerpts from "Basics of Comparative Advantage Aren't So Hard To Learn"

Manuel F. Ayau, Wall Street Journal, *October 20, 1983*

As a former member of the protectionist lobby in my country who had the opportunity to learn the error of his ways, I am annoyed with myself for having failed for so long to understand why countries are misled into paying the high cost of restricting trade. Many people, including professional economists who should know better, seem oblivious to the implication of the difference between competitive advantage and comparative advantage, despite the fact that David Ricardo explained it about 200 years ago.

Competitive advantage means, of course, that one party can do something at lower cost than another, and it typically is the basis for protectionist arguments. Comparative advantage is the relationship of one competitive advantage to another, or a comparison among competitive advantages. The uneconomic diversion of resources abetted by failure to comprehend this seemingly elusive distinction is enormous. . . .

What is rare in economic discussion is a simple example that demonstrates quantitatively the benefits derived from free trade. If the reader wants to do a little arithmetic, I offer the following exercise, based first on barter, and then on the use of money. This is a worst-case example; Japonia has a clear competitive advantage over Latinia in producing both radio and television receivers, as follows:

Man-Hours Required for One Unit

	Japonia	Latinia
Radio	1	4
TV	4	8

It follows that 48 man-hours of production results in 24 radios and six televisions in Japonia. The same number of man-hours produces six radios and three

TVs in Latinia. Adding, we find 30 radios and nine TVs being produced with 96 man-hours of effort.

Suddenly, Japonia and Latinia choose free trade and tear down the barriers they had erected against each other's products. And miraculously, with the same man-hour requirement per unit and the same number of man-hours devoted to production, their combined output can rise to 32 radios and 10 TVs.

This is not really a miracle. It simply is division of labor based on comparative advantage. Under free trade, Latinia is induced to withdraw resources it had devoted to radio production and concentrate entirely on TVs. Now, with 48 man-hours' input, Latinia produces six TVs and zero radios. Japonia is induced to reallocate some resources. It devotes 32 man-hours to radios, where its competitive advantage is greatest, and the remaining 16 hours to TVs, enabling it to turn out 32 radios and four TVs with every 48 man-hours of effort. The world has more product, but are Japonia and Latinia better off individually? To find out, we have to introduce the price system. In doing that, one thing needs emphasis: It isn't prices *per se* that count, but price relationships. Differences in price relationships are what people act on.

Here is the lineup of prices (we'll use the same prices both before and after free trade):

	Japonia	Latinia
Radio	24,000 yen	600 pesos
TV	96,000 yen	1,200 pesos

After free trade, the Japonian retailer can choose a TV at 96,000 yen or 1,200 pesos, corresponding to an exchange ratio of 80:1. He will want to buy pesos whenever he can get them for less than 80 yen apiece. The Latinian retailer can choose a radio at 24,000 yen or 600 pesos, corresponding to a ratio of 40:1. He will be in the market for yen whenever he can get more than 40 for a peso. . . . But the Japonian and Latinian radio and TV marketers should be satisfied if the yen/peso rate falls somewhere between 40:1 and 80:1.

We could choose any number, but let us say that the exchange rate becomes 60:1 right in the middle. Before free trade, a Japonian retailer could buy a shipment of 20 radios and five TVs for 960,000 yen. A Latinian retailer could buy the same shipment for 18,000 pesos. After free trade, the Japonian and Latinian retailers, each acting in his own self-interest, do their buying. Here is the result:

Japonian retailer:

20 radios × 24,000 yen	=	480,000 yen
5 TVs × 1,200 pesos × 60 yen	=	360,000 yen
Shipment:	=	840,000 yen

Saving: 120,000 yen

Latinian retailer:

20 radios × 24,000 yen / 60 pesos	=	8,000 pesos
5 TVs × 1,200 pesos	=	6,000 pesos
Shipment:	=	14,000 pesos

Saving: 4,000 pesos

In both countries, purchasing power has been increased. Both can afford to buy more of the same things, or to buy new things they could not afford before. Both are wealthier.

Possibly you aren't convinced until you can see it in dollars and cents. So why not create a world price, in dollars, for radios and TVs and do the arithmetic over again? At a 60:1 yen/peso exchange rate, the dollar price of a radio is $80 and the dollar price of a TV is $240, based on 300 yen equals five pesos equals $1. You will find that Japonia will have enough extra radios to sell at $80 each to buy from Latinia the TVs it stopped producing, and still have some dollars to spare. And Latinia will have dollars left over after selling extra TVs to buy all of the radios it no longer makes.

This is a severe test because neither radios nor TVs are sold at the "average" price (nor are they produced at the "average" cost). When voluntary exchange is the rule, these products, like all others, are produced at marginal cost and sold at the price the market will pay for the next increment of output. If we allow ourselves to think in terms of averages, it is easy to jump to conclusions.

One such conclusion is that our industry will collapse because it can't compete with their industry. It is true that some radio and TV manufacturers will not be able to compete with the lower-priced foreign products. It is also true that some manufacturers may have to close down some of their more antiquated production facilities. In either event, it is the marginal use of resources that must be relinquished, and that act could add to rather than subtract from, well-being.

There is a myth, which has about as many lives as a cat, that countries import and export surpluses. "Dumping" of surplus is a frequent complaint. But the fact is that most exported goods have been produced for export as a means of generating foreign exchange, which when in turn sold, produces a greater income in local currency than if the resources employed in export production had been devoted to production for domestic use.

If one country wants more corn, which should we plant: corn or cotton? The answer, of course, is that if with the cotton that we can sell we can buy more corn than we can produce with the same resources, we should plant cotton to have corn. If we stubbornly insist on producing our own corn, we deny ourselves the advantage of division of labor. Denial of that advantage is exactly the cost that trade barriers impose. But the cost is greater than money can measure because division of labor is the basis of civilization.

Somehow, watching the way the world behaves, it seems that it must be easy to forget the addition to well-being that results from the satisfaction of needs at lower

costs. Free trade allows pursuit of lowest cost, liberating resources that generate new consumption demands and new investment and jobs. Protective trade barriers amount to self-inflicted punishment, universally practiced. This tragic, divisive misunderstanding of our age probably will be a mystery to future generations. They will wonder how a period of great technological achievement could possibly have been accompanied by such strenuous efforts to obstruct trade and increase poverty.

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Notes

1 https://ourworldindata.org/international-trade
2 https://data.worldbank.org/indicator/NE.EXP.GNFS.KD.ZG?end=2016&start=1961
3 http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Country=US&
4 Krugman (1996, p. 207) writes: "It is a late 20th-century conceit that we invented the global economy just yesterday"; and furthermore (1996, p. 120):

> one should have some historical perspective with which to counter the silly claims that our current situation is completely unprecedented: the United States is not now and may never be as open to trade as the United Kingdom has been since the reign of Queen Victoria.

5 "Absolute advantage" is often considered synonymous with "competitive advantage," a general term that is rarely carefully defined. In this book, we use competitive advantage as a more general term that refers either to absolute or comparative advantage.
6 To illustrate these principles, as well as show more clearly why nations may trade even when one trading partner has an *absolute* (cost) advantage in the production of all goods, consider the example below. Mexico has an absolute advantage in the production of both apparel and computers since it uses 12 fewer labor hours to produce a unit of apparel and 3 fewer labor hours to produce a computer. But Mexico has to give up four units of apparel, while the United States must give up only one unit. Mexico can buy computers from the United States cheaper than it can produce them itself; likewise the United States will fare better if it specializes in computer production and buys apparel where it is cheapest, from Mexico. According to neoclassical trade theory, then, absolute cost advantages are, in essence, irrelevant to the question of whether countries will engage in trade.

Exhibit 4.1

	Labor Hours Required per Unit		*Opportunity Cost per Unit*	
	Apparel	Computers	Apparel	Computers
Mexico	3	12	1/4 units computers	4 units apparel
United States	15	15	1 unit computers	1 unit apparel

7 The result that regions will completely specialize in the production of the product in which they hold a comparative advantage is dependent on the implicit assumption of constant costs in production. An alternative assumption, such as increasing costs, would yield the more realistic case of incomplete specialization (regions producing some of all commodities). The constant cost assumption is a result of Ricardo's restriction of the analysis to one factor of production. With only one factor, there can be no diminishing returns; labor productivity remains constant. With increasing costs, regional prices will

converge short of complete specialization. Kreinin (1979) provides an accessible discussion of this issue.

8 We will use the example in Endnote 6 to see why this is the case. But first we have to introduce another wrinkle. To calculate the total benefits from trade for each country, we need the equilibrium exchange rate for the two nations after trade takes place. The equilibrium rate is determined by the intensity of demand in each region for the traded commodities; it must fall somewhere between the internal rates of exchange in each region. For example, the United States will sell a computer for any price greater than one unit of apparel (otherwise it could produce apparel just as cheaply itself), while Mexico will pay U.S. manufacturers no more than four units of apparel for each computer. Depending on demand conditions, the realized rate of exchange might be established closer to the Mexican internal rate, in which case the United States would benefit the most from trade. Alternatively, it might fall closer to the American rate. With Mexico paying close to one unit of apparel for each imported computer, well under the four units of apparel that it would cost to produce a computer itself, it would garner the bulk of the benefits of trade.

Assume that the world exchange rate is established at two units of apparel per computer. Assume also that Mexico produces 100 total units of apparel: 50 units for home use and 50 units for export purposes. For its part, assume that the United States produces a total of 60 computers, 35 units of which it consumes and 25 units of which it exports to buy apparel. Given free trade, Mexico consumes 50 units of apparel and 25 computers (each unit of exported apparel buys half a computer—or, it takes two units of apparel to buy a computer; 50 exported units of apparel times one-half equals 25). By similar reasoning, the United States consumes 50 units of apparel and 35 computers. In the absence of trade, Mexico could produce only 12.5 computers at home with the equivalent amount of labor used to export 50 units of apparel to the United States. Likewise, U.S. manufacturers could produce only 25 units of apparel locally with the same labor that, in a world of trade, may be used to pay for the import of 50 units. In both nations, the consumption of apparel and computers is thus higher with free trade.

Note that if the rate of exchange falls closer to Mexico's internal exchange rate, this is because Mexican demand for American computers is relatively more intense than American demand for Mexican apparel. Therefore, although the United States enjoys greater benefits from trade in exchange terms, the benefits are distributed more equitably in utility (or consumer satisfaction) terms. It should be clear that the distribution of the benefits of trade cannot be analyzed independently of demand considerations.

9 New trade theory is closely related to the new endogenous growth theory, which is discussed in Chapter 5.

10 Trade theory is useful in evaluating projects and strategies because it forces comparisons of the advantages of producing a commodity to its opportunity costs. Social benefit-cost analysis is the most appropriate method for making such determinations. By using world prices of tradeables as the shadow prices in the model, the benefits (costs) of local production can be compared to the benefits (costs) of trade.

11 Relative prices do not exist in all cases. Commodity exports not available in the receiving region or imports not producible at home are noncompetitive, and, therefore, relative prices do not exist in both regions. The trade of noncompetitive commodities, then, cannot be based on comparative advantage.

12 The *Census of Transportation* is a useful source for determining interregional commodity flows. Regionalized input-output tables can be used, with caution, to distinguish regional trade flows from flows based on national technical relations and to examine the composition of exports and imports.

13 Unfortunately, international development agencies have fostered commodity export diversification in less developed countries (LDCs) only to increase competition and lower relative commodity prices realized by all LDCs.

14 The equality of factor prices reverses the logic of trade theory and leads to equal commodity prices. On the other hand, trade can continue without equalizing the terms of

trade if transportation costs are assumed to exist. Furthermore, increasing returns to scale makes the outcome indeterminate, and government intervention may be required to reach a Pareto optimum.

15 For example, labor-intensive production, like textiles, often leave high cost areas for areas with cheaper labor. Does the relocation of textile plants constitute a comparative or an absolute advantage? The answer is found by asking why labor is more expensive. The reason could be scarcity of labor or scarcity of this specific type of low-skilled labor. Alternatively, institutional factors, such as minimum wages, unemployment insurance, and worker health and safety regulations, could be increasing the price of labor. If the difference in labor prices is due to scarcity, then the production of textiles in the lower-cost area may be due to comparative advantage. Otherwise, it is due to absolute advantage since textile firms are not responding to resource availability but rather to environmental factors unique to each area.

16 Though the principles of trade theory are often illustrated with trade conducted by barter, it is important to understand exchange rates and their relationship to balance-of-payments. Balance-of-payments refer to the transactions between a country (or region) and the rest of the world. What the country pays out for purchases of imports must be financed with income from external sources, generally through the sale of exports. Although short-term deficits may be financed by borrowing, persistent balance-of-payments deficits mean that a country (or region) is spending "beyond its means." Eventually simple accounting dictates that a contraction in expenditures will be required.

We continue the hypothetical example of trade between the United States and Mexico but with consideration of each trading partner's currency. The left-hand side of Exhibit 4.5 provides the production costs in each country, in their own currency, prior to engaging in trade. The actual exchange rate between the two countries is not established until trade ensues.

Exhibit 4.2

			Production Costs in Dollars, 3 Exchange Rates					
	Production Costs/ Unit		*$1 = 2 Pesos*		*$1 = .50 Pesos*		*$1 = 5 Pesos*	
	Apparel	*Computers*	*Apparel*	*Computers*	*Apparel*	*Computers*	*Apparel*	*Computers*
Mexico	1 Peso	4 Pesos	$.50	$2.00	$2.00	$8.00	$.20	$.80
U.S.	$1	$1	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00

Since the exchange rate, $1 = 2 pesos, falls within the limits by real resource cost differences, both countries may preserve their balance-of-payments equilibrium. Mexico is able to finance imports of computers with the money that it receives from the export of apparel, for example. A similar situation exists for the United States with regard to the export of computers and import of apparel. Although $1 = 2 pesos is an arbitrary rate within the identified limits, the actual rate will be determined by the pattern of demand in the two nations. As long as the rate reflects relative resource costs, balance-of-payments equilibrium will be maintained in each country. Note that the inability of subnational areas to adjust rates is a reason why some researchers have argued that the implications of trade theory have limited relevance for regional economic development.

17 Thirlwall (1980) introduces important basic concepts and considers both trade theory and growth theory from a Keynesian perspective. One concept relates to balance-of-payments adjustments. Another is income elasticity of demand.

In contrast to the neoclassical growth model, Thirlwall's model is demand-driven rather than driven by the supply of labor and capital; the balance-of-payments equilibrium may constrain growth due to income adjustments in spite of price adjustments;

unemployment is involuntary, not voluntary (real wages are too high); and the regional economy may be dominated by positive, not negative, feedback. The latter may hold because of "increasing returns in the broadest sense" (1980, p. 421). This Keynesian model may look like its neoclassical counterparts, but it is driven by income effects instead of price effects. Balance-of-payments constrains growth because, unless the region can draw on a permanent source of external financing (transfers), export growth must keep up with import growth.

Thirlwall's model may be used to contrast the logic of economic growth based on price adjustments (price and quantity effects) to the logic based on demand-driven multipliers (income effects). Whereas Keynes considered ex ante investment needed to achieve full employment as saving, Thirlwall examines the *ex ante* exports needed to equal imports. After showing the Harrod trade multiplier formulation and the tendency for depressed regions to run a balance-of-payments deficit, he notes that

> countries concerned with regional disparities allow depressed regions to run balance of payments deficits by directing autonomous expenditure and income transfers of various kinds which support consumption and investment in these regions. If the trade sector of a region is large, however, the level of compensation required may be unbearably high to prevent the Harrod trade multiplier from working.
>
> *(1980, p. 422)*

In the model, both exports and imports respond to negative price elasticity and positive income elasticity of demand. The balance-of-payments equilibrium income growth rate (yb) is given by the following equation. The key assumptions of competitive markets for traded goods and "the law of one price" reduce the equation to:

$$yb \quad \frac{e(zt)}{p}$$

where e is the income elasticity of demand for exports, zt is the growth of income outside the region, and p is the income elasticity of demand for imports. Thirlwall then relates growth and unemployment using the Verdoorn relationship. Assuming some inverse relationship between growth and unemployment, he argues that policies should "encourage activities in the region which are as income elastic as possible in markets outside the region" (1980, p. 424). Financial incentives will have positive income effects.

Thirlwall's model supports attention to the export sector, not to realize comparative advantage or input-output linkages but because export demand is a key part of regional demand, which results in the ability to finance imports. Thirlwall supports export promotion which may proceed like targeted recruitment strategies only focused on goods with high income elasticities of demand. Thirlwall does not discuss strategies to reduce the income elasticity of imports. Such strategies may work against the region's short-run comparative advantage, which is a function of price effects, but may build competitive (absolute) advantage in the region. However, imports may have to be curtailed to some extent. At least the developer should consider ways to tie imports directly to enhanced export capacity or greater demand for local production.

18 McCrone (1969) is describing a positive feedback system that works as a vicious cycle of interregional divergence and decline similar to Myrdal's (1957) backwash effects, discussed in Chapter 6.

19 A separate currency might be valuable, however, to the extent that it allowed a region to set its monetary and fiscal policies without worrying about the consequences of external inflation, assuming such policies could stimulate growth effectively.

20 Myrdal (1957) sees spread effects as primarily benefiting the areas near the growth center. He argues that circular and cumulative causation, rather than balance and equilibrium, will generate increasing differences among regions, resulting from the free interplay of

market forces. Spread effects are more powerful in rich countries and often lead to interregional convergence, whereas backwash effects are more powerful in poor countries and will maintain or increase interregional inequality (Chapter 6).

21 "There is some presumption therefore for supposing that, if left to market processes alone, tendencies to regional concentration of industrial activities will proceed farther than they would have done if 'private costs' were equal to 'social cost' . . . and all economies and diseconomies of production were adequately reflected in the movement of money costs and prices" (Kaldor 1978, p. 149). Consumers may also derive increasing satisfaction from nonmaterial or noncommercial forms of consumption as growth becomes excessive. In this case, a community's level of production could be reduced without decreasing consumer well-being. Negative externalities would decrease as the production of "bads" declined along with the production of goods. Consumers experiencing less congestion or pollution and more access to natural amenities would enjoy greater satisfaction.

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5

REGIONAL GROWTH THEORY

The regional growth theories discussed in this chapter attempt to explain changes in a key set of macroeconomic indicators, including output, employment, income, investment, savings, wages, and interest rates. The theories address both regional factors and (as discussed in Chapter 4) *interregional* growth. Regional growth theories address the question: what determines observed disparities in regional income and income growth? An important related question is whether disparities are likely to persist or instead disappear through the natural play of market forces. Several models suggest that the former is true and that a potential role for government intervention exists in alleviating disparities. Other theories predict that incomes across regions will eventually converge, and therefore regional development policies are unnecessary or even counterproductive. Existing empirical work is only a partial guide, since conclusions vary. Understanding regional growth theory then is important for local economic developers if only to comprehend why some citizens, businesspeople, and elected officials remain skeptical about the need for publicly funded development initiatives.

This chapter outlines two bodies of regional growth theory: (1) neoclassical models, including revisions described as endogenous growth theory or new growth theory; and (2) what we will term "post-Keynesian" models of regional growth, following McCombie (1988a, 1988b). At some risk of oversimplification, both traditional and new neoclassical growth theories focus on the supply side. Assuming sufficient demand, the theories consider what prevents the economy from achieving its maximum rate of growth. From the neoclassical point of view, this is a matter of determining the factors preventing firms from producing at full capacity such that economy-wide resources can be allocated most efficiently. On the other hand, post-Keynesian growth theories generally focus on deficiencies in demand, looking for reasons why demand is insufficient to fuel additional production and growth in some regions.

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Local economic developers encounter these supply-side versus demand-side perspectives more frequently than they may realize. Consider the case of the potential impact of unionization on the local economy. On the one hand, any wage increases due to unionization may have a dampening effect on local industries by directly increasing costs relative to other (nonunionized) locations. On the other hand, pay increases give workers more money to spend, which increases demand for goods and services and potentially fuels additional regional economic growth.

Endogenous/new growth theory represents an extension of the neoclassical model to account for increasing returns to scale and externalities. Interestingly, this theory can generate conclusions that closely mirror some post-Keynesian conclusions. The supply-versus-demand perspectives on regional growth have thus moved closer together, at least in terms of some of their conclusions.[1]

Overview

The neoclassical perspective is the dominant framework for regional growth theory. Neoclassical growth theory is principally focused on the supply side, and the nature and magnitude of demand for goods and services is typically ignored. Although early neoclassical growth models de-emphasize or discourage public sector intervention in the market, new growth theory admits the benefits of a more significant role for economic developers in encouraging growth or reducing regional disparities. Indeed, the supply-side focus of much U.S. economic development activity, including infrastructure development, training programs, technical assistance, and science and technology programs may find some justification from new growth models that explain regional industrial specializations in terms of externalities and agglomeration economies. Post-Keynesian theories, with their emphasis on insufficient demand for the output of regional industries, have had a more limited though still important influence on regional development thinking. Their impact on policymaking has been stronger in Europe than the United States, partly because they imply a need for a much stronger and explicit regional policy framework than is politically palatable in the United States.

Neoclassical theories of regional growth

Using a concise set of economic maxims as a basis for analysis, the single-sector neoclassical regional growth model postulates that the process of economic growth within a nation leads to a reduction, then the elimination, of disparities in productivity growth and per capita income across regions. There is no need for development policies to encourage growth in underdeveloped or lagging regions because the system tends to achieve and maintain this equilibrium result on its own. In fact, government intervention is likely to do more harm than good, since the market, through the price mechanism, determines the most efficient allocation of resources. Thus, the reduction of allocative inefficiencies in the market (often assumed to be caused by existing government policies) constitutes the theory's key

policy recommendation. More complicated multi-sector neoclassical growth models yield less precise conclusions, with some even predicting that regional disparities may persist. Nevertheless, the potential harm from government action is generally regarded as likely to be greater than any benefit derived from trying to intervene in the workings of the market.

Despite the prominence of both supply and demand in any treatment of elementary economics, many development theories restrict their attention to only one side of the regional economy given the complexities associated with modelling both sides of the market. According to economic base theory, for example, changes in the demand for regional exports determine changes in local output (Chapter 3). Since no supply constraints exist that would limit production, increases in demand can presumably be met with concomitant increases in production. In contrast, neoclassical regional growth theory focuses exclusively on the role of supply as the fundamental determinant of changes in local labor market or metropolitan area output.[2] In essence, demand is assumed to be perfectly inelastic.[3] It is the growth in regional factor supplies and technological change that determine output growth. In fact, the basic neoclassical growth model implicitly invokes Say's Law: supply creates its own demand (McCombie 1988b).

It is useful to review national economic growth models originally developed in the 1940s and 1950s since neoclassical *regional* growth theory represents the "regionalization" of those national models. National-level neoclassical growth models focus on the economy's long-run *potential* growth path. At any given time, the actual level of production in a given economy may deviate from its potential level, where the latter represents a state of full employment. Because literally zero unemployment is never possible, potential output defined more precisely is the level of output that can be achieved at the lowest rate of unemployment consistent with no inflation.[4] Neoclassical growth theorists assume that short-term government stabilization measures (monetary and fiscal policy) maintain the economy at full employment. They then attempt to determine whether the economic system tends to grow at what is referred to as a steady-state, stable rate of growth. The simplest growth model suggests that the rate of long-run potential growth is determined by technological change and the natural rate of growth of the labor force.

The simplest neoclassical regional growth model, often referred to as the Solow model, incorporates the unique features of subnational geographic units. This means that while its basic framework and assumptions are identical to the national model, it accounts for the possibility that labor and capital will migrate between regions by assuming that both factors will seek locations offering the best returns. Workers will be attracted to high-wage regions, while capital will migrate to regions offering the highest rates of return. The model also assumes that the latest technology is available to all producers, regardless of location. This implies the instantaneous diffusion of productive innovations over geographic space; that is, once an innovation is developed, no barriers will prevent particular firms (perhaps located in outlying or rural areas, for example) from taking advantage of it.

The process of regional growth from the traditional neoclassical perspective may be described as follows. Assuming a constant returns production function, the level of capital stock, labor, and technology in the first time period determine, through the production function, the level of output in that same period. In turn, output growth is determined by the growth in factor supplies and technology. Since technology is assumed identical in all regions, differential rates of growth across regions in any given period may be due to differences in indigenous labor force growth and factor migration. In the long run, the system tends toward an equilibrium where productivity growth, wages, and the rates of return to capital are equalized across all regions. As in the national case, long-run growth is determined by growth in technology and the natural rate of increase of the labor force. (See Appendix 5.1 for more formal descriptions of simple neoclassical growth models.)

The findings with respect to regional disparities hinge on the migration assumption and the returns to scale assumption. Faster growing areas, for example, will not enjoy persistently higher wages than those in slow growth regions since their attendant higher rate of labor force growth will dampen wage rates. The dynamic also applies to returns to capital. At the same time, the rate of growth of output across regions may vary, depending on the natural increase of each region's labor force. Moreover, it is possible that some faster growing regions may have to import capital from slow-growth regions in order to equalize saving and investment. As a consequence, some regions may import capital, while others export it. Interregional capital flows will occur even though the rate of return everywhere tends to become equalized (Borts and Stein 1964; McCombie 1988a, 1988b). Figure 5.1 summarizes the determinants of the simple neoclassical regional growth model.[5] The automatic equilibrating mechanisms of the model imply that little need for government intervention exists in order to encourage regional growth in depressed places. Growth disparities in regional output will narrow over time and eventually converge. Productivity growth, and thus growth in regional wage rates, will be determined by the exogenous rate of technological progress. Once again, any interventions to accelerate this process will likely generate inefficiencies.

Thus far, the results are based on an assumption that the local economy is comprised of a single sector. This particular formulation is often referred to as "the naïve" model of neoclassical growth (Richardson 1978). Since neoclassical theorists themselves have extended the analysis to multiple sectors, this chapter's characterization of the one-sector model as the fundamental neoclassical approach is an oversimplification (Borts and Stein 1964, pp. 125–161). As soon as multiple sectors are introduced, the model admits the possibility that labor and capital flow in the same direction, perhaps leading to persistent disparities in growth rates between regions. This possibility re-opens the door for renewed speculation regarding whether certain cities and regions are able to out-compete other areas consistently, not to mention the fact that the model yields a much more varied array of implications for economic development practice. Depending on how the multi-sector model is specified, local practice that encourages the growth of the export sector may indeed lead to increases in regional growth. Alternatively, if the importance of

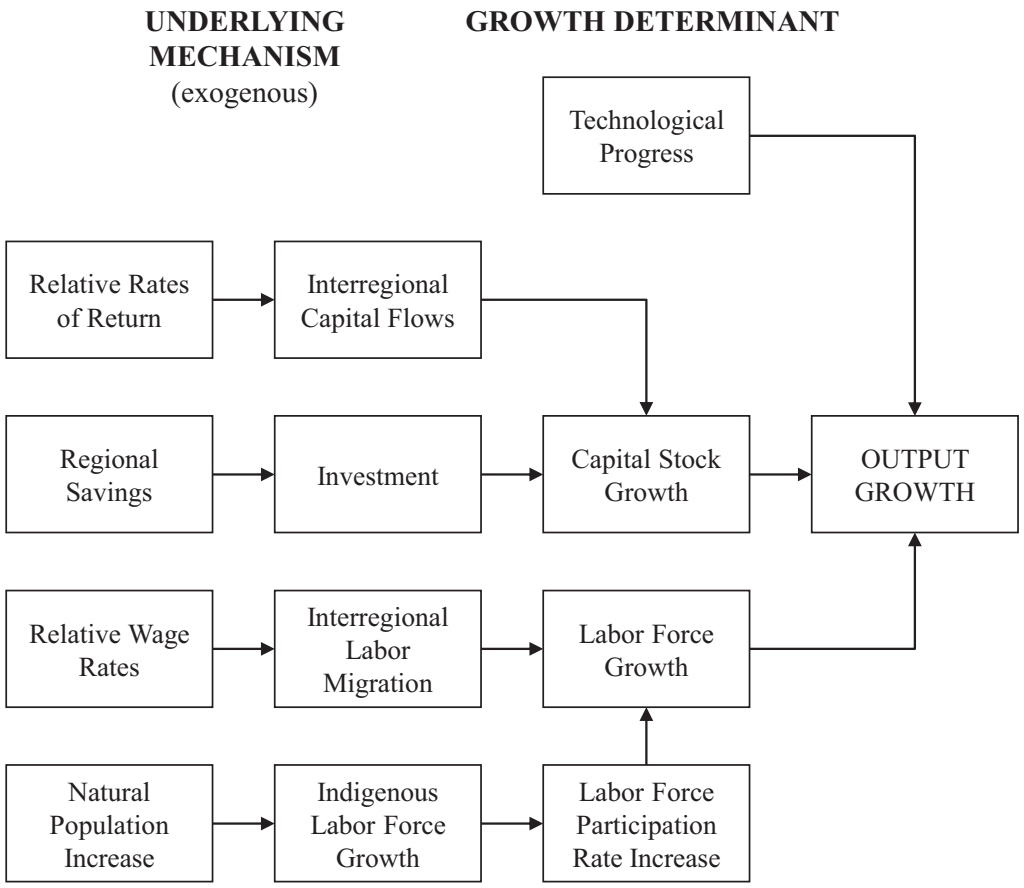

FIGURE 5.1 Determinants of regional growth

demand is assumed away, local policies designed to reduce the inefficient allocation of resources between sectors in a given region become more important.

The neoclassical growth model suggests that output growth in the near term is determined by growth in the capital-labor ratio. Investments in capital increase productivity. For example, with improved facilities incorporating the latest technology and additional and better machinery and equipment, the same number of workers can produce more and more commodities. If one assumes that the size of the labor force remains steady and that technology is constant, however, output growth cannot continue indefinitely because capital, like labor, is subject to diminishing returns. At some point, the additional increment of capital added to an existing workforce can yield no productivity improvement. Just as adding workers to a plant of a given size will eventually lead to overcrowding and a fall in productivity, capital can also, in effect, overcrowd the production process. At the same time, it is the prospect of achieving returns that induces investment in capital. Therefore, the neoclassical model implies that when the capital-labor ratio reaches the point where diminishing returns set in, investment will cease and growth will come to a halt. This is why ultimately exogenous technological progress and/or increases in the size of the labor force are needed to sustain long-run growth.

In the traditional neoclassical model, the factors driving long-run growth are therefore exogenous, or outside the model itself. *Endogenous* growth theory in neoclassical growth economics represents a revival of growth economics, an area of research that stagnated in the 1970s (Grossman 1996). One of the most important contributors is Romer (1986), who initially developed a model that demonstrated that long-run growth was possible even with no technological change and diminishing returns to capital. His innovation was to combine a neoclassical production function subject to constant returns with externalities or increasing social returns. Romer argued capital investments generate externalities, enabling all firms taken together to avoid diminishing returns. The externalities are termed spillovers and are related to the growth of knowledge (Romer's model) or human capital (Lucas 1988), important concepts that we address in later chapters.

Endogenous growth theory highlights the important role of increasing social returns with their spatial dimension (see, for example, Palivos and Wang 1996; Ioannides 1994). While most growth economists refer to spillovers as externalities that accompany economy-wide advances in knowledge and skills, there are good reasons to expect that some of these effects will be localized. In fact, local effects are quite consistent with the theories of cumulative causation (Chapter 6) and agglomeration economies (Chapter 9), a point Krugman has noted (1991a, 1997).

Lucas (1988), for example, has argued that the external effects of human capital or knowledge need to be specified more carefully to be useful for further theoretical and empirical work. Lucas' external effects of human capital, for example, have to do with influences economic actors have on the productivity of other actors. The scope of such effects depends on the "ways various groups of people interact" (p. 37). These effects could conceivably be regarded as either global in nature or purely local at the level of family or firm. But there is likely some middle (geographic) ground, since both individuals and firms typically interact at a larger social scale, such as the community or neighborhood, city, and industrial complex. The cost savings and enhancements in productivity that a firm gains by locating in proximity to other firms in certain cities and regions become a source of long-run growth for those places. Endogenous growth theory suggests that if we want to understand why some cities and regions grow while others stagnate or fall behind, we need to look closely at the nature of these external benefits—the ways they are encouraged *and* the ways they are inhibited.

Post-Keynesian regional growth theories

In contrast to neoclassical regional growth theory, post-Keynesian models of regional growth emphasize the disequilibrium nature of the growth process, the dependence of local fortunes on the strength of effective demand for regional exports, and the tendency for growth trends to become cumulative either in the positive or negative direction. McCombie (1988a, 1988b) provides a useful synthesis of the theory along with a comparison to the neoclassical approach.[6] Most importantly, the post-Keynesian approach does not ascribe to the view that markets

are generally equilibrating. The theory allows a much broader scope for government intervention.

McCombie (1988b) argues that the post-Keynesian perspective "provides a unifying theoretical basis for the export-base (or export-led growth) theory (Chapter 3) and the cumulative causation and polarization theories of Myrdal (1957) and Hirschman (1958) (Chapter 6)" (p. 400). This outcome is achieved because the theory asserts the primacy of the export sector, and the tendency for regional growth in output to lead to an increase in productivity through internal and external returns to scale. Recall that traditional neoclassical models assume constant returns to scale.

Figure 5.2 offers a simplified view of the regional growth process according to the post-Keynesian view. Output growth generated by producers in a given location drives increases in productivity through returns to scale. Improvements in productivity make the export sector of region more price competitive vis-á-vis producers in other locations. Price competitiveness stimulates growth in exports as consumers elsewhere buy more of the region's goods and services. Finally, purchases of regional exports generate further growth in regional output through a multiplier effect (McCombie 1988b).

The linkage between output growth and productivity growth is termed the Verdoorn effect. Growth of the region's production stimulates an influx of both migrating workers and investment; the growth of productive factors is not the cause but the consequence of output growth. The process can result in either cumulative advance or cumulative decline. It may be viewed as a formalization of Myrdal's (1957) notion of cumulative causation (Chapter 6).

The question for the local economic developer is how to stimulate output growth through increases in exports. That is, how can the performance of the export sector be improved? A number of factors are important, including prices,

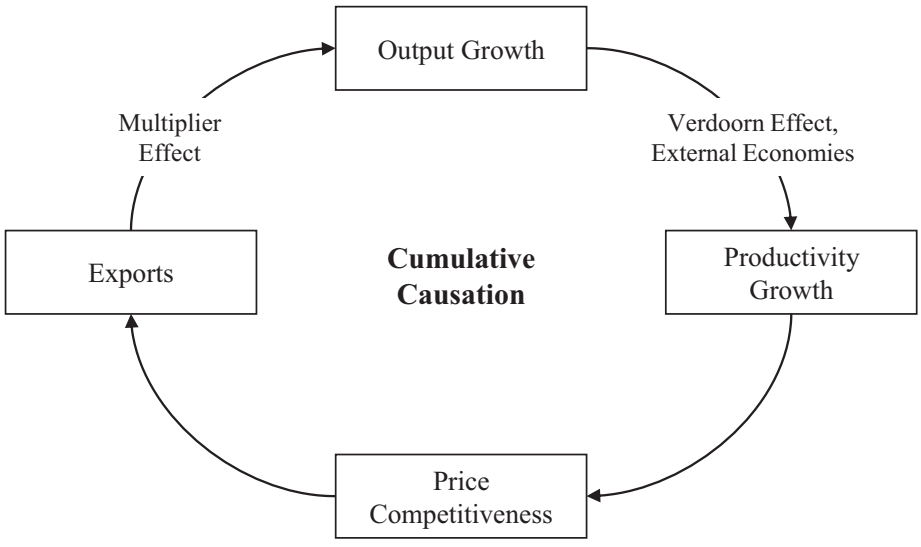

FIGURE 5.2 Simplified post-keynesian regional growth model

non-price aspects of competition, the income elasticity of demand for the region's exports, and the region's income elasticity of demand for imports (Thirlwall 1979, 1980; McCombie 1988b). To the degree that prices are set at the national level, the region's industry structure (e.g., the concentration of economic activity in industries producing income elastic goods) and factors such as product quality and service will determine its export prospects. The potential for some regions to gain a sustainable competitive lead in the production of some goods through increasing returns, externalities, and agglomeration economies means that other regions may fall progressively farther behind or at least face below-average rates of growth for sustained periods. In fact, post-Keynesians would argue that in a world of increasing returns, the tendency of some regions to lag behind others is the rule rather than the exception. Can market integration of lagging regions generate improvements that outweigh positive feedback mechanisms, benefiting growing regions, especially innovative ones?

Applications

Early neoclassical growth theory suggests that economic developers should do what is necessary to support the efficient allocation of resources and the operation of the price mechanism. For example, they might attempt to reduce aggregate inefficiencies in the economy by helping inefficient companies find more profitable locations or by encouraging unemployed workers to relocate, essentially two ways to assist with the economic adjustment process. Such assistance should take the form of information provision to companies and workers rather than direct financial or in-kind support. Many economic developers would not be comfortable with such a restrictive role. Modifications and extensions of this simple model, however, open up numerous avenues for intervention. For example, strategies for workforce training, industry networks, and expanding existing industries could become relevant.

Applications of neoclassical growth theory have been much more common in developing countries, where the monetary economy and market mechanisms are much weaker than in the United States and Canada. Many U.S. and Canadian regions are parts of industrial areas that are functioning as integral elements in an increasingly sophisticated and open global economy. Given this level of integration, proper application of neoclassical growth theory suggests that economic developers should rely heavily on market mechanisms and information flows rather than on various forms of government intervention. Indeed, developers should focus on activities that are consistent with traditional local government functions. Even in the competitive market economy, public goods and services must be collectively produced and financed. The objective would be to provide needed public goods and services as efficiently as possible, thereby minimizing the local tax burden on companies and workers. This efficient-government strategy would have another benefit in that it would potentially increase the amount of business and personal saving that is locally available. Greater local saving could lead to more local investment as long as competitive returns were available in the region. Although

economic developers are generally not interested in functioning as city/county managers, they need to forge good working relationships with them because of the value of sound public sector management.

Another application consistent with neoclassical growth theory would involve the analysis of existing forms of government intervention in business activities. Clearly, the widespread use of financial incentives would be soundly criticized as distorting market forces. More generally, economic developers could try to determine which economic development activities underway are really needed and which of these activities could be better handled by the private sector. Furthermore, the costs of intervention should be less than the benefits sought. Although surely to be unpopular with traditional economic developers, the elimination of some common but unnecessary economic development practices may improve the allocation of what are usually quite scarce local resources.

The post-Keynesian perspective makes a strong case for a national-level regional policy. Development incentives and infrastructure investments to lagging regions may help reverse a process of cumulative decline. Industry cluster strategies, to the degree that they are able to leverage increasing returns and externalities in slow-growth areas, may help reduce regional growth disparities as well. The problem with these applications, however, is that, like the growth center strategies of the early 1960s and 1970s (Chapter 6), they tend to be successful only where there is already a critical mass of economic activity. Developers might rather focus on improving the non-price competitiveness of local producers (both manufacturers and non-manufacturers) through technical assistance, technology diffusion, training, and so on. Endogenous growth theory suggests a role for economic developers in this regard, as a means of leveraging externalities and spillovers. Endogenous growth theory, with its focus on knowledge spillovers and human capital, also highlights the critical importance of quality educational institutions from primary and secondary schools through the level of research universities.

Elaboration

The traditional one-sector regional growth model has been subject to considerable scrutiny. The focus has been on four general problems embodied in its simplistic assumptions: (1) that the interregional reallocation of capital and labor depends solely upon factor price differentials; (2) that it is wage rigidity, rather than demand deficiency, that explains persistent regional unemployment; (3) that technological progress (product and process innovations) is instantaneously available everywhere; and (4) that the assumption of constant returns is a reasonable approximation of actual industrial conditions for theory-building purposes. A more detailed review of each criticism is useful for better understanding the nuances of the original model, revisions in the form of multi-sector models and theories of endogenous growth, and the ways in which the post-Keynesian perspective differs from the neoclassical one. For example, a consideration of the assumption of wage rigidity helps clarify some of the fundamental differences between the neoclassical and

post-Keynesian view of persistent unemployment problems, while the issue of constant-versus-increasing returns demonstrates how the emphasis on formal modeling in neoclassical economics may lead to the neglect of important topics. As the basic but highly flexible neoclassical model is modified, its implications regarding the growth process seriously challenge the prediction of regional convergence in growth rates and the associated call for minimal government intervention.

Technology diffusion

Related to the cumulative effects of economic growth in faster-growth regions is the notion that technological progress does not diffuse instantaneously across space. Technological advances would be expected to be made in more prosperous regions that possess the necessary agglomeration economies (Chapter 9) to permit significant investments in research and development. Thus, technological progress could enhance the competitiveness of faster growth regions vis-á-vis lagging or underdeveloped areas. In any case, all regions would not be expected to have equal access to the same technology both due to the friction of distance and due to institutional restrictions (such as patent laws, industrial secrecy, etc.). Clearly, the neoclassical assumption that technology is equally available everywhere is tenuous. Empirical research has partially confirmed that innovations are not adopted instantaneously and tend to diffuse through distinct routes, such as through the urban hierarchy or across buyer-supplier networks.[7] However, the more integrated the national space economy, the less important delayed technology diffusion should be as a source of differential regional growth.

Technology diffusion could be viewed as a case of market failure in the sense that regions do not possess perfect information on all available production techniques (McCombie 1988a). As market integration continues and information flows improve, backward areas should catch up to higher growth areas; the market mechanism should still lead to an equilibrium with convergence of regional growth rates. As is often the case, the neoclassical model is flexible enough to account for differences in technology diffusion.

A substantial literature has developed that relaxes the assumption of the basic neoclassical model that the level and growth rate of productivity is the same in all regions. This literature refers to the portion of output unaccounted by capital as total factor productivity (TFP), generally interpreted as technological progress. Alternatively, TFP is also explained as the intensity with which the factors of production can be used. TFP may become more important as talent-intensive services grow in more developed economies.

The contributions in the literature stress the importance of productivity in studying regional differences in levels and growth rates of output. Klenow and Rodriguez-Clare (1997), for example, argue that technology adoption and diffusion can have significant impacts on growth rates without requiring large differences in returns to capital. Specifically, they show that large differences in TFP result from slow technology diffusion from advanced regions to other regions.

Prescott (1998), in an evaluation across countries, finds that differences in factor endowments, in capital per worker, and in savings rates do not sufficiently account for the observed differences in income. He concludes that TFP is the driving factor behind labor productivity. Romer (1990) developed a framework that attempted to pin down the key factors behind the growth in technology. In his model, he specifically focuses on the role of human capital in spurring research and development (R&D), whereby increased innovative activity in turn increases TFP.

If technology diffusion is indeed an important source of regional growth, the implications for economic developers are unclear. Developers might attempt to improve the availability of information regarding new innovations to local firms as well as encourage research and development activities at home. Applicable strategies could include industrial extension, modernization programs, and the establishment of university-business linkages. Research suggests, however, that firms do not necessarily adopt new practices as they become available even if they know about them.[8]

Interregional factor reallocation

Increases in productivity are possible in the neoclassical model if an initial state of disequilibrium is assumed. If factors are allocated inefficiently (reflected in regional differences in rates of return), a possible source of productivity increases is the reallocation of factors between regions (McCombie 1988a). The neoclassical model predicts that labor will migrate to high-wage regions while capital will move where it can obtain the highest rate of return. Thus, a testable implication is that capital, wages, and the capital-labor ratio will grow fastest in low-wage regions, implying that the equilibrating tendencies predicted by the model may actually be at work. A seminal test of these hypotheses by Borts and Stein (1964) led to the rejection of the validity of the simple one-sector model based on compelling evidence that the fastest growth of capital and the capital-labor ratio has occurred in *high-wage* regions.[9]

One explanation for the model's poor performance may lie in the assumption of a single sector. Armstrong and Taylor (1985, pp. 59–63) posed a two-sector model of regional growth in which the domestic sector produces for local consumption, whereas the export sector responds to external demand. An increase in demand for the region's exports in their model will raise the price of those exports, and thereby the marginal revenue products of capital and labor. This, in turn, generates interregional and inter-sectoral differentials in wages and returns. Capital and labor migration *into* the region, as well as the inter-sectoral reallocation of labor and capital, will eventually reduce return differentials. Meanwhile, increases in regional income stimulate demand for the region's domestic product as well. The clear implication of their model is that regions exporting products for which demand exogenously increases will experience net inflows of labor and capital as well as regional growth.

The neoclassical theory's exclusive focus on differential factor prices as the determinant of migration is also questionable. Although investment capital may

flow easily around the globe, labor migration is far more difficult and costly. Highly unlikely assumptions include costless factor migration, reflecting the absence of barriers to migration, the possession of perfect information regarding factor returns in alternative locations, and perfectly flexible factor prices. Migrating workers incur both pecuniary and psychic costs from the transport and/or sale of assets (their homes). Furthermore, while investment capital may be safely regarded as highly mobile, existing firms that have their plant, equipment, and trained labor force in a fixed location are not (Armstrong and Taylor 1978). Even in an age of advanced information technology, the assumption of perfect information is unrealistic. Moreover, firms would incur added costs (as would workers) even if they attempted to calculate factor returns in every possible location.

Nevertheless, the one-sector model is not entirely without empirical support. The model is reasonably successful in explaining the variation in growth rates across states; capital and labor are shown to respond more to differential factor returns than employment opportunities, although the latter is still a statistically significant determinant.[10] Dynamic simulations of the model indicate a tendency toward convergence of regional growth rates of output and productivity, as predicted by the theory. However, it is noteworthy that a demand-oriented model has been proven to have more explanatory power in a test using the same dataset.[11] In a study of Indonesian regions, researchers applying growth theory found that the influence of quantity effects (the employment opportunity specification) is such that regional growth *diverges* in simulations over time (Giarratani and Soeroso 1985). This is because the growth-induced employment opportunities are stronger in the growing regions of Indonesia, creating a positive feedback mechanism that overpowers the equilibrating tendencies of factor flows assumed in neoclassical theory.[12]

In addition to regional differences in factor allocation, the literature has devoted significant attention to factor reallocation across sectors. Specifically, Restuccia and Rogerson (2008) show that while the optimal allocation will maximize welfare, misallocation of these inputs would result in lower levels of output and would manifest as a lower level of TFP. Misallocation can take two main forms. First, the wrong amount of input could be used. Second, the input available may not be appropriate. In the context of capital, misallocation would result in low aggregate output per worker as well as low aggregate TFP. In the context of labor, misallocation would suggest that people are employed in the "wrong" sector. In other words, high-productivity workers may be stuck working in low-productivity sectors. Hsieh and Klenow (2009) show that aggregate manufacturing output could increase by 30 percent–50 percent in China and by 40 percent–60 percent in India if capital and labor were reallocated to equalize marginal products.

Regional unemployment

Another source of criticism of the neoclassical regional growth model, and neoclassical economics in general, is the neglect of possible demand deficiencies as a cause of unemployment. Since the neoclassical model assumes that factor prices are

sufficiently flexible to keep capital and labor fully employed, involuntary regional unemployment is technically impossible. This approach is not particularly helpful in the regional context since persistent unemployment problems are frequently the primary concern of economic development practice. In the neoclassical world, regional unemployment can result from wage rigidities, perhaps caused or exacerbated by collective bargaining agreements, minimum wage legislation, and high unemployment benefits (McCombie 1988b). The implication is that, to lower unemployment, wages must be reduced through subsidies, limitations on trade union activity, or the elimination of its benefits.

McCombie (1988b) provides a useful analysis of the relationship between unemployment and real wages from both the neoclassical and post-Keynesian perspectives. Consider a cut in the real wage in order to restore a full employment equilibrium (the neoclassical prescription in a condition of high unemployment). Firms presumably employ more workers to produce additional output, which brings labor demand and supply back into balance but with a smaller labor force.[13] Instead imagine that the wage cut induces a reduction in consumption and, therefore, demand. Because workers have less money with which to purchase goods, firms reduce production below capacity, laying off workers in the process. Multiplier effects would come into play, further reducing production and employment. According to McCombie (1988b):

> If a fall in the real wage is associated with a decline in demand and the utilization rate of the capital stock falls, then it is possible that the level of employment will also actually fall.
>
> *(p. 401)*

The actual outcome depends on interregional effects, since exports may offset internal contractions in demand, and wage cuts may influence migration as well as wage-setting policies in other regions. In any case, the demand-side focus of the post-Keynesian approach raises important considerations.

Increasing returns and methodology

As noted earlier, one critical difference between traditional neoclassical growth theory and both endogenous growth theory and post-Keynesian theories is the returns to scale assumption. The assertion in early neoclassical models of constant returns in production, which arguably bears very little relation to the real world, is sometimes used as a reason to entirely discount such theories as simplistic, naive, and invalid. After all, simple observation would suggest that there are benefits to large size; firms clearly seek efficiencies through scale, as the popularity of expansions, mergers, and acquisitions in industry plainly testifies.[14] It turns out that the returns-to-scale assumption is a critical driver of the model's results, particularly from a spatial or regional perspective. Constant returns in the basic model suggest a gradual lessening of regional income disparities, whereas increasing returns

and associated externalities in post-Keynesian and endogenous growth models can imply polarized regional development, with some communities developing rapidly and others falling behind. The different implications for regional policy, particularly depending on one's view of distributional equity and the importance of place, are significant. Yet it would be incorrect and much less instructive to interpret the early treatment of returns to scale in regional analysis as a story of naive but technically skilled neoclassical economists pitted against gritty and realistic post-Keynesians and cumulative causation theorists. Instead, it is a story of how differences in methodological approach drive model building and the advancement in our understanding of the dynamics of regional growth and change.

Krugman (1997) makes this point clearly in his brief study of spatial analysis (or lack thereof) in mainstream economics.[15] Until recently, economists lacked the technical tools needed to model increasing returns in ways that were both tractable and insightful. This problem affected the neoclassical coverage of geographical questions in general; indeed, neoclassical economists focused on the questions they could address within the corpus (and with the mathematical tools) of microeconomic theory, neglecting location theory not because it was regarded as unimportant but because it could not be handled in a satisfactory way under the prevailing methodology. For similar reasons, "high development theory" (or the study of international development) also stagnated after its heyday in the 1940s and early 1950s. As Krugman notes:

> [T]he basic problem was neither one of ignorance nor of bias. Economists did not abandon the insights of development economics because they had forgotten about the subject; they did not ignore the ideas of geographers because to acknowledge space would somehow conflict with free market prejudices. No, these fields were left untilled because the terrain was seen as unsuitable for the tools at hand.
>
> *(p. 67)*

Endogenous growth models are possible because of improvements in mathematical tools. As a result, increasing returns have become a serious subject of neoclassical growth analysis simply because it is now possible to model them rigorously. And for the mainstream economist, the benefits of formal reasoning through expression in mathematics, such that the precepts and implications of theory can be presented in stark relief, outweigh the costs of neglecting phenomena that fall outside the purview of existing methodological techniques.

As a basis for the understanding of regional growth and change, new endogenous growth theories were further articulated and applied in various regional contexts (Capello and Nijkamp 2009). Together with the continued formalization of post-Keynesian ideas, regional growth theory improved in realism, but the empirical evidence remained mixed (Capolupo 2008). Furthermore, the complexity of the models made it much more difficult to generate clear policy insights (Maier and Trippl 2008). At least in the U.S. context, regional disparities have increased over

time (Moretti 2012; Florida 2017).[16] As regional inequality increases, it becomes increasingly important to understand how to counteract this trend effectively.

Discussion questions

1 Telecommunications technologies may increase the diffusion of innovations over space. Will the economic prospects of smaller metropolitan areas improve or decline with improvements in telecommunications technologies from the perspective of neoclassical growth theory?
2 Do post- Keynesian growth theories that are primarily concerned with the adequacy of effective demand seem applicable in your region?
3 How might concepts of sustainable development be incorporated into neoclassical and post-Keynesian growth models? Hint: Why are environmental impacts of development often ignored by firms?
4 Regional theorists are often concerned with reducing interregional disparities in income by promoting growth in lagging regions. Which arguments from growth theory support this concern? What are the costs and benefits of encouraging labor mobility from depressed to growing regions?
5 Assume that a region with a traditionally strong economy is hit by an economic shock in the form of several major and concurrent plant closures that result in a considerable number of lay-offs. According to traditional neoclassical growth theories, what adjustments are necessary for the system to return to a low unemployment equilibrium?
6 What kinds of costs might be associated with the economic adjustment process postulated in the previous question? Which costs might have longer-lasting effects on the future growth trajectory of the region?
7 The neoclassical perspective suggests that economic developers should be concerned with the efficient allocation of productive resources in their communities. What role should economic developers take in influencing the distribution of these resources?

APPENDIX 5.1

The simple neoclassical growth model[17]

An economy in which all variables are changing at a constant proportional rate, for example, 2 percent every year, is experiencing *steady-state* growth. An equilibrium is *stable* if, once the system is disturbed through some type of economic shock (e.g., the Great Recession), natural forces tend to bring the system back into equilibrium. The notion of stable growth requires a balance between two opposing feedback mechanisms. Positive feedback means that the system diverges from some initial state. Growth is usually a positive-feedback process. Negative feedback means that the system regains equilibrium after an equilibrium state is disturbed. Stable growth combines the two feedback mechanisms. Positive feedback (growth) moves the system farther and farther from its initial state, but negative feedback keeps the system on track.[18]

Neoclassical models predicting steady-state growth would be in general accord with observed economic phenomena. Data on the historical growth experience of the major industrial economies show that key economic variables (capital stock, labor, and output) tend to grow at constant proportional rates. Thus, growth theorists try to explain empirically steady-state growth and related phenomena.[19] The original developers of the theory, led by Solow (1956), were also interested in carefully examining the results of an earlier class of growth models that suggested that steady-state full-employment growth would probably *not* occur as a normal state of affairs.[20] This conclusion challenged the neoclassical position that the market mechanism is the certain route to full-employment growth.

The following are the specific assumptions and postulates of the simple one-sector neoclassical growth model:[21]

1 There is a single good (thus an economy with a single sector, say manufacturing) whose production may be characterized by a function that relates output to factor input supplies (capital and labor, for example) and technology:

$$Y = A_t F \quad K_t, L_t \tag{5.1}$$

where Y, K, and L denote output, capital, and labor, respectively, and t subscript indexes time. A_t represents technological change. Generally, a Cobb-Douglas production function is assumed as the specific form of the general production relation. In what follows, we eliminate the time subscript in order to simplify the notation.

$$Y = AK^{\alpha}L^{1-\alpha} \tag{5.2}$$

where α and $1 - \alpha$ represent the contribution of capital and labor to aggregate output or, more specifically, the output elasticities and relative factor income shares.

2 The production function 5.1 is characterized by constant returns to scale (i.e., a doubling of inputs leads to an exact doubling of output).

3 Technology and labor grow at exogenous, constant proportional rates δ and n, respectively, which puts both variables outside the scope of the model. For our purposes, technology growth may be viewed as the general advance of knowledge. At the national level, ignoring immigration and emigration, labor force growth is determined by natural population increase.

4 What is saved is, by definition, invested and, therefore, no separate investment function is needed. This is expressed by the following identity:

$$S \equiv I \tag{5.3}$$

where S and I denote savings and investment, respectively.

5 Saving is a constant (exogenously determined) proportion of output:

$$S = sY \quad 0 < s < 1 \tag{5.4}$$

where s is referred to as the average propensity to save, the share of output in a given period that constitutes savings. The growth of capital is simply the increment in new capital acquired by firms due to investment ($I = S$) divided by the existing level of capital (K):

$$\frac{Change\ Capital}{Initial\ Level\ of\ Captial} = \frac{I}{K} = \Delta K \tag{5.5}$$

The delta to the left of any variable is a simplified means of denoting a growth rate; thus ΔK is the growth rate of capital.

Manipulating the model outlined earlier yields the expression in (5.6), denoting the growth rate of output as a function of growth in factor supplies and exogenously determined technology:

$$\Delta Y = \delta + \alpha\Delta K + \ 1-\alpha \ \ n \tag{5.6}$$

where, ΔY and ΔK denote the *growth rates* of output and capital, respectively; n is the rate at which the labor force is assumed to grow; α and $(1 - \alpha)$ are the

elasticities of output with respect to capital and labor, respectively; and δ is the exogenous rate of technological change. Equation 5.6 simply states that the rate of growth in output is due to increases in the growth rates of the labor force, capital stock, and technological change.

A variable of critical interest is labor productivity, or output per worker. Labor productivity may be expressed as $(\Delta Y - n)$ or the growth in output less the growth in the labor force. To identify what determines the growth in output worker, we can rewrite equation 5.6 in the following terms:

$$\Delta Y = \delta + \alpha \Delta K + n - \alpha n \tag{5.7}$$

$$\Delta Y - n = \delta + \alpha(\Delta K - n) \tag{5.8}$$

Equation 5.8 indicates that labor productivity growth occurs either through technological change, δ, which by definition is determined outside of the model, or through the growth of the capital stock *in excess* of the rate of expansion of the labor force. When capital stock grows faster than the labor force, the ratio of capital to labor naturally increases (more machinery per worker). This process is referred to as "capital deepening."

To this point, we have simply explored the implications of the simple model. As already noted, early neoclassical theorists were primarily interested in the existence and stability of a steady-state growth equilibrium, whereby national output grows at a constant, proportional rate. Actually, this neoclassical model describes an economic system that tends toward equilibrium steady-state growth. Although the demonstration of this point is complicated, the important point is that the model implies that output growth in a state of equilibrium is determined solely by technological change and the rate of growth of the labor force. This is expressed as the following:

$$\Delta Y = \Delta K = \frac{\delta}{1 - \alpha} + n \tag{5.9}$$

The model is stable in that any shock that drives the economy away from the equilibrium will only be temporary; the economy will return to the steady-state equilibrium. Moving n to the left side of Equation 6.8 also shows that, in steady-state growth, increases in productivity (output per worker) are determined by technological change alone:

$$\Delta Y - n = \frac{\delta}{1 - \alpha} \tag{5.10}$$

The national model must be specified in greater detail in order to render it useful for analyzing regional economic change. In a system of cities or regions, increases in regional capital and labor supplies are a function of indigenous local growth as well as migration between regions. One could assume that all regions save an identical portion of income in each period, although regional variations probably exist. In addition, production technologies and the rate of new technology utilization

may or may not be assumed to be identical across regions. Finally, it is possible to deviate (both at the national and regional level of analysis) from the assumptions of a single good and constant returns to scale production functions. Indeed, in the case of regional growth, the two-sector model yields important contrasting implications for the relative growth rates across regions, as do models that incorporate the notion of agglomeration economies through production functions that exhibit increasing returns to scale.

The following are the basic assumptions of the simplest, one sector model of regional growth:

1 Production in each region may be described by the same constant returns to scale production function.
2 While saving in each period S_i varies across regions (regions are denoted by the subscript i) the propensity to save ($s = S_i / Y_i$) is identical everywhere.
3 The rate of technical progress, δ, is the same in all regions. No differences in technology diffusion exist.
4 In the national model, capital and labor growth were determined by s/v and n, respectively, where

$$\Delta K = \frac{I}{K} = \frac{S/Y}{K/Y} = \frac{s}{v} \tag{5.11}$$

and where $v \quad \frac{K}{Y}$.

In the case of regions, there is the additional influence of migration to consider:

$$\Delta K = \frac{s}{v_i} + \quad _j \; c_{ji}, n_i = l_i + \quad _j \; m_{ji} \tag{5.12}$$

where c_{ji} is the annual net capital flow from region j to i divided by the capital stock in region i (the rate of change of net capital flow), m_{ji} is the net migration of workers from j to i divided by region i's labor force (the rate of change in labor due to net migration), and l_i is the rate of growth of the local labor supply.

The amounts of capital and labor are determined solely by regional differences in wage rates and the rates of return to capital. The model does not allow for the possible costs capital and labor may incur in the process of migration. Rather, it embodies the typical neoclassical assumption that economic adjustments will occur with no friction of distance. Regional output and productivity growth in equilibrium are analogous to the national case.

Equilibrium growth in the neoclassical model

By definition, the economy is said to be in a *steady-state* equilibrium if output is growing at a constant, proportional rate (e.g., 3 percent per year). This requires that the rate of growth of capital equal the rate of growth of output. The critical issue

from the neoclassical perspective is whether the economy *tends to* a steady-state growth path. In fact, the model described previously suggests that it does. Return to Equation 5.6, and replace Δ with sY/K:

$$\Delta Y = \delta + \alpha s\frac{Y}{K} + \ 1-\alpha \ \ n \tag{5.13}$$

Now consider the case where the change in savings sY/K (and thus the rate of growth of capital) exceeds the values necessary to ensure steady-state growth. Since s is constant, K/Y must be below the value required for equilibrium growth. This ratio will adjust automatically to return the system to equilibrium because, by Equation 5.13, the rate of growth of capital must be greater than the growth rate of output. Therefore, since the capital stock is growing faster than output, the capital-output ratio must rise to the equilibrium level. A similar argument may be made to show how the capital-output ratio will fall to restore the system to equilibrium if full-employment savings and investment are below the amount required in a condition of steady-state growth.

Notes

1 As the generally unrealistic assumptions of the neoclassical model are relaxed, the models better reflect observed empirical trends. Some view neoclassical theory as providing a picture of how regional economies should operate, whereas post-Keynesian models are more consistent with reality (Chisholm 1990).
2 Chisholm (1990) notes that the reputation of neoclassical theory as a supply- side approach has fostered the notion that it provides an adequate description of supply-side issues. In fact, neoclassical growth theory neglects some important aspects of supply. This criticism may also be applied to economic base theory. An exclusive focus on demand does not necessarily demonstrate its satisfactory treatment.
3 Price elasticity describes how changes in quantity respond to changes in price. Perfectly inelastic supply means that the quantity of supply is fixed for the range of relevant prices.
4 This is referred to as the nonaccelerating inflation rate of unemployment (NAIRU).
5 Figure 5.1 is adapted from Figure 3.3 in Armstrong and Taylor (1985, p. 57).
6 McCombie adopts the term "post-Keynesian" to distinguish the perspective from the "Keynesian-neoclassical synthesis," which, according to Dome (1994), is "the synthesis between Keynes' *General Theory* and neoclassical economics; between macroeconomics and microeconomics; and between a fiscal and monetary policy and laissez faire" (p. 245). An example of the Keynesian-neoclassical synthesis is the neoclassical regional growth theory, outlined earlier, with its acceptance of the possible need for demand management strategies in the short run to maintain full employment but the belief that price adjustments would work in the long run to eliminate regional income and productivity growth differentials. Pinning down terminology is less critical than understanding the fundamental differences between perspectives.
7 See Berry (1972) and Thwaites and Oakey (1985). McCombie (1988a) provides a useful brief review of the innovation diffusion literature.
8 Salter (1966) showed that in some cases rational profit-maximizing firms may not adopt best-practice technology immediately.
9 This was true overall for the study period 1919–1957. Borts and Stein did find that the growth of capital was fastest in low-wage areas between the more limited time period of 1929–1948.

10 Ghali et al. (1978) estimated a simple neoclassical model of state output growth differentials between 1963 and 1973. They specified capital and labor growth as dependent upon lagged factor returns and employment opportunities, with the latter proxied by regional differentials in output growth. The lagged specification was meant to account for imperfect information flows.

11 Ghali et al. (1981) develop a recursive model that includes aggregate supply variables, aggregate demand variables, and factor mobility. They test two versions, with supply or demand factors functioning as the adjustment mechanism: interregional factor mobility is the adjustment mechanism for the supply-side formulation, while change in net exports is the demand-side mechanism. Interestingly, the model generates very similar growth rates under a 20-year simulation regardless of whether the demand-side or supply-side mechanism is used. This suggests that growth models that stress either supply or demand factors may be as useful as more comprehensive models in simulating growth or testing the impacts of public policies.

12 Although Ghali et al.'s (1981) attempt to broaden the explanation of factor migration represents an improvement over the simplest neoclassical specification, one could persuasively argue that an entirely different approach is needed. The human capital explanation of labor migration is one such alternative (Greenwood 1975). Indeed, the influences on migration are probably of significant enough complexity to warrant careful separate analysis rather than the somewhat trivial incorporation into an already simplified growth model.

13 This outcome requires further explanation. With demand and supply schedules based on neoclassical assumptions, wages could be "artificially" high. At this wage, the demand for workers is less than the available supply, whereas the supply of workers is greater than the quantity in demand. Unemployment occurs because workers are seeking employment at that higher wage, but jobs are not available. When the wage level drops to its "equilibrium" level, demand increases, and some formerly unemployed workers are hired. Unemployment is lower as a result. However, the remaining unemployed workers withdraw from the labor force presumably because they prefer not to work at the lower equilibrium wage. Thus, the fully employed labor force is smaller. Full employment is achieved at the cost of having fewer potential workers seeking work and therefore lowering the labor force participation rate.

    Some readers may question this neoclassical argument given the strong divergence between rising labor productivity and lagging wages in the United States since the late 1970s. With greater bargaining power, labor could have higher wages and more employment opportunities.

14 Flexible production theories highlight the benefits of smaller-scale production and increased outsourcing (Chapter 8). Also see Harrison (1994) for an insightful analysis of corporate flexibility, firm size, and regional growth and change.

15 Paul Krugman has argued for the better treatment of spatial questions in the main body of economic theory. For a summary of Krugman's work in economic geography, see Martin and Sunley (1996). For a view of the significance of his work for economic development and regional science, see Isserman (1996).

16 Regional disparities have been attributed to historical differences and path dependence. See Marti-Henneberg and Tirado-Fabregat (2018) and the discussion in Chapter 10.

17 This section draws on the Hamberg's (1971) mathematical analysis of neoclassical growth. See his Chapter 2.

18 Jones (1975, pp. 12–42) provides an elementary review of many of the basic growth theory concepts.

19 The economic regularities that growth models attempt to explain are referred to as the stylized facts of growth. See Branson (1989, pp. 564–568).

20 These are the Harrod-Domar models (Harrod 1939; Domar 1946, 1947); Higgins and Savoie (1995, pp. 76–84) provide a review.

21 The model also assumes perfectly flexible factor prices (thus full employment of capital and labor), factor substitutability, and diminishing returns to capital and labor.

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6

THEORIES OF SPATIAL CONCENTRATION AND DIFFUSION

Theories of spatial concentration and diffusion examine economic growth as a process that involves changing industrial structure and spatial structure, both between and within labor market areas. The theories portray the economic growth process as more complex and dynamic than economic base or neoclassical growth theories. They provide a conceptual bridge from early regional theories developed before 1950 to more contemporary regional theories. Francois Perroux's (1950a) theory of growth poles, Albert Hirschman's (1958) notion of unbalanced growth, Gunnar Myrdal's (1957) theory of cumulative causation, John Friedmann's (1972) core-periphery model, and Raymond Vernon's (1966) product cycle theory are the best known of these theories. They are closely related even though they were developed in different contexts or were intended to address very different development challenges. The common focus is to determine whether or not regional disparities in the level of growth and development are likely to remain persistent or even worsen in the absence of public intervention.

One important application of the theories is *growth center policy*, which suggests that industrial growth can be diffused to backward regions by concentrating infrastructure investments and direct business investments to selected locations that possess growth potential.[1] Investments in these designated growth centers are used to create spatial industrial complexes from industries that are technologically linked in buyer-supplier relationships. (See the discussion of input-output analysis in Appendix 3.2.) Unfortunately, despite the popularity of spatial concentration theories among regional development planners, growth center applications have frequently failed. As we will discuss in more detail, these failures are due to both weak theory and its misapplication.

In general, all five theories move us from strategies focused on a few sectors, factors, or products to strategies concerned with detailed economic structure, the interaction between structure and growth, and the spread of growth across space.

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Although the theories discussed here emphasize the concentration or polarization of growth in particular regions during some stage in a development process, they offer different explanations about how the pattern of economic growth will evolve across regions in the long term. Conceptions of regional growth diffusion range from Myrdal's hypothesis of persistent regional disparities to Hirschman's belief in strong trickle-down effects that gradually eliminate disparities.

Product cycle theory is useful because it moves us from a world of *given* commodities and factors of production to a world of *changing* production and trade relationships. In product cycle theory, product development becomes the driving economic force which emphasizes the dynamism of the growth process, like Perroux's growth poles, but with more clarity and specificity. Like entrepreneurship theories, the essential dynamic behind product development is the creation and development of new products.[2]

Spatial concentration theories

This section covers the theory of growth poles, unbalanced growth theory, cumulative causation theories, the core-periphery model, and product cycle theory.

Growth poles: Perroux's pure theory

The term "growth pole" is most commonly associated with Perroux's (1950a, 1950b) hypothesis that growth impulses emanate from particularly powerful actors, such as large firms, which operate in an abstractly conceived economic space. Using concepts derived from physics and mathematics, Perroux (1950a) argued that economic space consists of three principal characteristics: (1) a set of relations between a firm or an industry and its buyers and suppliers, (2) a field of forces in which these relations occur, and (3) a homogeneous environment or "aggregate" in which the forces interact. The concept of economic space as a field of forces gave him the definition of a growth pole: "centres (or poles or foci) from which centrifugal forces emanate and to which centripetal forces are attracted . . . the firm attracts economic elements, supplies and demands, into [its space], or it removes them" (p. 95). Poles of growth therefore may represent individual firms, industries, or economic sectors.

Firms, industries, or sectors as growth poles effectively dominate other economic actors through linkages based on commodity and information flows. We can imagine large firms that are able to control markets and dictate terms to dependent suppliers, for example. The "domination effect" exerted by a growth pole may or may not manifest itself in a spatial pattern of polarized growth. Perroux (1950b) argued that domination effects are likely to be nonlocal because the linkages between firms and other economic actors frequently transcend regional boundaries in highly unpredictable ways; a large producer in Atlanta, for example, may be more closely linked with industries in Singapore than with firms in the immediate surrounding regions. Perroux actually regarded geographic space "banal" or

unimportant for a true understanding of the economic growth process. Rather, he advocated that development be studied behaviorally and historically in order to understand the power relations among economic actors.

In essence, the theory of growth poles assumes that growth will be an uneven process and addresses how, why, and where growth poles occur. Perroux, who was interested in refuting the tenets of neoclassical equilibrium analysis, argued that growth proceeds in an unbalanced way and that changes in the basic structure of the economy as manifested through relations between dominant actors are critical to understanding the development trajectory of particular economies. Using an input-output framework, he sought to explain the structural change that occurs as output increases with the concept of a "propulsive industry." Growth poles are propulsive industries that dominate other sectors due to their large size, market power, high growth rate, and high degree of linkage. Subordinate industries often sell a high proportion of their output to the dominant industry on which they depend for their business success.

Growth experienced by the propulsive sector spreads to other industries via input-output multipliers.[3] More importantly, the propulsive sector leads growth by providing a focus for innovation and investment (Thomas 1975).[4] According to Perroux, the pole has some advantage due to technology, wealth, or political influence that permits it to increase internal economies of size and scale as well as generate external localization economies for linked industries (Moseley 1974).

Perroux (1988) refined the growth pole concept, seeking to address criticisms that pointed out the negative consequences of successful growth poles on the "dominated" units. He argued that growth pole development involves two distinct phases: an initial *clustering or attraction phase* when the dominated units lose resources to the pole, followed by an *expansion phase* when investments and information flow from the pole to the dominated units that sustain growth.

It is not difficult to see how these ideas might be applied in geographic space. We can imagine, for example, that a dominant industry's primary linkages could be to firms in the surrounding region, or at least to firms located within the same nation. In either case, the external economies initiated by the propulsive industry affect spatial relations as well as economic exchange. This logic led many reading Perroux to develop the concept of growth centers, which are intended to be propulsive regions rather than propulsive industries.

The fact that many economic development planners tried to implement growth pole theory in a geographical context led Perroux to make his own rare foray into spatial analysis. In particular, he articulated a strategy of creating development axes through the establishment of strong transportation links between growth centers. These axes would generate "spinoff development" which would benefit peripheral areas. In this analysis, he makes a new distinction between growth poles and *development poles*, which engender reciprocal economic and spatial relations that can increase overall complexity, "territorialized or non-territorialized." Here he appears to be arguing that we should continue to use growth pole theory in economic space and then apply the natural effects of polarization to territorial space.

In effect, he is saying that clusters of industries, which are linked by technology and trade in economic space, can become industrial complexes through mutual co-location. The tendency of firms to be agglomeration-seeking explains this spatial manifestation of economic relations. According to this reasoning, large, dynamic metropolitan areas will dominate smaller cities and their own peripheral areas as they accrue agglomeration economies (Chapter 9).[5]

Unbalanced growth theory

Although he did not claim to be borrowing Perroux's concept of growth poles, Hirschman was one of the first theorists to describe a development strategy based on the concept of geographic growth centers. He argued in the 1950s that in order for an economy to increase income, it must first develop within itself one or several regional centers of economic strength, termed "growth points" or "growth poles" (Friedmann and Alonso 1964, p. 623). In his view, some degree of inter-regional and international inequality of growth is inevitable, and indeed, beneficial. Hirschman saw activity generated within the growth center spreading to peripheral areas through increases in purchases and investments in these regions. He calls this the "trickling down of progress." He also recognized "polarization" effects, such as white-collar migration out of less developed areas and the dominance of growth center industry. In these poor regions, Hirschman contended that the trickling down of progress would outweigh the polarization effects. However, "if the market forces that express themselves through the trickling-down and polarization effects result in a temporary victory of the latter, deliberate economic policy will come into play to correct the situation" (Friedmann and Alonso 1964, p. 630).

Hirschman argues that public investment is the policy tool for directing growth. His strategy calls for directing investment toward industries that have extensive backward and forward linkages with other industries, which would enable the creation of the most advantageous external economies (economies external to a given firm in a particular industry and those between different industries). Since privately financed growth in a given region increases demand for public services like electricity and water, government could induce private investment to a chosen area by installing necessary infrastructure and services beforehand. Dispersing project funds widely over several regions could address concerns for equity and national cohesion but would have little chance of propelling the economy out of stagnation, in Hirschman's eyes. Public investment would first be used to establish growth centers and then seek to counteract polarization effects generated by the market. Hirschman's ideas were consistent with the views of economic planners in the industrialized and developing world in the 1960s who were becoming increasingly concerned that the neoclassical growth models (Chapter 5) were ignoring disparities in regional growth and welfare. Perroux's ideas were becoming more widely disseminated and modified to address regional concerns in the 1960s as well. His growth center concept became extremely influential as a solution to urban-rural disparities, peripheral stagnation, and the growth of mega-cities.

Higgins (1983) argues that growth poles and growth centers became extremely popular because they represented a middle course of action: decentralization with concentration, attention to peripheral areas (equity) with efficient means, and spatial inequality rather than income or wealth inequality. In contrast to economic base theory, popular in part due to its simplicity, growth pole/center theory attracted a large following because it was highly abstract, even vague, and therefore could be applied in different ways.

Hirschman's ideas became part of a lively debate in the 1950s regarding whether a balanced or unbalance investment pattern was more likely to be successful in advancing underdeveloped areas. Balance growth advocates emphasized the lack of effective demand in less developed regions and countries, a problem essentially ignored by the supply-oriented unbalanced growth advocates.[6] They argued for a "big push" of simultaneous investment across a range of complementary industries in order to exploit backward and forward linkages and generate external economies in underdeveloped regions. They assumed that a strategy of simultaneous investment in mutually supporting industries would create markets for the economy's production, thus reducing risks and therefore costs.[7] Balanced growth theorists saw this coordinated wave of investments as a way to overcome underdevelopment. Nurske (1953) argued that, because the forces were circular, such investments could turn cumulative decline into cumulative advance. In this case, the vicious circle becomes virtuous (Rosenstein-Rodan 1943; Streeten 1959; Gianaris 1978).[8]

Hirschman and other proponents of unbalanced growth, on the other hand, saw the larger problem in underdeveloped economies as one of weak entrepreneurial decision-making. From this perspective, development may be spurred by "generating a chain of unbalanced growth sequences in order to induce decision making through tensions and incentives for private entrepreneurs and state planners" (Gianaris 1978, p. 104). Therefore, generating development in stagnant, underdeveloped economies required focusing limited public and private investment in just a few key sectors and places to take advantage of economies of scale as well as maximize the use of scarce financial, physical, and human resources. Investment in the most strategic sectors of the economy is required to break the vicious circle of poverty.

Streeten (1959) concurs, arguing that bottlenecks created by uneven investment can themselves become powerful stimuli to the growth of lagging complementary activity. Whereas a balanced investment scheme would lead to the development of plants that would be smaller than that necessary for the optimum use of equipment, initial unbalanced investments in temporarily oversized plants could take advantage of greater cost reductions later as markets develop. Although overestimates of future demand may lead to losses in the short run, the expansion of capacity is more important than potential periods of slackness.[9]

Cumulative causation theories

Gunnar Myrdal (1957) describes a vicious cycle of development in the context of his principle of circular and cumulative causation: economic changes cause

related and supporting social changes in a process that continues in one direction.[10] Because of this circular causation and positive feedback, the dynamic behind poverty in underdeveloped areas becomes cumulative and often gathers speed at an accelerating rate. He argues, however, that any change induced by organized actors can start the cumulative process in either a favorable or an adverse direction. Moreover, "there is no tendency toward automatic self-stabilization in the social system" (p. 13). Although social forces may array themselves in such a way as to bring a social process to rest, this position is inherently precarious, and any exogenous change has the ability to start the change process in a new direction. Myrdal was trying to provide theoretical justification for development process intervention. He asserted that without intervention, backward areas may be relegated to perpetual underdevelopment, whereas a scheme of balanced locational investment may provide the needed push toward cumulatively positive growth.

Myrdal's analysis of the diffusion of growth is more pessimistic than Hirschman's. The play of market forces can increase inequalities between regions, leaving underdeveloped areas in the "backwater" of growing ones. Less fortunate regions receive the "backwash" effects of proximity to growth centers, such as out-migration, capital flight, and unfavorable terms of trade since "the movements of labor, capital, goods and services do not by themselves counteract the natural tendency to regional inequality" (1957, pp. 26–27). Migration, capital movements, and trade are "the media through which the cumulative process evolves-upward in the lucky regions and downward in the unlucky ones" (Ibid.). Myrdal is essentially taking issue with neoclassical interregional trade theory (Chapter 4), which stresses how the price mechanism should bring the economy into an equilibrium such that disparities between regions are gradually eliminated. Yet he acknowledges that underdeveloped areas may enjoy beneficial "spread effects" from nearby developed areas, including growing markets for primary goods produced in the poorer area, increasing demand for raw materials (thereby increasing employment and subsequently benefitting consumer goods industries), and the absorption of the poorer region's excess unemployed into the growing one.[11] Unfortunately, spread effects could be weak, thereby perpetuating inequality and ineffective democracy, which reinforce the need for activist state intervention.[12]

The Myrdal and Hirschman's counterposed outcomes depend on whether positive feedback (deviation amplifying) or negative feedback (equilibrium tendency) mechanisms are more powerful in the regions under study. Hirschman, like Perroux, recognizes that growth is usually unbalanced initially, occurring in places where innovation and investment are supported. Yet he argues that trickle-down effects will ultimately prove to be stronger than polarization effects. Myrdal sees negative feedback as less powerful than positive feedback. In other words, the spread effects promoting development in poor regions will be weaker than the backwash effects that drain resources from these areas.

Michael Storper and Allan Scott (2009) draw on these ideas. They identify cumulative causation as the dynamic that drives urban growth after the inception of any city. This cumulative process proceeds as follows: the organization of the

production system generates agglomeration economies that sustain growth. These external economies are powerful enough to increase city economic development even where wages, rents, and other costs of production and living are relatively high and continue to increase. As city size increases, economic diversity increases in tandem as new local specializations are added to existing ones. Innovation, which is necessary to sustain growth, is realized more frequently in larger cities than in smaller, less diverse places. Such innovation is not generic but arises from the specializations of the place. These differences in the city's major specializations matter because they define the domain of innovation.[13]

Friedmann's core-periphery model

Friedmann (1966, 1972) poses a theory of regional development based on the notion of cumulative causation that incorporates elements of stages theory (Chapter 3). The process of economic development, according to Friedmann, involves a critical transition from a preindustrial phase, where agricultural activities are dominant and industry is a relatively small share of economic activity, to a fully industrialized economy. This transition strongly affects the spatial structure of settlement, which, in turn, affects future economic performance. In the preindustrial phase, the economy is dominated by relatively autonomous cities and their related agricultural hinterlands. As industrialization begins, however, and as the economy moves into its transitional phase, investments tend to be concentrated in particular locations, establishing an unequal relationship between "core" regions and peripheral areas. These relationships evolve to establish a functioning system of cities. From the perspective of an underdeveloped country, Friedmann is concerned that the poor economic prospects of outlying areas, in contrast to the prosperity of core regions, will lead to political instability. Friedmann argues that without government intervention to ensure that additional cities develop outside the core areas, the cores will come to dominate the spatial economy, which will retard subsequent growth. His underlying model is a normative assertion (not necessarily justified with substantive empirical work) that a spatial economy focused on a few large urban centers, if allowed to establish itself, will ensure the continued impoverishment of its peripheral areas.

Friedmann (1986) later revised and updated this model given his understanding of the international spatial division of labor in the global economy. His model represents a fusion of regional development ideas with theories of central place and urban hierarchy (Chapter 9). He also draws from theories of concentration and diffusion. These theories support Friedmann's ideas, which essentially describe the geography of linkages and support the assumed core-periphery or top-down flow of growth.[14]

Product cycle theory

Raymond Vernon first developed product cycle theory as a way to explain the "Leontief paradox" that contradicted the expected outcomes of trade theory

(Chapter 4).[15] During the 1950s, the U.S. economy was considered relatively capital intensive. Yet, Leontief's empirical results for the international trade of the United States during this period showed that the United States exported relatively labor-intensive products and imported relatively capital-intensive products. Vernon's product cycle hypothesis offered one explanation for the paradox. His ideas drew heavily from his previous empirical research on the New York metropolitan region, which provided evidence for his argument.[16]

Product cycle theory can be explained by contrasting its tenets to the basic ideas of interregional trade theory and location theory.[17] Like interregional trade theory, product cycle theory is grounded in neoclassical economics and considers the interregional pattern of specialization in trade. Unlike trade theory, product cycle theory is a partial equilibrium argument about the dynamics of development. The theory is more descriptive of actual development dynamics and, concomitantly, less dependent on formal logical argument. It suggests that interregional development patterns are modified over time by recurring cycles from new product to maturing product to standardized product. Interregional trade does not necessarily lead to convergence of per capita incomes, nor is convergence achieved with labor mobility. Consumption differences, production economies, and communication advantages may continue to favor the more developed region even with complete factor mobility.

Like traditional location theory, product cycle theory focuses on firm-level decision-making (a partial equilibrium framework). However, location theory considers the profit-maximizing locations for existing products, most of which are standardized. In general, it ignores the factors important to the development of new products, which is the point of departure of product cycle theory.[18]

In the international case, product cycle theory presents stylized facts about the United States, Western Europe, and less developed countries. These countries are distinguished by their different industrial structures, levels of technology, factor costs, and consumer tastes. Capital is considered mobile and labor immobile between countries. Although all areas have access to modern science and technology, new products tend to originate in the more-developed country for two reasons. First, potential markets for more sophisticated new products are larger in the more developed country. Second, entrepreneurs there have better information about these commercial opportunities and innovation possibilities because communications channels are more efficient. Greater incentives for new product creation exist in the more developed country because both incomes and wages are relatively high there. High incomes correlate with more complex consumer tastes, and high wages encourage the production of new capital goods that can substitute for expensive labor.

The innovation process results in the creation of new products that initially satisfy local demand in the more developed country. As the product matures and becomes standardized, producers are able to export it to less developed countries. Once the production process becomes completely standardized, the product can be produced in either areas, but competitive pressures drive producers to seek

the lower-cost, less developed country location. Relatedly, the price elasticity of demand increases as the product matures.[19]

This diffusion process benefits the less developed country because it experiences more rapid economic growth as the result of external investment and trade in standardized products. Yet firms headquartered in the more developed country set the nature and rhythm of its growth. In essence, diffusion leads to a form of economic dependency in less developed areas because the tastes satisfied and the technology developed through new products are intended to meet the economic realities of the more developed country and, therefore, are not always appropriate for less developed countries.

The location of production in less developed countries does not follow the trade theory logic of comparative advantage where relative differences in product costs and factor endowments are most important. Instead of trade, direct investment embodying advanced technology for standardized production processes establishes new plant and equipment in less developed countries. The decision to invest is stimulated by the desire to defend the market penetrated earlier by exports of the maturing product. Low wages and insufficient capital accumulation in less developed countries are advantages to outside investors and increase the regions' attractiveness to them. Capital market segmentation may also work in favor of foreign investors who have access to the formal capital market. These advantages may compensate for the disadvantages of smaller markets, higher transport costs, and fewer external economies in less developed countries.

The regional context

Vernon's original three-country presentation of international trade can be simplified to consider one more developed region (MDR) and one less developed region (LDR) within the same country: during the new product phase, all production is consumed in the MDR. As the product matures, consumption is initiated in the LDR and increases as its imports continue. Obviously, production exceeds consumption in the MDR during the maturing-product phase. Then, it becomes profitable to locate production of the standardized product in the LDR. During this phase, production may drop to be equal to or less than consumption in the MDR. Later on, the standardized product may be exported back to the MDR. When this occurs, standardized production increases to exceed consumption in the LDR.

On the basis of this product cycle process, economic development can be defined as the creation of new products followed by the diffusion of standardized products. Development originates in the MDR and is exported to the LDR through trade and then investment. Establishing a new industry in the LDR creates a progressive force that can help eliminate barriers to interregional equality. Yet product cycle theory does not predict convergence of regional incomes; the development process can be convergent or divergent.

Even if regional incomes did not converge, the diffusion process could provide other benefits to the LDR and lead to other forms of convergence. First, access

to mature products expands the range of consumption opportunities in the LDR. Second, establishing branch facilities that produce standardized products expands job opportunities. Even if wages paid for standardized product manufacturing are low compared to wages paid in the MDR, they should be higher than the average in the LDR. Third, investments, loans, or grants from the MDR should increase in the LDR initially to support imports of mature products and subsequently to construct facilities for the production of standardized products. Fourth, increasing the number of standardized producers could help diversify the local economy and increase its stability. Finally, multiplier effects could create opportunities for new enterprises in the LDR, but this outcome may be unlikely because standardized-product manufacturers often require few local inputs beyond labor and physical infrastructure. Most are obliged to purchase goods and services from other divisions of their company. Thus, only local businesses providing goods and services to local households may grow.

On the other hand, the diffusion process could exacerbate the inequality between the two regions. Although favorable terms of trade could evolve for the exports of standardized products, this outcome is neither assured nor expected to be long-lasting given the high price elasticity of such products. Even if per capita income in the LDR increased, the inequality in the levels of development in the two region is likely to increase for three reasons. First, the dependency of the LDR on the MDR would increase. Consumers and producers in the LDR would exercise less and less control over the local economy since mature products were designed to respond to consumer tastes in the MDR and standardized products were developed with the technology of that region. Second, relatively high wages in the standardized product sectors could stagnate unless workers found ways to press demands for improvements in wages and working conditions.[20] Third, outsiders clearly own and control the branch-plant economy. Extensive "foreign" ownership would eventually increase the volume of repatriated profits (profits earned in the LDR are paid to owners located in the MDR). In some regions, the branch facilities would form a separate enclave economy that would have very limited beneficial spillover effects. Given these likely interregional outcomes, the national government may need to intervene to promote development in the LDR.

In general, product cycle theory supports the need for active government intervention to encourage the diffusion of standardized products and the creation of new products that would alter regional specializations. The theory calls for the implementation of public investments in transportation, communications, and other infrastructure. It would disseminate current information on scientific, technological, and other relevant developments to entrepreneurs. For the LDR, it would be particularly useful to insure sufficient exports to permit the importation of maturing products and to train workers and managers for industries producing standardized products.

In summary, product cycle theory describes the relationships between innovation, structural change, and economic development outcomes. In its regional application, the theory focuses on the spread effects generated by the diffusion of

productive investments from the innovating MDR to the LDR. Firms in the MDR introduce new products in response to the high incomes or high labor costs there. As new products mature, firms seek export markets and find them in the LDR. When products become standardized, they can be more competitively produced in the LDR. The innovation process required to create new products has developmental impacts in the MDR, while the investment needed to establish standardized products generates economic growth in the LDR.

The following section sequentially applies the five theories of spatial concentration and diffusion to economic development practice. The third section describes the theories more fully and criticizes them.

Applications

Growth center policies essentially represent attempts to affect the urban hierarchy as a way to overcome disparities among regions within one nation. One argument is that intermediate-sized cities should be favored for development as growth centers because they are large enough to attract capital, yet sufficiently dispersed spatially to be accessible to commuters from more remote areas. In addition, they may permit fewer diseconomies than larger metropolitan areas but more external economies than smaller areas.[21] Furthermore, intermediate-sized centers can provide the necessary level of infrastructure and services to serve as central places but have not yet reached the size and scale at which service provision and infrastructure maintenance becomes problematic, and land prices, other expenses, congestion, and environmental deterioration overtake the benefits to be found there.[22] This logic encounters a fatal flaw, however, because it ignores how externalities are internalized: society absorbs most of the diseconomies of agglomeration. Conversely, private actors enjoy most of the benefits of agglomeration economies. Rational government intervention may favor decentralization and growth centers, but private investors will still rationally prefer the larger cities.

Growth center strategies were supposed to improve upon the preexisting pattern of spatial development rather than create a new structure. The ideal spatial pattern would be a dispersed hierarchy of cities, far enough from each other to be considered "decentralized," yet still allowing access to peripheral populations. While there has never been consensus on the optimal size of a growth center, Hansen designated a "growth spurt threshold" of between 150,000 and 200,000 people to represent the ideal range for taking advantage of agglomeration without the drawbacks of large city diseconomies.[23]

Though these plausible hypotheses became the conventional wisdom in the 1960s and early 1970s, they eventually proved difficult to apply usefully in practice. On the one hand, many policy initiatives proceeded without any regard for the types of places most likely to serve as effective growth centers; the temptation to name any needy area a growth center proved too great (Higgins 1983). On the other hand, no research could establish a relationship between level of economic development and spatial structure. Allan Pred (1976) found that intra-organizational linkages

are often more important than spatial proximity (spread from core to hinterland) or urban hierarchy (diffusion from largest centers to smaller ones). Researching growth transmission processes in North America, he asserts that the assumed top-down channels of growth are wrong and that growth transmission occurs primarily between urban centers rather than between each center and its periphery. After citing the role of multi-locational firms in this process, which generate significant "non-local multiplier leakages" between urban areas, Pred demonstrates how many urban areas in the United States and Canada do not have linkages to smaller urban places nearby but have stronger linkages with New York, San Francisco, Los Angeles, and Chicago. He then urges planners to focus more on the spatial structure of organizations and on growth transmission studies before they adopt intuitive approaches to spatial economic development, such as growth center strategies. His argument has even greater force in the current era of telecommunications than it had in the 1970s, when he conducted this research. Consistent with Perroux's emphasis on economic space over "banal" geographic space, Pred views corporate organizational structure to be too important to ignore in spatial models of innovation and growth.

Although growth center strategies at the interregional level proved flawed, more useful applications of these ideas are available to the economic developer focused on one area. Most metropolitan areas in the United States experienced a significant growth spurt sometime in their economic history. In these cases, one dominant industry—either one firm, one industrial sector, or one industrial complex—can be identified as the "growth pole" that was largely responsible for the area's growth. Although staple theory offers more useful insights about long-term growth and change, concentration and diffusion theories provide engaging ideas about changes in industrial structure and the spatial pattern of growth.

Another useful idea is support for the strategy of infrastructure concentration which usually represents a more rational allocation of public investment than dispersion. Economies of scale in the provision of public facilities become more feasible, and these facilities can help local firms realize external economies. With the growing concern for sustainable development, infrastructure concentration becomes a strategy for preserving or conserving valuable land and natural resources and for utilizing existing capacity as well as a way to achieve thresholds required to accelerate economic growth. Since "pork barrel" politics encourages dispersion, it is helpful to have good theoretical support for concentration. Whether the economic developer is working at the state or local level with one type of infrastructure (e.g., transportation facilities) or with entire planned unit developments, infrastructure concentration makes sense. Economic developers can also use infrastructure concentration to advocate for sharing the tax base that is eventually generated by private companies accessing the infrastructure.

Finally, the core-periphery model directs attention to interactions between core metropolitan counties and nonmetropolitan hinterland counties within one labor market area. Most nonmetropolitan areas in the United States depend heavily on the adjacent metropolitan center because many residents of the hinterland work in

the core area. In rural "bedroom communities," out-commuting is essentially their economic base, and the wages and salaries of out-commuters are the most important source of purchasing power in most cases. Although primary and resource-oriented products from the hinterland may be sold in the core and elsewhere, the potential for rural development depends more on manufacturing or service-sector jobs available to rural residents.[24]

The economic developer in nonmetropolitan areas dependent on the nearby metropolitan area might be able to estimate, at least roughly, the magnitude of financial inflows and outflows. An assessment based on these flows will suggest whether spread effects or backwash effects are dominant. In either case, developers in these areas need to pay close attention to the plight of the metropolitan center because it impacts the level of local employment.

The theories of growth poles and unbalanced growth place great emphasis on economic power, which can be manifested in different ways. Local firms may have considerable market power if part of oligopoly industries. Local business leaders may be prominent in national trade associations. Local politics, entertainment, and media may also be strongly influenced by families who own or manage major firms. The economic developer who studies these connections is more likely to understand how to be effective given local power relations.

Product cycle theory applications

With respect to product cycle theory, economic developers can gain insights by thinking about the concept of economic diversity. Among the industrial sectors exporting goods or services, the developer could try to identify the sectors that primarily generate new, maturing, or standardized products. Although a relatively even mix of new, maturing, and standardized products is not easily achieved, the developer at least should become suspicious of naive diversification strategies that attend only to increasing the diversity among industries. An area may become increasingly attractive to a variety of industrial sectors over time, but all of these industries may produce standardized products. As a result, the area's vulnerability to external competition may increase as it becomes more diverse in term of its mix of industries.

Developers can also assess the competitiveness of their region using the framework provided by product cycle theory. Some regions may have sufficient size, specializations, and wealth to serve as locations for new product development. Other regions possess attractively priced human and natural resources and may be competitive due to relatively low costs of production. Still other regions may fail to be competitive for either new or standardized products. From the product cycle perspective, these regions are the most hard-pressed to establish some meaningful role in the global economy.

Competitive regions in the United States and Canada are more likely to function as new product locations than as locations for standardized production since the factors and intermediate inputs are relatively high quality and high cost. To the

extent that standardized products are generated from routine production processes, regions outside of the United States and Canada with lower production costs are likely to be more attractive standardized product locations.

The economic developer who wants to apply product cycle theory in its most literal form must try to identify manufacturing or export service companies that can create new commodities. If these companies can be found, the developer should survey management to find out how well the economy is able to support the process of new product/service development. Companies that were unable to move forward with new ideas because of agglomeration diseconomies or other local problems would provide the most useful insights. The developer may be able to mobilize the resources needed to improve the local physical or business infrastructure in ways that would enhance new product/service development.

A related approach is to divide important local companies into those headquartered locally and those headquartered elsewhere. Developers should survey companies from both groups to see whether they have different business orientations and therefore draw on the regional economy's capacity in different ways. The goal would be to identify the agglomeration economies and diseconomies important to companies in these two groups. As before, the general response is to find ways to support the economies and mitigate the diseconomies. To carry out these strategies successfully, however, requires substantial effort and resources. The developer would need considerable research capability to find the relevant firms and survey management. Business infrastructure would have to bestow benefits on more than one company to be politically feasible, and such infrastructure could be very difficult to mobilize.

More generically, product cycle theory emphasizes the possibility of competitiveness arising from research and development (R&D), and, generally, from professional education and technical training. A deep pool of university-based talent may provide opportunities for information exchange and joint R&D ventures with local enterprises. Such linkages have the potential to encourage new product or service development.

Economic developers could gain further insights by considering product cycle theory in terms of its implications for business relationships and linkages among local firms. Just as industrial complexes offer firms external economies that lower production and marketing costs, interfirm linkages can offer support for the processes of innovation and customization that can often lead to competitive success through new product development. Unfortunately, it is not clear how to select important interfirm linkages or support interfirm networks, especially at the local level.[25]

In conclusion, strategies that are based on product cycle theory should focus on the internal development of the regional economy rather than on the diffusion of growth from external sources. New product-oriented strategies should emphasize R&D, university-business partnerships, business services development, and other efforts to improve the chances of local product or process innovation. Although new product-oriented strategies are attractive for many reasons, they are

also risky because they may generate results too slowly given the time frames set by local public officials. Targeted efforts to assist particular firms may result in protests from firms not receiving assistance. Such strategies require extensive and intensive research that may be beyond the capacity of local economic developers.

Standardized product-oriented strategies are entirely consistent with those supported by economic base theory: industrial recruitment, efficient government services, and infrastructure investments that would lower production costs. Economic developers may recruit branch plants successfully when the internal market has sufficient size and costs are attractive to such branch facilities.

Furthermore, economic developers could identify the agglomeration economies supporting standardized products. There may be pools of skilled labor, suppliers and business services, physical infrastructure, and local knowledge that can generate external economies. Developers may be able to encourage the production of capital goods in these sectors, in essence, supplying the technology needed by currently competitive standardized product-oriented regions.

This strategy is similar to the economic development strategy articulated by Thompson (1968), who suggests that regions could move up "the learning curve" from routine production to precision production. Such a strategy has worked in some regions. For example, the Greenville-Spartanburg, South Carolina region, transitioned from textile product production to the production of textile machinery and related capital goods.[26]

As noted, the economic future is not bright for regions that are neither attractive for new products nor attractive for standardized products.

Elaboration and criticisms

The proliferation of regional strategies designed to develop growth centers provides a clear track record to evaluate past applications of growth pole theory and other models of concentration and diffusion. Overall, the number of failures far outweighs the successes. Is this the result of a misapplication of theory, or are the theories either fundamentally flawed or not well-specified? Certainly the very vagueness of Perroux's work has caused problems when extending growth pole theory to practice. His noble goal of creating a general theory of economic actors involved in power relations counterposed to neoclassical economics led him to keep the formulation of his thinking at a very general level. For example, growth pole refers vaguely to entrepreneurs, firms, and industries. This generality has invited applications of the concept to widely varying circumstances, often inappropriately. Despite Perroux's initial warnings not to apply his concepts geographically, they have been so applied many times. Unfortunately, unbalanced growth, cumulative causation, and core-periphery are not specified any better than growth pole theory.

One of the most basic assumptions of growth center applications has been that the effects of growth will spread or diffuse to the periphery. It is assumed that the interactions of the center with its periphery will be strong if the necessary linkages exist; yet nowhere is it stated how this phenomenon will occur if the linkages

to rural areas or slow-growth firms do not exist (Gore 1984). Perroux (1950b) speaks of the domination effect, bringing lagging industries (later applied to lagging peripheries) along. Yet he does not seem to question that this outcome might not occur in all circumstances. It is useful to recall the context in which Perroux first formulated his growth pole theory. He was writing in Europe during the early 1950s, a time of primitive communication networks between regions and nations when peripheral regions, abundant in vital natural resources, could directly experience spread effects from nearby centers. For example, areas of iron, coal, or forest reserves were directly affected by the growth of nearby mill towns. Despite his general avoidance of geographic applications of his theory, Perroux was undoubtedly influenced by this European context.

Support for the assumed core-periphery connection and related spread effects is found when strong backward linkages exist between an industry in the growth center and its periphery that provides natural resources. Once industries become human resource-based, however, it is likely that these spatial links are broken. With this insight, Higgins (1983) proposes a stages theory conception of growth poles: the process of change begins with a propulsive region of primary (natural resource) production experiencing growth at the center. This propulsive center processing primary products causes growth in the periphery. After further evolution, industry at the center generates more connections to other centers than to its own periphery. The growth pole concept may only be an effective spread mechanism during the second stage. It is worthwhile to look at growth poles in this temporal context, especially when one remembers that Perroux himself urged taking a historic approach to growth and development.

Because of their vagueness, concentration and diffusion theories have been applied almost indiscriminately to regions of various sizes. In the United States, the Economic Development Administration designated small, stagnating rural towns of 500 or so people as official "growth centers," to be assisted by funding and investments in propulsive industries. This approach has failed miserably. In such cases, it seems that policymakers mistook the need for growth and development in a region for the potential for such growth and development. As a result, funding flowed to these depressed areas with the hope of more equitable spatial development, but little economic growth resulted. Although the Economic Development Administration has long abandoned this program, states and local jurisdictions continue to misapply growth-pole logic. They provide incentives and/or focus infrastructure development in peripheral rural areas with the hope of attracting private investment to these places. This supply-side approach has rarely reversed the fortunes of nonmetropolitan areas in need.

In the early 1980s, secondary city development was advocated as a way to concentrate investments in these areas to spur local economic development appropriate to the local economic base and thus diffusing benefits to the periphery. However, consensus on the potential of this approach never existed, and by the 1990s, such efforts were largely abandoned by international lending institutions in favor of macroeconomic approaches, such as structural adjustment.

Growth center strategies also tended to emphasize "one-shot actions" instead of sustained investment that, for example, Hirschman would have stressed. An initial capital outlay designed to stimulate growth was assumed to become self-sustaining through the domination effect. This "one-shot" emphasis led to the inappropriate bias toward investment in industrial parks and spec buildings at the expense of investment in educational and social services. Moseley (1974) advocated developing human resources, building local administrative capacity, and decentralizing political power as more self-sustaining approaches to growth center development.

For the small growth center, heavy subsidized investment in one type of industrial infrastructure may prevent it from adapting to changes in the macroeconomic climate.[27] Likewise, investments in heavy industry to generate "propulsive effects" on a developing economy with a large rural sector often miss the mark. The existing economic activity in many medium-sized centers in developing countries focuses on the processing and marketing of agricultural products. Much of the marketing activity is very small scale and considered to be part of the "informal" economic sector; that is, it is nonregulated, nonstationary, and requires very little capital investment and overhead costs. Such informal marketing activities often generate relatively large amounts of income and employment. It follows, then, that a growth pole strategy in such a context would be best focused on harnessing the entrepreneurial drive that undergirds the informal sector. Investments in agro-processing, basic marketplace infrastructure, transportation links, and credit extension would thus be appropriate.

Another criticism of growth pole theory is that in today's world, the national level is the wrong level on which to focus. Transportation and communications linkages have transformed the structure of economies around the world. Thus, if Pred's work were extended internationally today, he would find that many primate cities around the world have stronger economic linkages to other large cities elsewhere in the world than they have with cities within their own country. This is especially true for those "poles" specialized in the advanced services but is also true for manufacturing complexes. Spread effects to a center's periphery and to smaller centers are becoming increasingly less likely.

Currently, the local level has become more important because the local labor market area is now the basic functional economic unit in the global economy. Local economic developers are now more relevant actors, as the influence of macroeconomic policies have waned. At the very least, this reality means that theoretical assumptions must be closely examined and adjusted before any spatial economic development strategy, such as development of growth centers, is embarked upon.

Economic developers have been preoccupied with seeing growth pole theory as a justification for growth center strategy rather than as a way to understand economic development. Thus, we have seen growth center designation in clearly stagnating areas, large-scale industrial projects in isolated rural areas, and other misallocations of investment capital. We have also seen blanket applications of the growth center strategy to widely varying contexts without consideration of the "stages" of growth pole development that make certain contexts clearly inappropriate for such

a strategy. It is safe to say that growth center theory is no longer useful in the context of the developed, post-industrial economies found in North America, where linkages are often human-resource based, giving rise to different developmental needs. Multi-locational firms play an important role in strengthening the linkages between headquarter and branch locations at the expense of linkages between the firm and its geographic periphery. These firms can have detrimental effects on developing regions when they fail to generate significant spread effects to peripheral areas or in some cases actually aggravate rural-urban disparities.

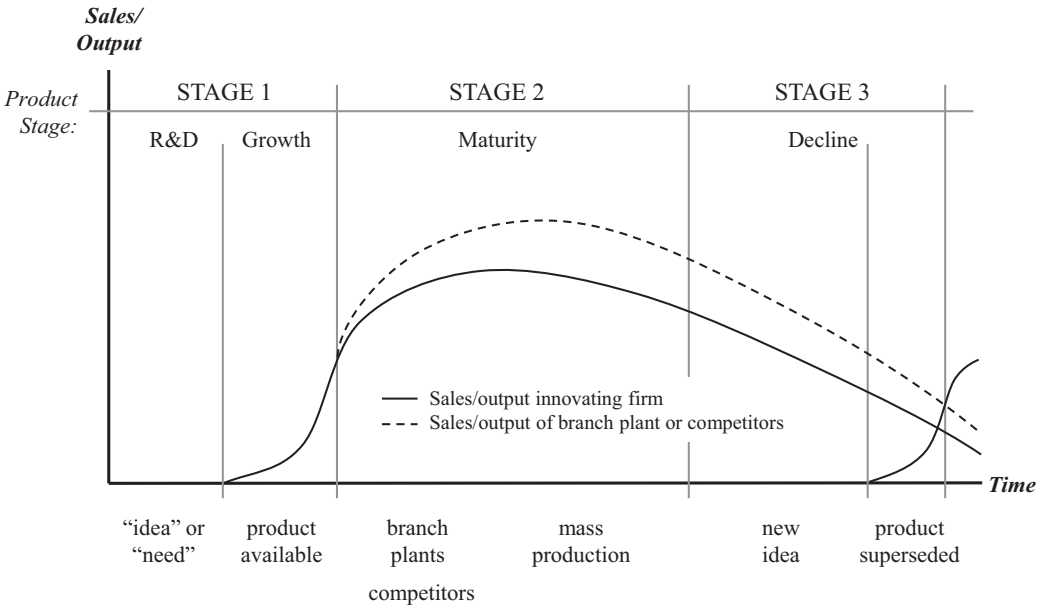
In conclusion, theories of concentration and diffusion cannot be taken as self-contained sets of rules, principles, or statements designed to explain a phenomenon. Many of these ideas are essentially descriptive; to gather explanatory power, they need to be further elaborated and carefully specified. Perroux's original work often seems as though it was co-written by an economist and an amateur physicist struggling over some grand professional compromise, while the refiners of Perroux have subsequently accumulated baggage from an assortment of economic and spatial theories. All this was done with the intention of both clarifying Perroux's ideas about economic development and attempting to put them into practice as a normative development strategy. The result of implementing a concept without its own unified theoretical base has been the misapplication of Perroux's ideas, depending on the "spin" of the practitioner.

Higgins and Savoie (1995) present an updated and supportive treatment of Perroux's theory. They state that we need more knowledge before we can apply growth pole theory effectively. They emphasize the need for a better understanding of growth and change in different settings and of the role of market forces in creating and alleviating regional and income disparities. They also call for examining the potential of using different types of government interventions to guide market forces. They advocate research into the role that distance currently plays in spatial processes. Given the revolution in telecommunications that has occurred, this advocacy is now even more important. Finally, they recommend research into city size and urban hierarchies and the role they play in development.

Their admonitions would also apply to the other related models—unbalanced growth, cumulative causation, and core-periphery. Unbalance growth has been both updated and subsumed in neoclassical growth theory, especially the recent specifications which treat spatial factors more explicitly (Chapter 5). Although cumulative causation and unbalanced growth ideas continue to receive some attention and application, trade theory and growth theory (Chapters 4 and 5) can address many aspects more systematically. The revised and updated core-periphery model is now specified in the context of world-city research (Friedmann 1995).

Product cycle theory is far more specific. It explains that each stage of a product's life requires a distinct set of locational attributes. The characteristics of regions that encourage new products or standardized products are different, as are their locations in the urban hierarchy. New product locations offer better jobs and have a higher skill mix than standardized-product regions and tend to attract more professional and technical workers. High-tech industries or other industries with

significant research and development activities are more prevalent. R&D efforts can lead to new product innovation. Entrepreneurial activity in these regions is presumed to be high due to better information and "swift and effective" communication resulting from proximity (Vernon 1966, p. 195). Furthermore, new spin-off industries are likely to be created from innovative companies. All these activities increase linkages within the local economy. Regions with active product innovation tend to become relatively high cost, larger markets that offer agglomeration economies. These locational attributes of product cycle theory are summarized in Figure 6.1.



Region:	**REGION 1** *(innovating region)*	**REGIONS 2, 3** *(less-developed regions)*	
Product:	New product introduced in response to higher incomes or higher labor costs in Region 1; mature-product firms seek export markets in less-developed regions (2, 3, etc.)	Standardized product attracted to regions with lower costs (e.g., labor)	New product cycle begins in Region 1 through innovation or entrepreneurial activity
Locational characteristics:	New-product locations offer better jobs and have higher skill mix; greater entrepreneurial activity; spin-offs; increasing linkages and agglomeration economies	Lower comparative costs; product's value is high relative to weight; labor force with lower skills; localization economies	
Developmental impacts:	Attracts more professional and technical workers; high-tech industries more prevalent	More rapid economic growth from external investment and trade in standardized product; may become economically dependent on Region 1	

FIGURE 6.1 Product cycle stages and locational characteristics

Vernon argues that new product locations must offer firms flexibility in sources and types of inputs and good communication channels to reach consumers, suppliers, and even competitors. Comparative costs, emphasized in location theory, are more important to understand why standardized production is attracted to regions that offer lower comparative costs, especially abundant lower-cost labor. Facilities are likely to be located in such regions as long as the product's price elasticity remains high, production is vertically integrated, product obsolescence is deferred, and product value is high relative to weight. Vernon identifies standardized textile products as a good example of such products.

Hekman (1980) broadens the application of product cycle by looking historically at one industry—cotton textile production. His article is an excellent source for identifying the elements needed for product innovation: entrepreneurs and managers, product designers, engineers, toolmakers, machine builders, and so on in contrast to typical factors cited in location theory: labor, transportation, and electric power. The combination of entrepreneurship, skilled mechanics, innovations in management, and textile machinery production resulted in highly immobile agglomeration economies. As the product became standardized, however, the South offered lower costs to support automation and the substitution of unskilled for skilled labor. Thus, the product cycle is useful in explaining the historical development and location of textiles and certain other manufacturing sectors.

Erickson and Leinbach (1979) adopt product cycle theory to explain the diffusion of branch plants to nonmetropolitan areas. The factor inputs required for standardized products make nonmetropolitan areas relatively attractive production locations. As the product becomes standardized, major changes in factors inputs occur. First, scientific knowledge, engineering applications, and technical expertise, required to create new products, decline in importance. With standardization, external economies made available to the firm by virtue of its location in a more developed region become increasingly less important. On the other hand, the demand for good production managers and unskilled workers grows.

Erickson and Leinbach argue that management inputs are most important to foster growth as the new product matures. Management expertise is least important for standardized-product production. Capital is relatively unimportant during the new-product phase but becomes very important to achieve the growth necessary to export the maturing product and then to construct the branch plants needed for standardized-product production. Their argument is unclear about the changes in factor intensity over the product cycle, however. The new product would require different labor inputs to be used with limited capital inputs. The standardized product clearly requires both heavy capital investment and significant amounts of unskilled labor. Capital-intensive production, which Vernon originally posed for standardized products, usually implies high labor productivity and high average wages. On the other hand, production primarily exploiting unskilled labor would usually suggest lower labor productivity and wages.

After Vernon's article was published, product cycle theory gained widespread popularity and was adopted in marketing and by economic geographers, who

molded it to their particular uses. Additional regional applications are found in Norton and Rees (1979),[28] and Moriarty (1983, 1992).[29] Another group of economic geographers and planners has used the product cycle model to help them understand the role of technology in regional development.[30]

Criticisms of product cycle theory have been raised by Vernon (1979) himself, Steiner 1987 and Taylor (1986), among others. One general criticism is that, as a partial equilibrium theory, the product cycle concept may only be appropriate for manufacturing and primary export staples, thereby ignoring the growing importance of service sectors. It is difficult to extend the theory to all exporting sectors because the product cycle concept and the reality of export service production are not easily reconciled.

Vernon suggests that the explanatory power of the product cycle model for international trade patterns has eroded because of the changing international environment. United States-based firms are more "comfortable" locating outside the home market. With the rise of the multinational corporation, fewer firms have distinct home markets and production facilities in the first place. Market information on various international markets has become more accessible. Moreover, the large companies that account for the most international investment and trade are often vertically integrated, which lessens the importance of agglomeration economies available in any given location. Furthermore, the previously unique characteristics of the United States such as high income and labor scarcity are no longer unique. Other nations, such as Japan and those in Western Europe, now have economies similar to the United States. With the world economies becoming more homogeneous, the potential for the United States to lead in product innovations has declined (Vernon 1979).

Taylor (1986) attacks the product cycle concept on numerous grounds. First, he considers the theory an example of technological determinism. This criticism is somewhat misplaced. Standardized product production may be determined by technical, input-output relations. However, new and maturing products are shaped far more by design, marketing, and management factors than by technology.

Taylor points out that the theory assumes a sufficient market and/or effective marketing, but, in fact, the market may not be able to absorb all production. Furthermore, product differentiation is an important marketing strategy that is ignored. Neither is product cycle theory clear on the issue of ownership or control nor is it clear even about the definition of the product itself. Its treatment of invention and innovation is unrealistic and cannot offer much evidence of products moving through the entire cycle where mass production is the end result.

Although these criticisms are somewhat valid, Taylor and other critics fail to offer an alternative formulation. These criticisms fail to recognize that Vernon never posed product cycle theory as a general theory of development. In fact, its intuitive simplicity remains one of its main strengths. Rather than trying to integrate concepts relating to the innovation process at the enterprise level, it may be more useful to focus on the definition of the product and product development *per se* as well as consider the proper treatment of export services.[31]

Discussion questions

Theories of spatial concentration and diffusion

1 Do any ideas from growth pole theory appear to be applicable currently to metropolitan economies in the United States?
2 What can we learn from the failures of the growth center strategy?
3 Can you construct an argument to defend the concentrated provision of public infrastructure as a means of making development more sustainable?
4 Are the major industries in your area linked to other industries within your region, or are they primarily connected to industries located elsewhere?
5 Why would the unbalanced growth approach tend to stimulate more entrepreneurship than the balanced growth approach? Which should be more effective in impacting the "vicious circle" of underdevelopment?
6 Under what circumstances should spread effects be more powerful than backwash effects?

Product Cycle Theory

1 How does price elasticity change over the product cycle?
2 Assume you could assemble any mix of industries, occupations, or products in a region in order to build a "seedbed" for new products. Which activities would you want located in your region?
3 Are both the organization and control of production important determinants of regional growth or simply the outcomes of trade theory-type comparative advantage?
4 Which factors would you examine to determine a region's competitive advantage from the perspective of product cycle theory?
5 Which economic development strategies would make sense if you worked in a region with competitive advantage in new product creation, standardized product production, or neither of the above?
6 Much emphasis is placed on swift and effective communication in product cycle theory. In the 1960s, spatial proximity was required. In the age of telecommunications, is proximity still required?

APPENDIX 6.1

Location theory and applications

As noted in Chapter 2, location theory and migration theory are beyond the scope of this book. Both consider location decisions at the firm or household level, while the theories in Part II consider the regional economy as a whole. Yet it is important to briefly consider location theory at this juncture for two reasons. First, Vernon and other contributors to product cycle theory argue with some of the basic tenets of classical location theory. Second, location theory has applications that economic developers should understand.

Industrial location theory considers how profit-maximizing firms select their location in space. Some of the literature treats production at one point and examines how competing firms select locations to serve demand in a geographic market area. Other literature assumes that demand is centered at one point and considers how land- and resource-intensive production will be organized in space. The latter is the inspiration for central place theory, discussed in Chapter 9. Much of the literature assumes equal access to markets and focuses on how the location of raw materials, intermediate supplies, or labor should influence the location of the production process. The analysis of comparative costs leads to the identification of the best, cost-minimizing location.

The seminal works in location theory are by Weber, Lösch, Hoover, Isard, and Alonso. An excellent brief review is in Alonso (1964, Chapter 4). The optimal location of individual firms, although important, does not address the interaction effects that lead to agglomeration. Yet agglomeration economies, which tend to be found in larger urban areas, provide an important focus for product cycle theory as well as other regional theories. These locational factors, such as deep pools of labor, and so on, presented in the Chapter 9 discussion of agglomeration economies, are important during the new and maturing product phases. Once the product is standardized, the comparative costs of alternative locations and the logic of classical location theory come into play. See Harrington and Warf 1995.

Moriarty (1980, especially Chapters 5–6) and Herzog and Schlottmann (1991, especially Chapters 11–12) provide useful descriptions of how geographically based factors influence the location of manufacturing firms or their branch facilities. The location process is a two-stage process. In the first stage, the large geographic region is identified from which the markets served by the facility can be accessed. In the second stage, the specific site and community are selected.

If consumer markets are targeted, access to the relevant wholesaling and distribution centers needs to be identified. If the product serves intermediate markets, the locations of purchasers need to be identified. The product itself, specifically its weight-to-value relationship, determines the relevant mode of transportation, although often several modes are used to ship one product. With market locations and transportation modes determined, geographic areas can be identified that provide reasonable access to these locations in terms of the transportation costs and convenience of transportation service.

Once acceptable market-serving areas are mapped, the analysis turns to the availability and cost of various location factors. Primary and intermediate inputs include land, labor (in appropriate occupational or skill categories), utilities (natural gas, electricity, telecommunications), supplies (intermediate inputs and maintenance), and public services (police, fire, etc.). Qualitative factors are also considered: the livability of the area (quality of life for employees and especially for management), the business climate (often emphasizing the posture of local government and the degree of union activity), and environmental issues (both the desire for reasonable environmental quality and the threat of costly environmental regulations). Capital costs are not very important since capital is rarely accessed at the selected location.

Traditionally, local property taxes and state income taxes have not been influential in the industrial location process, notwithstanding the emphasis given to them by state and local developers. However, this situation changed in the 1990s, with the widespread use of financial inducements and incentives (Wasylenko 1991). It may now be possible to skew locational choices away from optimal locations with enough corporate subsidies.[32]

The typical manufacturing facility can usually find several locations that offer good access to markets and roughly equivalent capital outlays and operating costs of production. The process involves starting with many possible locations and screening out more and more communities and sites until only a small number remain. The site selection decision often resolves to more subtle qualitative factors since the remaining sites have very similar capital costs and can provide the necessary production inputs at similar unit cost. In these instances, personal relationships and effective marketing can be decisive.

This brief description of the site selection process enables one to reconcile two different views of the industrial location process. Most economists, relying on growth theory and trade theory, argue that firms select profit-maximizing locations as a result of logical calculations and rational analysis. They disparage the role played by economic developers in the location process. Economic developers, on the other hand, can document the ways they have facilitated the location process

and how effective recruitment, marketing, and incentives have influenced locational outcomes.

In fact, both groups are correct. Firms usually select places where they can carry out their operations profitably; if they do not, they may not remain in business very long. However, more than one place usually exists where firms can conduct profitable operations. Economists emphasize the screening process that eliminates most communities and sites. Economic developers focus on the hard work and relationship building that usually becomes telling in the eleventh hour when the final location decision is made.

Notes

1 Attempts to identify or create promising growth centers have led to important contributions to the literature on central place theory and urban hierarchy (Chapter 9).

2 Theory and practice often labeled "economic development" would be more appropriately called economic growth. Theories presented in previous chapters explain the process of economic *growth*. Product cycle theory and theories presented in Chapters 7–10 attempt to model the process of economic *development* and help us understand the theoretical and practical differences between growth and development. The growth-development distinction is of fundamental importance to local economic developers, as explained in Chapter 2 and applied in Chapter 10.

3 In a major review of the growth pole literature, Darwent (1969) describes "propulsive industries" as having distinct characteristics: high interaction with other firms (i.e., linkages), a high degree of dominance, and greater than average size (to generate economies of scale and economies internal to the industry). The linkages can be either *backward*, with other firms involved in supplying factors of production or intermediate inputs, or *forward*, relating to all sectors other than final demand. The strength and importance of these linkages determine a propulsive industry's role as a growth pole. Interindustry flows can be used to assess the relative importance of inputs and outputs and, therefore, the potential dominance of one industry over others. See the discussion of input-output analysis and linkages in Appendix 3.2.

4 Perroux's ideas regarding the role of the innovator or propulsive industry can be seen as a mediated approach to economic theory. Like Schumpeter (1934), he explicitly elevates the importance of individuals in their role as innovators and decision-makers in the economic process. Thus, Perroux's "active units" involve human agency in creating an engine of economic growth.

5 Amos (1990) views development as a global process governed by long cycles of about 100 years. Spatially, growth poles become dominant, and polarization occurs during the first half of the cycle and then these poles diffuse growth and development over the next 50 years. Amos speculates that, around 1980, the diffusion cycle from U.S.-based growth poles was ending and a new concentration phase was beginning, led by growth poles arising in Japan and in other Pacific Rim countries. Amos' article includes concise summaries of growth pole theory and long-wave theory in presenting a spatial-temporal synthesis similar to that of Suarez-Villa (1988).

6 Underlying balanced growth arguments is the notion that certain socioeconomic forces act to keep less developed economies or regions in a permanent state of underdevelopment. The problem may not only be lack of capital but the lack of demand for capital. On the demand side, the small size of the market in an underdeveloped economy may dampen any inducement to invest. Market size is determined by the buying power of the populace, which is limited by low real incomes, which in turn result from low productivity. Productivity remains low due to minimal inducements for investment, thus a "vicious circle." On the supply side, low per capita income fails to satisfy the needs of

consumption and so effectively limits the capacity to save. However, low incomes are a function of low productivity, and productivity is dependent on the capital investment that is itself limited by low savings.

7 A scheme of planned industrialization, as envisioned by balanced growth theorists, necessarily requires substantial state intervention in the workings of the market economy. Firms are concerned with what is profitable in terms of private net marginal product and not with social net marginal product. The latter, which would include the benefits derived from pecuniary external economies, should ideally be considered in any calculus of profitability. If investment is based solely on potential profits for private firms, inducement to invest in any given project will be inadequate when rational investors, acting under profit motives and in isolation, perceive market deficiencies. Although the marginal productivity of capital over a range of complementary industries (encompassing many individual projects that such investors would avoid) is often considerable, rational individuals would fail to recognize this potential. One role for the state then, is to ensure that producers do not overestimate the risks of production and underestimate potential benefits.

8 Though much of the literature regarding the balanced/unbalanced growth argument was written during and after the 1950s, previous authors dealt with similar issues. Friedreich List advocated balanced investment among agriculture, manufacturing, and commerce and argued that it was the duty of the state to establish such a policy (Gianaris 1978). Conversely, Adam Smith and the Physiocrats stressed growth in the agricultural sector as a means of creating surplus food production to feed growing urban populations. Thomas Malthus argued that increasing returns justified concentrating investment on industry.

9 Have countries and regions that have experienced faster rates of growth developed in a balanced or unbalanced fashion? In a series of tests using different combinations of sectors for a sample of 40 developing and developed countries and over the period 1938 to 1960, Swamy (1967) generally found positive and statistically significant correlations between measures of sectoral variability and aggregate economic growth rates. The results proved robust across different time periods and in an analysis of countries at different levels of development. He concluded, somewhat cautiously, that the evidence "points out that sectoral growth rate imbalance need not inhibit the overall growth of the economy" (1967, p. 300). Demery and Demery (1970, 1973) also published evidence of a positive relationship between unbalanced growth and aggregate growth rates. Tests by Youtopolous and Lau (1970), however, indicated that a high level of variation in sectoral growth rates tends to be negatively correlated with overall growth rates. Their analysis suggests the fastest growing places grew in a more balanced fashion.

10 Myrdal first challenged the equilibrium view of the social process in his classic 1944 study, *An American Dilemma, The Negro Problem and Modern Democracy*. He derided the prevailing view that the level of social and economic development of the black population would necessarily be slow and uncertain, and that any state intervention would be ineffectual at best, and counterproductive at worst. The status of the American black, which seemed to be stagnating at the time of his writing, suggested that some sort of "stable power equilibrium" had evolved. Myrdal predicted that this equilibrium was only a "temporary interregnum." He was proven correct by the subsequent upheaval in interracial relations that occurred in the 1960s and 1970s.

11 The concept of spread-backwash has been subjected to a number of tests using several different methodologies, including spatial regression methods (Casetti et al. 1971; Lewis and Prescott 1972) and trend surface analysis (Robinson and Salih 1971). In his analysis of 21 studies on spread-backwash, Gaile (1980) found that although promising methodological work had been done, not only have the empirical findings of the work been inconclusive but the research in general has neglected a "theoretical focus." Most of it also fails to examine spatial unbalanced/balanced growth in an interregional context, concentrating instead on the intraregional scale of development. This focus is noteworthy since the original concept, as formulated by Hirschman and Myrdal, focused on interregional development.

12 Unfortunately, since spread effects in less developed countries are characteristically weak, the low level of development coupled with regional inequalities combine in the cumulative process such that "poverty becomes its own cause" (Myrdal 1957, p. 34). This process suggests that the state must promote policies favoring underdeveloped regions. Myrdal notes that advanced European countries approach the status of welfare states precisely because stronger spread effects caused less inequality, a social luxury that provided for the growth of effective democracy. These states are characterized by a "quiet contentedness" that is the result of national integration achieved through government regulation of market forces.
13 Storper (2013) elaborates on these economic relationships underscoring the importance of institutions in regional development. He concludes this book by arguing that cities are employment centers first (workshops) and secondarily playgrounds (sand boxes) for the affluent.
14 Friedmann (1986) argues that world cities now constitute the core areas of the economy, while underdeveloped regions comprise the periphery. The core areas fulfill command and control functions and are locations of capital accumulation. They also serve as places where migrants are destined, which generates high social costs. The revised model, grounded in neo-Marxist theory, emphasizes capitalist contradictions and the resulting polarization between core and peripheral countries, between regions within countries, and within metropolitan areas. Friedmann (1995) synthesizes world-city research as pertaining to (1) large nodal regions (urban core areas) that embody intensive interaction, (2) a changing global urban hierarchy based on command and control, (3) capital accumulation predominantly in core areas, and (4) a powerful "transnational capitalist class" that is engaged in conflict with more localized classes (p. 26). The Appendix after Works Cited provides a brief overview of Marxist theory.
15 Parts of this section are drawn from Malizia and Reid (1976).
16 Hoover and Vernon did extensive research on the economic development of the New York metropolitan area. See Hoover and Vernon 1959 and Hoover 1971.
17 An overview of location theory is provided in this chapter's Appendix 6.1.
18 Beginning in the 1930s, Simon Kuznets, Arthur Burns, and others working at the National Bureau of Economic Research provided evidence that industries went through cycles. They identified industry cycle phases—experimentation, rapid growth, stability, or decline. Product life cycles follow a path that resembles industry life cycles. Analysis at the industry level could bring the product cycle concept and industry cycle evidence together to form a stronger argument.

    Ann Markusen (1985) presents the profit cycle as a better conceptualization than the narrower product cycle concept. She views regions as highly varied locations with unique histories. Like Pred (1976), she sees broad generalizations about regional economies on the basis of geographic location as overly simplistic. She changes the assumptions and broadens the scope of the model. She argues that the focus should be on corporate decision-making behavior. The level and rate of profit determine the trends in output growth. In product cycle theory, demand is assumed to be adequate, and production decisions are simple reactions to market demand.

    Markusen also criticizes the treatment of market structure in product cycle theory. In the product cycle model, free entry and price competition require firms to search for least-cost standardized product locations. In the profit cycle model, imperfect competition is the rule. Oligopolistic industries change the spatial pattern of production and employment in response to changes in profits. She empirically examines the profit cycle in 15 industries and finds considerable variation in the pattern and trends of regional location. For a concise summary of the profit cycle as it relates to the product cycle, see Malecki (1997, pp. 64–65).
19 In fact, standardized-product companies from the less-developed country may invade and become dominant in the home market of the innovating country. See Barnet and Mueller (1974) about the last phase of their four-phase product cycle model (pp. 132–33).
20 The benefits of unionization discussed by Thompson (1965) are not likely to materialize in the less-developed region. Such regions are carefully screened by companies seeking

locations for branch facilities and are preferred precisely because the probability of successful unionization there is very low.

21 Agglomeration economies figure prominently in the reasoning of growth center advocates. As in growth pole theory, agglomeration involves maximizing interindustry linkages and multiplier effects. Unlike growth poles, however, growth centers focus on encouraging the organization of these linkages in geographic proximity. Clustered public investment in services and infrastructure encourages agglomeration. The agglomeration of industrial activity results in cost savings as firms share the benefits of infrastructure, amenities, and the exchange of information, which results from being in close proximity (Chapter 9).

22 In the context of developing countries, Rondinelli (1983, p. 14) also called for such a targeting of intermediate-sized cities, arguing that

> they offer economies of scale for a wide variety of basic social and economic activities, organize the economies of their hinterlands, provide access to transportation and communications networks, offer off-farm employment in tertiary or secondary sectors, and provide access to markets, services and facilities in larger towns and cities.

An integrated system of such cities would spread the benefits of growth and innovation from the primate city to other areas. He cited the lack of such a hierarchy or system of central places as a reason for the failure of development to diffuse to non-primate areas.

23 The issue of optimum city size has a long history in urban planning and regional policy. Planners focused on minimizing the average cost of municipal services to argue for cities in the 200,000 to 500,000 size range and against large cities. Alonso pointed out that marginal revenue and marginal cost may be more pertinent than focusing solely on average cost. These marginal rates may be equal at city sizes well above 500,000 or 1 million if average and marginal revenue increase with city size. In advocating intermediate-size cities around 200,000 as growth centers, Hansen implies that average revenue does not increase monotonically with size.

24 Most of the territory in the United States is in rural or nonmetropolitan areas. The economic base of some of these areas is in primary products where agriculture, forestry, fishing, mining, and oil and gas extraction dominate the local economy. To these places one can add places providing outdoor recreation and related tourism services. Parts of the western United States, for example, have economies that are driven by nearby national parks. Other rural communities have grown as retirement communities. As the "baby boomers" continue to retire, such communities will become more popular. These areas rise and fall with the economic base/export staple in ways described by these theories in Chapter 3.

25 Most of the applications to date focus on the state-level assistance to stimulate the formation of interfirm networks. See Rosenfeld (1995), for example.

26 The transition from routine to precision production is difficult. First, considerable international competition exists in the production of capital goods for consumer products such as textiles, automobiles, furniture, etc. Second, as suggested by Moriarty (1983, 1992), restructuring from consumer-goods manufacturing to capital-goods manufacturing is more difficult for smaller and less technologically sophisticated regions.

27 In other words, overemphasizing efficient production can retard the region's ability to produce adaptively or innovate in response to changing markets and "niche-filling" opportunities.

28 Norton and Rees (1979) note the change in the regional location of the industrial seedbed from the mechanical era, which was based on the proximity of machine tools production, to the current era, during which the electronics sector serves as the spatial anchor. However, the geographic roots of the current seedbed are less deep due to global communications and the fact that researchers have much less loyalty to place than the machine tool craftsmen who lived in the Midwestern manufacturing belt. The authors use product cycle theory to argue that agglomeration economies tie industries to one place, while standardization makes them footloose.

29 Moriarty provides more thorough empirical analysis and more consistent conceptualization than either Erickson and Leinbach or Norton and Rees. Moriarty examines the

spatial diffusion of manufacturing through the U.S. urban hierarchy. Although product cycle theory provides an instructive point of departure, he provides a more specific locational model. The analysis emphasizes relationships between average wage rates, agglomeration economies, and urban size. Moriarty argues that larger places offer higher wages and more external spatial economies than smaller places. As a result, small-scale, high-wage, capital-intensive manufacturers seek metropolitan locations. Conversely, large-scale, low-wage, labor-intensive manufacturers find smaller places and nonmetropolitan areas more attractive.

Moriarty suggests a reformulation of product cycle theory. He identifies that theory with the period of the 1950s and 1960s when market-oriented multi-locational firms followed the locational predictions of product cycle theory. After 1970, the availability, quality, and cost of labor became more important than markets. Large manufacturers sorted out their production to exploit the relative strengths of large cities and smaller places. Nonproduction workers became increasingly prevalent in large areas as processing, fabrication, and assembly operations grew in nonmetropolitan areas.

30 Malecki and other researchers draw on aspects of the product cycle model to understand the dynamics of technology-oriented regional development. Malecki proposes a model which takes into account "the product life-cycle model and its corollaries, the profit cycle, the innovation cycle and the manufacturing process cycle" (Malecki 1997, p. 63). Although these related cycles enrich our understanding, they are not sufficiently well specified to suggest many practical applications. Product cycle theory remains more applicable than any of these more complex formulations. Malecki (1997, pp. 63–71) provides an excellent summary of the relevant literature.

Malecki (1981, 1989) argues that the connection between regional development and high technology is not well understood. High-tech firms do not universally serve as growth simulators. Nor do they represent good examples of development that follows product cycle theory. Definitions of high-tech activities are often not well specified and are applied loosely to different operations of high-tech industries.

Goldstein and Luger (1990) try to clarify the importance of high-tech in regional development. They identify many of the interacting factors necessary for success of research parks. Some high-tech areas have become innovation centers. The premiere successes generally cited are Route 128 near Boston, Silicon Valley in California, and Research Triangle Park in North Carolina. However, each of these areas has a complex array of unique characteristics (Saxenian 1994). Policies based on recruitment and promotion of high-tech industries rely on the assumption that the location of these companies will eventually result in growth patterns characteristic of the premier areas. This assumption is tenuous at best. High-tech manufacturing facilities located in research parks tend to introduce process innovations rather than product innovations. While product innovation is the driving force in the product cycle, process innovation becomes important later after the product matures. Therefore, many research parks simply attract high-technology manufacturing facilities and do not become vibrant innovative centers.

Goldstein updated this analysis of technology-based economic development 20 years later (Goldstein 2009). He begins by noting the broadening of sectors considered tech-oriented with the growth of information technology and "the knowledge economy." He summarizes relevant theories, which include endogenous growth theory (Chapter 5), cumulative causation, and Porter's cluster theory (Chapters 8 and 9), as well as the important ideas of path dependence, institutional capacity, and creative milieu/creative class. He identifies popular approaches used to promote tech-based regional economic development that involve investments in human capital and R&D, formation university-industry partnerships for product commercialization, and place-based strategies to attract talent and entrepreneurs. Because these approaches are often not sustained long enough to be effective, he argues that strong leadership is needed to sustain investment and consequently increase the supply of knowledge workers in the region.

31 Given these criticisms, how can product cycle theory be sharpened to provide better understanding of regional economic development? First, the product must be more

clearly defined for the set of industries that are exporting or have the potential to export. All industries that are exporting from the region should be analyzed annually and, for simplicity, classified as generating either maturing or standardized products. The annual analysis responds to the fact that product cycles are inherently dynamic.

If this analysis of product differences fails to proffer clear distinctions, focused examination of the ownership and control structure of major establishments may be more useful. If many branch manufacturing facilities which produce standardized products exist, the region is likely to be attractive as a relatively low-cost location. The problems and opportunities facing such regions depend on their ability to offer low comparative costs (absolute advantage). If the region contains major headquarter establishments or R&D facilities, it is likely to have a high-wage, high-skill occupational mix and should function much more like a new product location. Industry size, ownership and control structure, and major function (R&D versus standardized production) provide powerful insights about the region's competitiveness.

32 The use of financial incentives has become routine since the 1990s. The location of the Mercedes plant in Alabama at extraordinary cost to the taxpayers of that state brought national attention to the issue. The major public subsidies offered to Amazon and its selection of Queens in New York City and Crystal City near Washington, D.C., for major facilities in 2018 once again put incentives in the national spotlight.

7

ENTREPRENEURSHIP THEORIES

The regional development literature views entrepreneurs primarily as change agents. Their defining characteristic is that they do something novel or different, whether recognizing unexploited profit opportunities by offering new products that both create new markets and disrupt existing markets (Schumpeter's view) or by finding superior ways to produce or deliver existing goods and services (Kirzner's view). These views are more precise than the common use of the term "entrepreneur" as someone who starts a new business or owns a small business.[1]

The study of entrepreneurship is not part of mainstream economic theorizing, which favors formal (mathematical) systems tending to equilibrium. Traditional neoclassical theories have no clear role for the entrepreneur because they do not recognize human agency. With few exceptions, theories previously discussed have conceptualized the regional economy as operating according to the predictable behavior of economic actors that include producers, investors, workers, and consumers. These actors conform to the well-accepted concepts of utility or profit maximization; consumers and workers maximize their utility, whereas producers select inputs, devise production plans, and produce goods or services in order to maximize profits. Through the competitive market, the economy achieves an equilibrium where costs are minimized and physical and human resources are utilized efficiently.

The entrepreneur has no role in this neoclassical world. Prices and technologies are known by assumption; neither uncertainty nor imperfect information exists for entrepreneurs to act upon. A temporary imbalance of demand over supply might encourage new firms to enter the market, but new entrants are just like existing producers that increase output in response to price signals. Furthermore, innovative entrepreneurs work toward establishing markets that do not yet exist; thus there is no clear price signal for them to act upon (Eckhardt and Shane 2010). Yet in modern capitalist economies, stories about successful entrepreneurs are commonplace. Entrepreneurs have accomplished far more than efficient

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management of resources. Neoclassical theory notwithstanding, the existence of a particular class of economic actors who attempt to marshal resources in unique ways to bring new ideas for products or services to economic fruition is undeniable. It is also close to impossible to explain more than sevenfold increase in per capita income over the 20th century solely on the basis of static efficiency gains (Baumol 2010). This type of unparalleled economic progress requires consideration of dynamic and transformational actors, namely innovative entrepreneurs. Moreover, stimulating entrepreneurial activity is an important, growing focus of economic development efforts throughout the United States and Canada. Claims that economic developers should focus primarily, if not exclusively, on promoting entrepreneurship are not uncommon (Shapero 1981; Schweke 1985; Yarzebinski 1992; Rosen Wartell et al. 2011).

This chapter begins with a review of entrepreneurship theories that situate the entrepreneur within the broader conception of economic growth and change. These theories usually take neoclassical economic theory as their point of departure. Important theorists in this vein include Harvey Leibenstein, Israel Kirzner, and Joseph Schumpeter as well as more recent contributions by David Audretsch, Zoltan Acs, and Maryann Feldman. Related theories address the factors explaining entrepreneurial behavior and its context. Economic theorists are less dominant in this body of work; psychologists, sociologists, historians, management scientists, and urban and regional planners have been more important in advancing this research.

We then review theories that emphasize the spatial dimension of entrepreneurship. These theories connect entrepreneurship and regional development, particularly those that identify the characteristics of entrepreneurial places (e.g., Shapero 1977, 1981 and others). From the point of view of the local developer, these theories are more relevant because they have direct implications for encouraging or promoting entrepreneurial activity at the local and regional levels. All entrepreneurship theories are important, however, because they articulate a fundamentally different vision of growth and development over time that incorporates structural change. Although not purely theoretical, it is also worth summarizing the growing empirical literature that investigates the spatial context of entrepreneurship.

The application of entrepreneurship theories focuses on business development, especially the role of small- and medium-sized firms in the economy, the link between size and newness to innovative activity, and differences in entrepreneurial outcomes at the regional level (Storey 2003; Audretsch 2004). Historically, the study of small businesses has been closely associated (even synonymous) with entrepreneurship research (Malecki 1993; McQuaid 2002; Storey 2003; Audretsch 2004; Plosila 2004; Bianchi et al. 2006). Recently an emphasis on firm age, as opposed to size, has become the primary barometer of entrepreneurial development (Haltiwanger et al. 2013). Still, the nurturing of young and small businesses remains a popular focus of local economic development efforts, and the two foci overlap greatly (e.g., Sexton and Kasarda 1992). Thus, the application section provides a critical examination of the logic behind business development strategies, particularly those targeting small enterprises.

In the "Elaboration" section of the chapter, we address Schumpeter's ideas at some length, since he provides the most comprehensive theory of entrepreneurship and economic development. We also examine Shapero's work as well, since he addresses the spatial dimension most completely and is an important predecessor of contemporary debates on economic resiliency, opportunity versus necessity entrepreneurs, and entrepreneurial ecosystems. We present additional discussions of entrepreneurship and regional development in the final section and add a case study in the appendix.

Theories

Entrepreneurship theories share a perspective on development that puts human agency at the center of the development process. People doing work make development happen. The key figures are entrepreneurs carrying out venture creation or similar functions that generate development through the innovation process. The theories constitute an important departure from neoclassical economic theory, which assigns little role to the entrepreneur (Baumol 1968; Kirzner 1973; Casson 1987; Baumol 2010). In the neoclassical model, firms must choose among alternative values for a small number of well-defined variables: price, output, and input levels. The choice involves the consideration of costs and revenues associated with each alternative set of combinations. The firm decides which of these combinations yields the optimal values in order to maximize profit. The economy as a whole tends toward equilibrium where resources are allocated efficiently. In this context, the entrepreneur has no *unique* function.[2]

Economists have addressed this problem in two fundamental ways. On the one hand, many regard entrepreneurship as beyond the scope of the self-contained and well-defined problems that economics attempt to solve. It is hardly possible to study entrepreneurship without raising issues of managerial skill, psychology, motivation, and so on. These topics are not easily accessed with the tools of the modern, mathematically oriented economist. As a result, entrepreneurship is ignored. On the other hand, some economists have introduced the entrepreneur by altering basic assumptions of the neoclassical model to varying degrees (Casson 2003). These theories succeed in finding a role for the entrepreneur in broader models of economic growth and change, although they do not address the thornier questions that are most relevant to local development practice: (1) What determines why some undertake entrepreneurial ventures and others do not? (2) What determines the degree of entrepreneurial activity across particular places? (3) In which ways might economic development strategies encourage entrepreneurial activity and success?

The role of the entrepreneurs in economic growth and development

Leibenstein (1968, 1978, 1987) distinguishes "allocative efficiency" from "x-efficiency." Allocative efficiency refers to the efficiency with which "resources and factors of production are combined to satisfy effective demand within an

economy." Leibenstein sees x-efficiency as being more important. It is tied to "differential and inadequate motivation and information usage." Leibenstein states that "the simple fact is that neither individuals nor firms work as hard nor do they search for information as effectively as they could." He believes that for any particular firm or industry, the relationship between output and the application of inputs is indeterminate because firms do not achieve x-efficiency. Therefore, the production function cannot be clearly or uniquely specified.[3]

Leibenstein sees the role of the entrepreneur as providing the motivation to increase x-efficiency in four ways. First, entrepreneurs connect different markets to exploit arbitrage possibilities. Second, they remove market deficiencies by "filling gaps" in the market process. Third, they are input completers in that they coordinate all of the inputs required for production. Finally, they create or expand firms as productive outlets (Binks and Vale 1990, p. 36). Leibenstein sees the entrepreneur as the person who has the motivation of personal success or monetary reward to keep pushing to reduce the uncertainties in seeking the most efficient production function.

Kirzner (1973, 1979, 1982, 2009) presents the entrepreneur in the context of the general equilibrium system.[4] His entrepreneur helps move markets towards equilibrium by exploiting arbitrage opportunities for profit in real time and under conditions of uncertainty. Thus, the entrepreneur perfects information flows and, in the process, reduces market fragmentation and imbalances between supply and demand. The primary entrepreneurial trait required to carry out this arbitrage function is *alertness* to market opportunities. Entrepreneurial actions are necessary to eliminate price distortions and move the system toward general equilibrium.

Schumpeter (1934, 1947, 1950) explains the innovation process much more comprehensively and assigns the entrepreneur a central role in the transformation that typically distinguishes economic development from growth. He identifies entrepreneurs introducing innovations as the phenomenon that best explains capitalist development as an historical process.[5] Innovation creates the "perennial gale of creative destruction" that increases uncertainty and causes development to be an uneven and cyclical process. More importantly, entrepreneurial innovation increases the social product. Instability is a necessary cost of continual growth.[6]

Most contemporary research on the regional development implications of entrepreneurship follows from either the Schumpterian or the Kirznerian perspectives. The Schumpetarian tradition receives far more attention, largely because of its direct association with innovative entrepreneurship and its implication for long-term regional growth, decline, and transformation. The Kirznerian view of entrepreneurship is perhaps more directly relevant for understanding the vast majority of new and small business enterprises—most of which are not particularly innovative.

Although still largely outside of mainstream economic theorizing, there have been notable attempts to integrate the entrepreneur into neoclassical growth theory. The Knowledge Spillover Theory of Entrepreneurship (KSTE) serves as an important illustrative case that integrates neo-Schumpeterian perspectives on the role of the entrepreneur into an endogenous regional growth framework (Audretsch and Lehmann 2005; Audretsch et al. 2006; Audretsch and Keilbach

2007; Acs et al. 2009, 2013; Ghio et al. 2015). Incumbent firms, universities, and other "knowledge" incubators invest in the production of new knowledge but are not always capable of recognizing the full potential market value of their investments. The entrepreneur, by contrast, recognizes otherwise ignored opportunities and, in doing so, does not bear the full costs of producing the basic knowledge. Knowledge spillovers enable entrepreneurial firms to contribute to economic growth despite size disadvantages. Whereas large corporations promote innovation through internal R&D, entrepreneurial firms exploit external economies available in knowledge-rich regions. Their primary activity is to organize the necessary resources to translate ideas into new products and services.

Implicit in this explanation of innovation is the importance of spatial proximity. The hypothesis from the new economic geography (Chapter 5) is that spillovers occur close to the sources of knowledge generation where entrepreneurs exploit them (Krugman 1991b; Fujita et al. 1999). Entrepreneurial firms must be resourceful to access external knowledge and need sufficient financing to succeed (Audretsch et al. 2006). Regionally specific barriers to entrepreneurship and the regional endowment of entrepreneurs also come into play.

Framing KSTE within a broader context, Audretsch et al. (2006) reinterpret Schumpeter's well-known concept of creative destruction. In Shumpeter's closed system, creative destruction is the source of both innovation and competition that increases productivity and welfare. In the open region subject to global competition, job losses, company closures, and other forms of destruction are caused by competition from lower-cost producers in other places.[7] The entrepreneur promoting innovation that advances the knowledge economy may be better characterized as carrying out "creative construction."

The KSTE helps explain why investments in R&D do not necessarily translate into growth as predicted by regional growth theory and posits that innovative entrepreneurship will flourish in areas with more investment in knowledge and R&D. By providing the primary conduit for knowledge spillovers, entrepreneurship provides the "missing link" that acts as the connector between the creation of new knowledge and regional growth. The commercialization of available knowledge does not just happen; entrepreneurs must purposefully carry out this task (human agency). The KSTE is supported by evidence showing that new firm creation acts as an important mediator between knowledge inputs and regional growth (Acs and Plummer 2005; Audretsch and Keilbach 2008; Acs et al. 2012). Although not a direct test, some of these basic propositions are complementary to Klepper's (2001, 2002, 2011, 2015) work on the central role of spin-off firms in commercializing new technologies. He shows that small firms are relatively more likely to engage in radical innovation compared to large ones (see also Acs and Audretsch 1987, 1988, 1990; Acs 1996).[8]

Entrepreneurs and regional development

Research on entrepreneurship at the regional level has blossomed since the late 1990s, perhaps associated with a recognition of the growing importance of

innovation to long-term economic growth, as well as the widespread uncertainty about viable sources of jobs in the face of the heightened international mobility of capital.[9] Entrepreneurship, by contrast, is viewed as inherently more place-based, as most startups form in close proximity to the residence of the founder(s) where they likely have superior knowledge of local market opportunities and superior social and business networks (Delmar and Davidsson 2000; Sorenson and Audia 2000; Stam 2007; Dahl and Sorenson 2009).

Another strand of inquiry connects entrepreneurship to regional resilience and related concepts of economic sustainability. According to Albert Shapero (1977, 1981), a region's long-term economic viability requires *resilience*: the ability to adapt and change with changing economic forces and trends. Resilient places can adapt to opportunities and rebound from adversity more quickly than places that lack people who possess these talents and resources.

Shapero points out that most places equate economic development with more employment, income, or exports and support industrial recruitment and promotion as the best way to achieve these outcomes. If successful, Shapero argues that this strategy is likely to engender more costs than benefits. Significant public concessions and inducements, new infrastructure and services, and major growth pressures often accompany new facility location. In the long term, the area may become reliant on few large establishments and share the fate of those narrowly specialized cities that declined because they were unable to adapt to change.

The work of Benjamin Chinitz (1961) stands out as a key early contribution linking entrepreneurship to regional resilience. In his comparative analysis of the industrial evolution of Pittsburgh and New York City, Chinitz stresses economic diversity and industrial dominance as key factors that help to explain why some regions, exemplified by New York City, are capable of continually reinventing themselves through entrepreneurship. Pittsburgh, by contrast, was historically dominated by steel, making it less supportive of new and small businesses and ultimately less capable of adapting to changing economic conditions. At one level, Chinitz's work serves as an exposition of beneficial economies of scope associated with large and diverse regional economies (Carlino 1980). However, Chintz also emphasizes that local industrial structure helps shape the cultural norms that either encourage or dissuade entrepreneurial risk-taking. Similar themes would be taken up later by Saxenian (1994), in her comparison of high-tech culture in Silicon Valley compared to Boston's Route 128 corridor.

Shapero (1981) also sees a close tie between regional resilience and entrepreneurship. To build resilience, he argues, local developers need to create an environment in which entrepreneurship can flourish: high-quality factor inputs (talented and skilled labor), business and personal services that support innovation, research and development activities, and physical infrastructure which results in more communication and networking opportunities.

There has been considerable attention to resilience as a "new" guiding concept in regional growth and development, largely as a reaction to the "Great Recession" of 2008 and stimulated by funding from the McArthur Foundation. Some of this

work has generated insights about the development process, although it does not directly build upon Shapero's promising early work directly linking entrepreneurship to resilience (Chapple and Lester 2010; Christopherson et al. 2010; Fingleton et al. 2012; Hill et al. 2012; Augustine et al. 2013; Lester and Nguyen 2016; Martin et al. 2016). An exception is Clark et al. (2010), who suggest that regions dominated by smaller firms may be more resilient, although they do not test this proposition against a direct measure of resilience. One consequence is that the concept of resilience has been applied so broadly as to lose its conceptual strength.

Another cross-cutting contribution builds on social capital theory, which is often cited as an important factor in regional development. Dealmakers play a vital developmental function in addition to entrepreneurs leading growth companies, angels and experienced businesspersons helping them, and venture capitalists or other sources providing early-stage finance. Dealmakers tend to be serial entrepreneurs who have successfully (and unsuccessfully) started and spun off ventures previously. They are especially valuable as mentors and sources for expertise for new company formation. Like other factors related to entrepreneurship, the regional distribution of deal makers/serial entrepreneurs is highly variable with heavy concentrations in locations like Silicon Valley, New York City, and Boston (see Feldman and Zoller 2012; Zoller 2010.)

Entrepreneurship theories do not provide complete theories of the historical or spatial aspects of development; yet, they offer important insights about innovation and economic development. As development evolves over time, entrepreneurs create something new—new combinations, new companies, or more generically new forms of work. Entrepreneurial development affects spatial relationships. Resilience and diversity (even if not precisely defined) appear to be important characteristics of sustainable local economies.

Applications

The primary application of entrepreneurship theories at the local level in the United States and Canada is through business development strategies. Three different relevant business development strategies are often confounded: (1) new business development, (2) small business development, and (3) entrepreneurial business development. The different foci are largely a matter of specific objectives. Focusing on developing *new* businesses may be an attractive way to offset, in part, employment contractions or firm closures. The main advantages of strategies to promote *small* businesses, either new or existing, may be greater economic diversity and stability. The developer may focus attention on new and existing *entrepreneurial* businesses in order to encourage local innovation and long-term development through new firm creation and expansion. The confusion enters when one realizes that, at some point, all existing businesses were new and small, and, at least some of them are entrepreneurial. The distinctions between strategies turn on definitions of innovation and entrepreneurship and pertain to the importance of firm size.

New business development strategies attempt to promote the creation of new enterprises of all kinds. Developers have devised a range of programs to support startups, including technical assistance, marketing networks, financing, and infrastructure provision (Popovich and Buss 1990). One popular approach is the creation of incubators that provide new businesses with basic infrastructure and services at low cost for a limited period.[10] Business incubators for new business development are a useful development tool in the same way industrial parks or spec buildings support the industrial recruitment or expansion process. Whether they lead to the creation of enterprises that otherwise would not have been established is an open question. Most incubators screen applicants and require business plans to determine their potential for success (Lumpkin and Ireland 1988). A confounding factor is that only those most likely to survive are offered space. Of course, these firms were the most likely to succeed in the absence of incubator space.

The more significant problem with new business development strategies is that, unlike recruitment or expansion, few new enterprises are likely to add many jobs to the local economy. A large percentage of new businesses fail altogether, while most that survive do not grow large. One study found that, of the 245,000 startups in the United States in 1985, 75 percent of the jobs created by these firms in the subsequent three years were attributable to 735 firms, a very tiny share of the total cohort (Harrison 1994).[11] More recent work reports similar results.[12] The fact that so few new businesses have any significant growth potential suggests that new business development may be a strategy doomed to yield low returns. Yet there are other benefits beyond direct job creation. Fritsch and Mueller (2004, 2008) provide evidence that the primary job benefit of entry is not due to jobs created by the new firms themselves, which are typically short-lived and often at the direct expense of incumbents. Rather, new entries place competitive pressures on incumbent firms, potentially yielding higher growth in the long term. New business development may also be an important ingredient in neighborhood (or rural) revitalization efforts, where the scale of the success is in line with the size of the community. Indeed, the proliferation of microenterprise loan funds attests to the demand for startup assistance in lower-income communities. Nevertheless, the limited growth potential of most new businesses does not bode well for the developer who attempts to use new business creation as a mechanism to increase jobs significantly.

Small business development and *entrepreneurial business development* are concerned with both new and existing businesses, yet one can safely say that the roles of small businesses and entrepreneurial companies in the U.S. economy differ significantly.[13] The terms "small" and "business" are almost redundant. The most reliable statistical information available from the Census Bureau suggests that, in 2007, almost 28 million firms existed in the United States, and 78 percent of them had no employees. These firms typically represent sole proprietorships that may generate personal income but limited or no full-time employment opportunities. Even if only firms with paid employees are considered, less than 2 percent have 100 employees or more. In 2010, there were only about 100,000 firms with 100 employees or more

and about 17,000 with 500 employees or more. The average size of firms with employees was less than 20, whereas the median was fewer than 5 employees; the same average size and median have existed since the late 1970s.[14]

This static picture does not contradict the statement that "small businesses create most net new jobs." The confusion arises by using the wrong adjective—*small*. As noted previously, a tiny fraction of firms is responsible for the lion's share of new job creation. Evidence by Birch (1979, 1987), Acs and Mueller (2008), and Decker et al. (2014) shows that much of this job-creating is attributable to a handful of relatively young, entrepreneurial firms with significant growth potential, presumably because they serve large markets, develop new products, or introduce new technologies.[15]

Although more research is needed on high-growth firms, one message is clear: job creation efforts that focus on small businesses *per se* (companies with fewer than 100 employees) are, like new business development strategies, not likely to generate many net new jobs. "Small" businesses eliminate almost as many jobs as they create. Almost all survivors that have employees do not grow (or decline) dramatically. Furthermore, small businesses dominate the local (non-basic) sector; their multiplier effects are minimal because the size of the local market limits their expansion potential.[16] High turnover, low barriers to entry limit, and the limited size of the market reduce the potential effectiveness of assistance to existing small firms.[17]

The types of economic activities targeted distinguish *entrepreneurial business development* strategies. In this sense, they are much more focused than new or small business development programs. Generally, entrepreneurial firms are defined as young enterprises introducing fundamentally new products or innovations. They are often classified as high-technology firms or internet-based businesses, although they may belong to any industry. The statistical portraits developed by some of the research suggest that successful entrepreneurs typically have considerable business experience, working either for others or in previous business ventures. Many have insider information about how to apply new technologies or meet market needs. They tend to be single-minded, narrowly focused, and driven to carry out an idea they believe has great merit. They may be pursuing an opportunity; but, more often than not, they are driven to innovate as the result of corporate downsizing or some other form of adversity.

The typical means by which economic developers might directly support entrepreneurs in their region include: financing assistance (accessing angel investors or venture capital); providing technical assistance (locating suppliers or customers, conducting energy audits, or negotiating regulatory requirements); meeting infrastructure needs (incubator or accelerator facilities); and facilitating networking through the organization of entrepreneurial councils, entrepreneurship forums, monthly breakfast meetings for the CEOs of young growth companies, and other events to provide opportunities for peer support. The success of these measures will vary with regional context. However, in providing direct assistance in any region, economic developers should avoid promoting new ventures that would increase competition for the same local market opportunities, thereby reducing the chance

for any new venture to gain monopoly profits. In service sectors with low barriers to entry requiring minimal training, the ultimate outcome could be fewer firms and less regional employment.

Specialized direct assistance may be impactful in regions with many of the following characteristics: one or more research universities, significant private sector R&D, a large cohort of college or technically educated 20- to 35-year-olds, the presence of angel investors and serial entrepreneurs, and a relatively large labor market area. In such locations, economic developers may take on the challenge of building an entrepreneurial culture. The building blocks could include support for business planning (launch-the-venture plans), new-business competitions with cash prizes, formal and informal mentoring by retired executives (SCORE chapter), or, if serial entrepreneurs are available, periodic events featuring successful entrepreneurs, cheap space with month-to-month leases, and privately managed funds providing small seed-capital grants. Although business startup rates have declined since the 1980s, the high degree of job insecurity in the U.S. economy provides a powerful negative incentive for entrepreneurship.

Of course, the degree to which the state or local developer can develop viable programs in any region will vary and certainly favor larger places. Improving the supply of venture capital, for example, may not be possible in regions without good airline connections. More fundamentally, these programs and activities must address two important concerns. First, it is difficult to identify entrepreneurs at a point in their venture when they might benefit from assistance. Entrepreneurs are too busy to surface during the early stages of business development. They usually become visible to economic developers after they are established and need far less help. Second, entrepreneurial companies often achieve success by going public or through acquisition by existing corporations. Capital raised from going public enables the entrepreneurial company either to expand in place or in another location. When acquired, the entrepreneurial firm may be merged with the acquiring company or moved to the headquarter location.

Thus, typically, entrepreneurial companies must overcome major challenges, come into view when assistance from economic developers is not highly valued, and often leave the region when they are about to experience significant employment and sales growth. Like new and small business development strategies, entrepreneurial development programs, on average, are likely to have very limited impact on local employment. Like industrial recruitment, economic developers should consider entrepreneurial development a high risk-high reward strategy. This bottom-line lends support to the idea of improving the quality of local facilities (e.g., public education and vocational training) and services (e.g., high-speed internet connectivity) for *all* businesses.

Studies of entrepreneurial motivation suggest other types of strategies, particularly in the area of workforce education and training.[18] More importantly, material incentives must be in place to support entrepreneurship. Individuals should be able to build businesses without great difficulty and accumulate wealth as a reward for assuming business risk. Economic developers, for their part, should try to sustain

local competition and lower barriers to market entry; they should try to make local government regulation of business effective yet simple. They should support local tax policies that are fair and not oppressive to any particular industry or group. They should be tolerant of new ideas, support democratic processes, and foster ethical standards that promote individual initiative, responsibility, and honesty. These fundamentals appear to be more important than specific business development strategies.[19]

Evidence of effectiveness of entrepreneurship strategies

Business support services entail the provision of counseling services to entrepreneurs that offer assistance on topics such as developing business plans and dealing with a variety of financial, legal, marketing, and production challenges. Two studies provide evidence that firms receiving services from the U.S. Small Business Administration's Small Business Development Centers (SBDCs) benefit from enhanced survivability rates (Chrisman and McMullan 2004; Chrisman et al. 1985). However, the lack of comparison to a control group in Chrisman et al. (1985) raises doubts about whether improvements in business performance were actually due to SBDC treatment. Three additional studies of business support services in Canadian and European contexts offer evidence of a positive relationship between receiving services and firm survivability and success (Cumming and Fischer 2012; Keeble and Walker 1994; Storey 2003). Belso Martinez (2009) found no significant evidence of a relationship between participation in business support services and business growth among small firms in the Spanish footwear industry.

Incubators provide a temporary physical location for emerging firms at a reduced cost and often provide firms with business support services. The reviewed literature offers little empirical support for the idea that incubators aid new firm survival and success in the long term. Peña (2004) found no significant evidence of a relationship between participation in an incubator and the growth of new firms in Spain's Basque country. Tamasy (2007) summarized empirical studies on the role of incubators, reporting that "results suggest that business incubators do not increase the likelihood of firm survival, innovativeness, and growth" (p. 469).

As opposed to the one-on-one counseling setting for business support services, entrepreneurial education is generally delivered in a classroom setting and aims toward building a more general awareness of the skills and knowledge necessary to pursue entrepreneurship, rather than focusing on building an individual business. These programs may be aimed at youth or a college-aged population through business school curricula. Charney and Libecap (2000) evaluated the University of Arizona's Entrepreneurship Program and reported that graduates were more than three times likelier than control group members to start their own firms and have higher incomes. Of course, it is also possible that selection bias explains the results.

The startup loans/subsidies category covers a variety of programs aimed at reducing barriers to market entry for new firms, including the provision of low-interest loans, subsidies, and incentives. In his study of Spanish footwear entrepreneurs,

Belso Martinez (2009) found a "significant positive effect on return of sales and sales growth for public subsidies" (p. 208). Almus (2004) found that German firms receiving startup loans experienced significantly greater employment growth than firms in a control group did. Finally, Davidsson et al. (1994) study of new firms across Sweden found a positive relationship between the regional provision of startup support—such as loans, infrastructure development, and reduced social insurance obligations—and the regional firm birth rate.

The literature offers a mixed verdict on the ability of public venture capital and seed financing programs to encourage entrepreneurship. In his analysis of an Australian public venture capital fund, Cumming (2007) reported that the public fund was more likely than its private counterparts to make investments in startups but could offer little insight into the long-term outcomes of these investments. Lerner (1996) analyzed the performance of firms receiving Small Business Innovation Research (SBIR) awards and found that awards only had a positive relationship with employment and sales growth when the firms were located in areas with high levels of private venture capital activity. This finding led Lerner (1996) to conclude that SBIR awards served as a complement to private funds rather than a standalone enabler of entrepreneurship. Finally, Norrman and Bager-Sjögren (2010) found no significant relationship between the receipt of funds from the Swedish Innovation Center and the subsequent development of firms.

Targeted industry policies seek to attract and develop firms in a specific sector, usually a high-technology sector. An example of such an initiative is a state science and technology policy. Woolley and Rottner (2008) present an analysis of these programs focused on nanotechnology and find that the presence of state technology initiatives and related economic tools contributed to earlier founding of nanotechnology firms in that state, along with subsequently higher rates of firm formation.

Compared to the previously mentioned factors, government spending is a decidedly vague policy. However, analysis of its relationship to entrepreneurship may offer overall insight into the role of government policy. Monte and Luzenberger (1989) and Reynolds et al. (1994) found no significant relationship between the level of government spending on economic development and entrepreneurial activities. The case for more general public services spending on items such as education, public safety, and overall government spending was more positive. Bartik (1989) found a positive relationship between government spending and business startups. Reese and Ye (2011) found a positive relationship between government spending on public services and sustained economic health—citing this as evidence of the role of investments in quality of life for economic development.

The literature reported that tax rates had either an insignificant or a negative relationship to entrepreneurial activities. Bartik (1989) found property taxes to have a particularly significant, negative relationship to startups and speculated that this may be because these taxes are levied regardless of profitability. Bruce and Mohsin (2006) also find support for a negative relationship between tax rates and entrepreneurship but state that the impacts are so small as to make changing tax policy an infeasible approach for stimulating entrepreneurship.

Feldman et al. (2011) and Kim et al. (2012) present evidence that suggests a connection between policy efforts which enable labor mobility and the level of entrepreneurial activities. Motoyama (2019) provides a comprehensive assessment of many entrepreneurship-promotion strategies. Overall, he shows that these policies and strategies are largely ineffective. In his final chapter, he offers commonsense ways to promote and support entrepreneurship.

Elaboration and criticisms

Although Schumpeter ignored the spatial dimension, his theory provides the most complete picture of entrepreneur-led economic development. The disequilibrium model he developed (1934) has two circular flows. The upper circular flow contains routine production and consumption of the economy. Over time, the upper flow reproduces the economy and seeks equilibrium. The lower circular flow disrupts the upper flow's stationary state through innovation. Thus, only in the absence of economic development and innovation is general equilibrium possible.

Revenues received in the routine circular flow are needed for existing inputs and are not available for risky investments. Innovation must be financed from outside the upper circular flow. Bankers (more properly, venture capitalists or merchant bankers) stand ready to provide credit to entrepreneurs from the savings of property owners. By using their power to create new money in the form of credit, they provide the needed funds.[20] Due to full employment, credit creation generates inflationary pressures in the economy, which reduce real wages and force saving. That is, since inflation increases profits and reduces real wages, consumption declines relative to total income and therefore real saving increases.

Capitalism as an evolutionary process cannot remain stationary. According to Schumpeter (1950), through innovation, producers anticipate and produce what consumers need rather than respond to consumer sovereignty. Entrepreneurs are motivated to introduce new combinations—new consumer goods, new methods of production or transportation, new markets, new sources of supply, or new forms of industrial organization created by capitalist enterprise. New combinations are the driving force behind economic development.[21] Creating new combinations is the function of Schumpeter's entrepreneur. Thus, Schumpeter's entrepreneur is neither capitalist (owner), nor inventor, nor manager. Schumpeter's entrepreneur is the heroic innovator who requires intuition, the "capacity of seeing things in a way which afterwards proves to be true" and of "grasping the essential fact" (1950, p. 85).[22]

The established firm is more likely to concentrate on expanding output and gaining market share using existing methods and procedures, increasing economic growth as a result. On the other hand, entrepreneurs tend to carry out new combinations in new firms, which eventually displace older ones. They create new products or markets, find new methods to produce and market commodities, or introduce new methods to organize production. Through the innovation process, entrepreneurs foster economic development.

With this conceptual model, one should not look at capitalism in static terms nor worry about existing structures of the economy. The more important issue is how capitalism creates structures and destroys existing ones. The capitalist system is "incessantly revolutionizing the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter 1950, p. 84). This process of "creative destruction" or innovation is the essential dynamic of capitalism. Competition from new combinations, then, is the real threat to existing firms, not only in fact but also as an ever-present threat. "It disciplines before it attacks" (Schumpeter 1950, p. 85). Monopolies and other forms of imperfect competition are not only temporary market conditions but can be beneficial if based on price-lowering economies of scale.[23]

Schumpeter does not believe that innovations or new combinations are evenly distributed in time but instead appear "discontinuously in groups or swarms" (Schumpeter 1934, p. 223). This process takes the form of a cycle when entrepreneurs, financed by bank credit, introduce innovations. If these innovations are successful, imitators follow, any existing monopoly ends, investment for related innovation increases, and the economy begins an upswing. The railroad, the automobile, and the internet provide examples, as their introduction caused numerous related innovations. Investment and innovation eventually slow down, however, and mass production, due to standardization of the innovation, floods the market and dampens price increases. Rising costs and interest rates reduce profit margins, the economy contracts, and recession ensues. Sequenced around the overall upward trend of the economy, recessions and depressions are a natural response to the grouping of innovations during the previous economic upswing. Business cycles are inherent in the long-term process of economic growth.

In his developing economy, Schumpeter believes that above-normal profits are the reward for innovation and the assumption of risk. It is the price society must pay for revolutionary gains in economic development. In addition, Schumpeter contends that capitalism actually reduces inequality in several ways: (1) by increasing equality of opportunity relative to earlier, more class-bound societies, (2) by creating mass-produced products that benefit the working masses more than they do any other sector of the economy, (3) by philanthropy and social legislation underwritten by the process of capitalist economic growth, and (4) because "absolute poverty" falls as capitalist development proceeds, although the variation in incomes and wealth may increase. Unfortunately, the distributions of income and wealth have grown dramatically more unequal since the late-1970s in the United States.

In summary, the entrepreneur investing under risk and uncertainty is not the rational calculating manager making routine decisions. The entrepreneur is neither manager nor inventor nor capitalist. The capitalist may risk funds, but the entrepreneur controls the use of those funds. The entrepreneur is an innovator who introduces new combinations—a new product, new method, new market, new resource, or new organizational form.

The introduction of new combinations, which are spontaneous and discontinuous, leads to cyclical development and the "creative destruction" of existing

activities for new and better ones. In this vein, Schumpeter is not concerned with the monopolization of markets or the rise of colluding oligopolies. Large producers often are more efficient than smaller producers, and oligopolies will ultimately be smashed by innovation that makes these industries obsolete. Of course, this position is supportable as long as entrepreneurship continues. Dominant companies have been able to extend patent protection, purchase inventions, and suppress innovations that threaten profits and market share. Large corporations may also be better able to sponsor R&D and introduce new technologies.[24]

To his credit, Schumpeter gives an important role to development finance. Again, his ideas must be reconsidered in the contemporary world of financial sources and instruments. Corporations can finance innovation from retained earnings (business savings) or from the sale of securities (stocks and bonds). Independent businesspeople must rely primarily on commercial lenders. But these financial intermediaries are not often sources of development finance (equity capital). Independent businesses need access to long-term equity capital, what is called "patient money," that is not easily found. Although angel investors finance and manage the few promising ones, most new businesses continue to be financed with informal sources and personal loans (credit cards or home-equity loans). Some entrepreneurs may now be able to access start-up capital through crowdsourcing.

In regions that are largely technology-borrowing and import-substituting, some economists have claimed that Schumpeter's priorities of innovator over "mere manager" should be reversed. One of the problems lies in the inefficiency of the routine managerial functions that prevent entrepreneurs from continuously expanding their firms and from moving into more complex economic activities.[25] In addition, the entrepreneur does not have to stimulate demand; imports have already mapped out large markets. In this environment, perceiving truly new economic possibilities and carrying out pioneering technical and organizational innovations are not very relevant.[26] The work of Kirzner (1979), Baumol (1983), Leibenstein (1987), and Kilby (1988), among others, illustrates the need for efficiency-seeking behavior. This need includes gaining the ability to manage an increasingly complex business organization.[27]

Related to the problem of how the entrepreneur fits into or drives the development process are the many theories about the institutional, cultural, and educational factors that inspire entrepreneurs to undertake business ventures. Among the best known is McClelland's (1961) model of *n* achievement. McClelland argues that entrepreneurs are motivated by a need for achievement, not necessarily other more commonly regarded factors, including monetary reward and acquisition of power. He bases his thesis on a detailed study of entrepreneurship in the industrialized West versus underdeveloped countries. Much subsequent work in the international development field in the 1960s and early 1970s focused on the different factors affecting the supply and demand for entrepreneurship in industrialized versus less developed countries (Leff 1979).

The most important studies from the local developer's perspective are those that connect entrepreneurial behavior to environmental influences. In a study of Italian entrepreneurs, Dubini (1988) examines the interaction between personality and

location.[28] Other studies attempt to identify generic barriers, or, alternatively, the characteristics of receptive environments, for example, Bruno and Tyebjee (1982). Important examinations of entrepreneurial behavior can be found in Bird (1989), Bird and Schjoedt (2009), and Acs and Audretsch (2010).

The contributions of scholars from so many different fields have led to the creation of a rather rich and diverse literature on entrepreneurship that has proven resistant to the type of intellectual lock-in that often plagues research dominated by a single discipline. But at the same time, it also means that body of entrepreneurship research often seems scattered and piecemeal. Studies on regional differences in entrepreneurship are rarely connected to individual actions, while studies of individual motivation and organization rarely acknowledge environmental influences or the broader context in which entrepreneurship takes place.

While there is still no universal theory of entrepreneurship, the individual-opportunity nexus proposed by Shane, Venkataraman, and others has received considerable attention as a step forward in advancing a framework for understanding how the disparate stands of entrepreneurial research fit together into a coherent whole (Venkataraman 1997; Shane and Venkataraman 2000; Shane 2003; Eckhardt and Shane 2010). Human agency is at the center of this framework, whose primary focus is to understand how and why entrepreneurs discover, evaluate, and organize resources in order exploit perceived opportunities for profit. However, it also recognizes that individual motivations and actions are shaped by contextual forces, including place and regional attributes, such as culture, industrial organization, regulations, and policy decisions, as well as institutional resources and supportive networks (also see Thornton et al. 2011). For regional development, the key takeaway from the individual-opportunity nexus is that research should focus how policies and regional endowments influence an individual's motivation for identifying opportunities and whether they enable or hinder their ability to exploit these opportunities once identified successfully.

Entrepreneurs and regional development

Recent empirical work situates entrepreneurship and innovation in broader models of regional development. Much of this research addresses new company formation and the related concepts of human resources, knowledge spillovers, and industrial organization. Identifying opportunities to spur entrepreneurship initially depends on an understanding of the factors that enable new firm formation, survival, and growth. Scholars theorize that firm startup and performance depend on personal characteristics of the entrepreneur, the environment facing the entrepreneur, and, after startup, the characteristics of firms (Wagner and Sternberg 2004; Tamasy 2006; Korunka and Kessler 2010). Relevant personal characteristics include education, experience, wealth, access to information and support networks, and motivation. Among the important regional characteristics are the education level of the regional workforce, available financing, infrastructure quality, market demand, the presence of other entrepreneurs, a culture that is supportive of small businesses and

tolerant of failure, related firms or industry clusters, and research activity. In addition to being impacted by these personal and regional factors, the growth prospects of new firms may also be diminished by their novelty and small size (Tamasy 2006).

Additional studies report significant regional variation in the formation of entrepreneurial enterprises, whether measured by the relative presence of small business, the self-employed, or new/young firm formation rates. These studies also provide empirical evidence of the factors that are associated with differences in regional entrepreneurship, although most are based on cross-sectional regressions and are best interpreted as correlations and not necessarily cause and effect. The following list provides, in rough order of the significance or scholarly attention, a summary of those variables found to influence regional variations entrepreneurship positively.

1 Regional market demand as expressed primarily through population growth rates and/or growth in household/personal income (Monte and Luzenberger 1989; Davidsson et al. 1994; Keeble and Walker 1994; Reynolds et al. 1994; Wagner and Sternberg 2004; Lundstrom and Stevenson 2005).
2 Education and experience levels of entrepreneurs and the regional workforce (Bartik 1989; Audretsch and Fritsch 1994; Cooper et al. 1994; Keeble and Walker 1994; Davidsson and Honig 2003; Bosma et al. 2004; Peña 2004; Lundstrom and Stevenson 2005; Bruce and Mohsin 2006; Bergmann and Sternberg 2007; Kim et al. 2012).
3 Capital availability (Cooper et al. 1994; Keeble and Walker 1994; Bosma et al. 2004), or higher homeownership rates as a proxy for the availability of household equity (Reynolds et al. 1994; Renski 2014).
4 Population density and agglomeration affects (Audretsch and Fritsch 1994; Davidsson et al. 1994; Garofoli 1994; Reynolds et al. 1994; Lundstrom and Stevenson 2005; Verheul et al. 2009; Sternberg 2011).
5 Favorable regional attitudes toward entrepreneurship as proxied by the abundance of small firms in a region and/or the relative absence of large "dominant" firms (Keeble and Walker 1994; Armington and Acs 2002; Lee et al. 2004; Wagner and Sternberg 2004; Acs and Armington 2006).
6 Entrepreneur access to firm networks (Davidsson and Honig 2003; Bosma et al. 2004; Peña 2004; Lundstrom and Stevenson 2005).
7 Regional variations in industrial mix, to the extent that entry is more common in some industries than others, and these more or less entrepreneurial industries are relatively more concentrated in certain places (Fritsch 1997; Johnson 2004; Fritsch and Falck 2007; Renski 2014).
8 Higher tax rates limit entrepreneurship (Bartik 1989; Lundstrom and Stevenson 2005; Bruce and Mohsin 2006; Hansson 2012; Kim et al. 2012), while higher spending on public services creates places attractive to entrepreneurial talent (Bartik 1989).
9 Level of regional innovation (Goetz and Freshwater 2001; Kim et al. 2012), or the presence of creative individuals as measured by employment in artist and cultural industries (Lee et al. 2004; Renski 2014).

10 More extensive labor regulations and higher wage levels limit entrepreneurship (Bartik 1989; Van Stel et al. 2007; Verheul et al. 2009).

Based on the empirical evidence, policies that can influence these factors may be expected to affect the level of regional entrepreneurship activity.

A smaller, but growing, body of work looks to explain spatial differences in new business survival and/or growth. The results are more mixed than those for regional entry rates and may depend on the type of industry in question. For example, population growth, educational attainment, and the prevalence of smaller firms in the region are often found to be neither significant nor associated with higher failure rates (Acs et al. 2007; Renski 2011). Beneficial external economies of localization are associated with higher new business survival rates in some studies (Woolley and Rottner 2008; Renski 2011), although others find a negative effect from a concentration of similar firms, presumably due to heightened competition (Stuart and Sorenson 2003). Several studies find that new firms are more likely to survive in urban areas (Fotopoulos and Louri 2000; Acs et al. 2007; Brixy and Grotz 2007), as well as in industrially diverse regions, which are usually larger metropolitan economies (Renski 2011). However, several others find lower survival rates in urban areas possibly due to greater competition or because cities attract more innovative entrepreneurs working in more risk-laden domains (Renski 2009; Huiban 2011; Yu et al. 2011).[29]

Shapero argues that resilient regional economies need many small firms that may succeed or fail but which, overall, offer more stable growth. Furthermore, small firms, indigenous or recruited, are often more innovative than large ones. The most desirable entrepreneurial firms are small knowledge-intensive enterprises because they build the region's skills and human resources. Better-educated workers become more fully involved in the community. Thus, local economies become resilient and diverse as a result of people who are creative, willing to take initiative, and able to assume risk. Resilient, diverse areas can adapt to external forces and adopt new patterns of behavior (Alchain 1950).

The proper "industrial ecology" for resilient, self-renewing economies is built in stages. Expansion of a high value-added company can often be considered a random event. To survive and prosper, however, such firms need (1) proper financing, which may require educating local lending institutions; (2) a network of supportive business services—technical, legal, financial, marketing; and (3) adequate physical infrastructure. In particular, Shapero was keen on educating bankers to help them evaluate new business loan requests more accurately.[30] The entrepreneurial culture as well as the local business environment should improve as a result.

Over time, diverse economic growth increases local incomes and consumer demand. Deeper markets make the region more attractive to additional new companies (Shapero 1977).

Shapero offers many interesting insights about innovation and economic development. Like Kirzner and Schumpeter, he puts entrepreneurs at the center of the growth and development process. Entrepreneurs learn from experimentation and

from failure. They are motivated by positive but more often by negative career events. They usually gain valuable work experience with large, established firms. They often strike out on their own after confronting a crisis, such as losing a good job. Collectively, they can sustain economic development.

Yet, Shapero's argument has several flaws. He measures entrepreneurship as the rate of new company formation, but this indicator is far too broad because it treats all new businesses as if they were entrepreneurial firms. As a result, Shapero does not suggest good measures of the capacity communities have for self-renewal.[31] Shapero assumes that all regions have the ability to recruit new or young companies and can build an industrial ecology or milieu that will promote new company formation. These assumptions, however, are not correct for many places, especially smaller cities and rural areas. Furthermore, Shapero never clarifies exactly how entrepreneurship leads to self-renewing local economies. He does not define resilience operationally.

Shapero misunderstands diversity when he points to the evolutionary process as an example that "nature" provides economic developers. In nature, diversity decreases as closed ecosystems evolve over time. In the ecological context, the concept of *resistance* may be counterposed to resilience (Volker et al. 1992; Volker and Wissel 1997; Bodin and Wiman 2004). In the regional development context, large firms and oligopolies have demonstrated considerable staying power. Highly specialized regions have withstood greater cyclical instability and often experience sustained periods of growth. Perhaps deep pools of talented workers (occupational specialization) represent one form of resistance that can lead to positive economic outcomes. Resistance can also be viewed as a characteristic that increases with city size underscoring the notion that size matters.

Further research on entrepreneurship most helpful to economic developers should assess ways to increase the odds of entrepreneurial success in particular regions. Yet, as they stand, the various theories of entrepreneurship provide a substantial counterweight to economic growth theories. The latter analyze the economic outcomes of existing structures; the former examine how the economic structures themselves change. This distinction is an essential aspect of the difference between growth and development.

Discussion questions

1 In what ways does entrepreneurship rely on notions of individual agency that is otherwise lacking in mainstream economic theorizing?
2 What are the benefits of focusing on developing *new* businesses generally? How do these compare and contrast to strategies that focus on small or locally owned businesses?
3 How do entrepreneurship theories such as the knowledge spillover theory of entrepreneurship align with other contemporary theories of regional growth, such as new growth theory? Does this union help bridge the divide between growth and development?

4 Are entrepreneurs and new businesses inherently more place-based than incumbent firms, such that targeting them is more likely to produce local returns than trying to recruit businesses from elsewhere?
5 What types of development strategies might arise from a Kirznerian perspective on entrepreneurship versus a more Schumpeterian perspective?
6 According to Shapiro, what is the association between entrepreneurship and regional economic resilience? How does this align with or differ from other conceptions of economic resilience, such as those stressing industrial diversity?
7 What social or cultural factors determine the inclination to innovate? Do these help explain regional variations in rates of entrepreneurship?
8 Does regulation, the general extension of state control over the economy, reduce or motivate innovation? Can you provide some examples where state regulation has fostered or hindered innovation?
9 Do entrepreneurship theories offer insights as to how the goals of sustainable environment and sustainable economy might be balanced? Does an entrepreneurship-based strategy make it possible to undertake ecologically sustainable development while also ensuring economically sustainable development?
10 Can the entrepreneurial element of economic advance be promoted directly through policy or is it better to improve the overall livability of an area and/or the business climate?
11 Should a region attempt to "pick winners"' by nurturing and supporting specific entrepreneurial business seen as having growth potential, or should a region instead try to encourage as much entrepreneurship as possible.

APPENDIX 7.1

Entrepreneurship strategies in context: the Research Triangle region

Many ideas discussed in this chapter can be illustrated by using the Research Triangle region as a case study. The Research Triangle Park (RTP) is one of the best-known research parks in the world. In the early 1980s, the *Wall Street Journal* editorialized that RTP, along with Silicon Valley and Route 128 in Boston, was one of the more prominent centers of entrepreneurship in the United States. The editorial was wrong.

From its inception in 1959 until the late 1980s, RTP housed largely institutional research. U.S. and foreign corporations headquartered elsewhere established branch R&D facilities in RTP. By the early 1990s, RTP had experienced over $2.0 billion in development and provided for more than 35,000 employees in a metropolitan area of about 1.0 million population. Over the years, corporate R&D conducted in RTP has served parent companies. Activities range from experiments that have led to new products (e.g., drugs to retard AIDS) to routine research that enables the company to customize an existing product in order to provide better customer service. Although IBM put RTP on the map in 1965, eventually employing over 10,000 people in production as well as R&D, most other major corporations limited RTP operations to research and prototype development.

IBM's R&D activities were innovative to the extent that they led to new products and technologies. As a major focus during the 1980s, the company developed, tested, and produced personal computers in the RTP. IBM developed this product line in order to gain share of a market that was growing much faster than the mainframe market it already dominated. Firms like Apple, Intel, and Dell were the more innovative firms; IBM was a successful imitator.

In fact, the IBM case seems to illustrate Schumpeter's argument about structural change fairly well. Large oligopolistic firms that have come to dominate a market find their competitive position undermined not by competition from within their own market but by firms producing a fundamentally different yet substitute

product. In this case, personal computers effectively undermined the market for mainframes.

The most successful innovative company in the Research Triangle area that actually followed the scenario of an entrepreneurial firm is SAS Institute, Inc. SAS, like most startups, could not afford to develop a facility in RTP, in part, because of regulations allowing for building on only 15 percent of the site. In the late 1960s, two members of the faculty at North Carolina State University commercialized software products they had developed to implement canned statistical procedures on mainframe computer systems. By the late 1990s, SAS had become one of the largest independent software companies in the United States, with annual domestic and international sales in excess of $300 million. Red Hat and Quintiles are also successful entrepreneurial firms in the Triangle area that had no relationship to RTP. IBM has acquired Red Hat, and Quintiles and IMS Health have merged to form IQVIA.

In the late 1980s, major tenants of RTP began downsizing in response to growing competitive pressures. IBM changed its time-honored policy of job security and began to lay off employees. Two British pharmaceutical companies merged into Glaxo-Welcome, leading to the merging of R&D facilities and personnel in RTP. In the 1900s, Nortel, a major Canadian communications company, had 9,000 employees at its peak; it closed down its RTP facility in the early 2000s. Other large corporations experienced similar although less dramatic downsizing.

As a result of mergers and downsizing, many highly skilled research and marketing staff were looking for jobs. Some of these workers either left the Triangle area or found employment with other local firms. Some became consultants and found enough work to justify staying in the area, at least in the near term. Others founded new companies some of which succeeded.

These new companies began as entrepreneurial firms. In this case, Shapero's insight that entrepreneurship is encouraged more by adversity than opportunity appears to be correct.[32] Some of these firms are engaged in exciting new product development in the areas of computer software, genetic engineering, clean energy, or medical devices. Other founders have exploited profitable niches providing services to their former employers. The most prominent among these in the Research Triangle area are IQVIA (formerly Quintiles) and other contract service organizations that test new drugs and report research findings to major pharmaceutical companies. These activities represent an example of outsourcing, which is a way to reduce labor costs more than a means to spur innovation.[33]

By the turn of the century, the Research Triangle area had finally achieved, in fact, what had been proclaimed two decades earlier. The area had become a hot bed of entrepreneurial activity. The local Council for Entrepreneurial Development, one of the largest organizations of its kind in the country, moved from it spacious RTP offices to cramped, funky space in downtown Durham. This relocation reflected the preference young tech-savvy entrepreneurs appear to have for vibrant urban centers. Experienced businesspersons are also coming to redeveloping areas in downtown Durham and Raleigh as never before. Sometimes their motivation is to work in a region where their household can experience a higher quality of

life. Other times, it is to pursue opportunities with growing entrepreneurial firms in the area. New business licenses and incorporations are being issued at rates far above the historic averages.

Since the turn of the century, the spatial pattern of entrepreneurship thus has shifted from the RTP's suburban office park environment to the core areas of Durham and Raleigh. Major redevelopment projects in both cities combined with advanced research at the three major universities and successful commercialization of technology have resulted in more rapid economic recovery and sustained growth.

As noted earlier, state and local economic developers may have been able to assist these entrepreneurial companies directly in useful ways. They could help entrepreneurs find mentors, peer groups, or formal organizations they control, like the Council for Entrepreneurial Development. Many younger entrepreneurs appear to seek compact, mix-use walkable locations with urban amenities. Economic developers can lend support to such redevelopment efforts.

In conclusion, the most attractive strategies based on entrepreneurship theories do not attempt to forecast markets or pick winners. In larger regions, various kinds of direct assistance can be beneficial, especially through entrepreneur-led organizations and serial entrepreneurs. In all regions, long-term approaches make sense to build the infrastructure that makes the region more attractive, both to entrepreneurial firms and to talent-rich households. One important and challenging task for state and local economic developers is to assess the entrepreneurial capacity of the places in which they work. They should use the theoretical insights presented in this chapter to think through the elements of a local entrepreneurial ecosystem and the connections between these elements.[34]

Notes

1 New firms that survive and grow or small firms may indeed be innovative.

2 Citing Baumol (1968), Casson (1987) notes:

> The "disappearance" of the entrepreneur is associated with the rise of the neoclassical school of economics. The entrepreneur fills the gap labeled "fixed factor" in the neoclassical theory of the firm. Entrepreneurial ability is analogous to a fixed factor endowment because it sets a limit to the efficient size of the firm. The static and passive role of the entrepreneur in neoclassical theory reflects the theory's emphasis on perfect information—which trivializes management and decision-making—and on perfect markets—which do all the coordination that is necessary and leave nothing for the entrepreneur (1987, p. 151). See also Casson 1982 and 2003. In the more recent edition, Casson acknowledges that modern neoclassical theory, specifically endogenous growth theory, recognizes the entrepreneur as the agent improving technology through the introduction of innovations.

3 Knight (1921) anticipates Leibenstein by recognizing that economic decisions are made in real time under conditions of uncertainty. Of all decisions, planning decisions incorporate the longest time frame and involve the greatest uncertainty. Large corporate organizations can reduce uncertainty by bringing more elements under corporate control and expanding available resources. Thus, the large corporation may be more effective than individual entrepreneurship. Its effectiveness depends on corporate managers who exercise alertness, foresight, and good judgment in making sound planning

decisions. Successful managers become corporate leaders who bear the costs and reap the benefits of uncertainty.

Since the global economy is dominated by the large corporation and not independent firms, corporate innovation is quite relevant. One hypothesis is that the business groups which are organized within many countries can provide the entrepreneurial function (see Strachan 1976). Another hypothesis is that through "intrapreneurship," individuals can innovate within the corporate umbrella (Pinchot 1985). In either case, identifying innovators and understanding the innovation process in the U.S. context is critically important. See also Drucker (1985).

4 Walras, who, in the late 19th century, formalized the general equilibrium system in mathematical terms, recognized the need for an information channel to communicate and coordinate *a priori* plans between consumers and producers. Such communication is necessary to apply the neoclassical assumption of perfect information in a meaningful way. Walras devised a mythical auctioneer who perfected markets by providing information as a public good to various actors about the plans of other actors. This coordination of *a priori* plans was sufficient to overcome the ignorance reflected in initial price discrepancies. The effective auctioneer would enable households and firms to arrive at equilibrium prices and quantities that cleared all markets. Kirzner, a member of the Austrian school of economics and protégé of von Mises, substitutes a real actor for Walras' mythical figure.

5 Schumpeter also conceptualizes the entrepreneur in the Austrian tradition. His theories are based on assumptions of an existing capitalist institutional environment with private property and initiative, a system of money and banking, a spirit of industrial bourgeoisie, and a scheme of motivation demonstrated in advanced economies during the late 19th century (Schumpeter 1934, p. 145).

6 Another possibility is that economic change may gradually give rise to anti- capitalist political and social elements. Schumpeter acknowledges that cyclical unemployment and economic inequality will occur, but he believes that the secular trend will be positive. Contrary to Marx's prediction, unemployment as a percentage of the labor force has shown no upward trend; the capitalist system will continue to be productive enough to provide relief of cyclical unemployment (Schumpeter 1950). See Elliot's (1980, 1985) comparison of Marx and Schumpeter.

7 This interpretation recognizes that the "global knowledge economy" is not pervasive. In fact, the global interregional economy derives its competitive strength from multiple sources including regions that are the low-cost producers of various commodities. These regions are putting competitive pressure on higher-cost regions to lower costs or, more realistically, finding other ways to compete. Of course, cost differentials are not the only factor. These low-cost regions also tend to have few labor protections, lax environmental policies, and unfair trade practices, including manipulated currencies.

8 This is not to say that large firms are not innovative. Larger firms (those with over 100 employees) generate innovations more consistently and are more dominant in introducing new products, especially in more traditional industries. They also have the financial resources to encourage innovation by funding internal R&D and supporting new profit centers. They are also able to find innovations recently commercialized and purchase the innovating company or the rights to use the technology. The issue is not firm size; the product, management, competition, industry growth potential, regulatory environment, and so forth are the more relevant factors that determine entrepreneurial success.

9 Many important articles are organized in edited volumes. See Zoltan Acs, ed. 2006. *The Growth of Cities*. The most relevant sections are new economic geography (Part II), new growth theory (Part III), knowledge spillovers in cities (Part IV), and human capital and the growth of cities (Part V). See also David Audretsch, ed. 2006. *Entrepreneurship, Innovation and Economic Growth*, and Charlie Karlsson et al., ed. 2009. *Entrepreneurship and Innovations in Functional Regions*.

10 Incubators typically provide low-cost space, shared office assistance, and business development assistance (Allen and McCluskey 1990).

11 Harrison's (1994) numbers are from an internal study by Dun and Bradstreet.
12 Small firms with employees can be placed in three groups. Lifestyle firms which account for 90 percent of all start-ups will take on some employees but remain small and often go out of business. The remaining 10 percent has growth potential. Nine of the ten will forecast revenues up to $50 million in five years. These "middle-market" firms may attract private equity, usually angel investors. Entrepreneurial ventures are the remaining 1 percent with high growth potential with forecasted annual growth rates of 20–50 percent (Bygrave 1994). Therefore, economic development strategies to help all small businesses, whether defined as companies with fewer than 500, 100, or 50 employees, would most likely result in job churning more than job creation. Strategies aimed at new businesses have more potential to result in net new jobs, but these jobs may not last long due to competitive pressures and business failures (Kane 2010). Finally, the ability to find, qualify, and assist entrepreneurial ventures in meaningful ways would be both difficult and extremely rare.
13 Unfortunately, the distinctions are rarely drawn sharply. During the 1980s, the entrepreneur became a popular, even heroic, figure. At the same time, David Birch (1979, 1987) presented the idea that new and expanding small firms were primarily responsible for all net new job creation. Soon, the culture of entrepreneurship became entangled with the demography of businesses. As a result, small businesses development, which in almost all cases, refers to non-entrepreneurial activity, became confused with entrepreneurial business development. The very few new businesses with high growth potential, almost all of which begin small, may be considered entrepreneurial firms. Many other businesses fail within a few years. The survivors individually offer few jobs as long as they remain in business.
14 What is noteworthy is the economic importance of the few companies with 100 employees or more. In 2010, these firms controlled 65.1 percent of total employment and 70.8 percent of total payroll. In 1987, firms with 100 employees or more controlled 57.5 percent of total employment. Firms with over 5,000 employees accounted for only 0.35 percent of all firms but 33 percent of all employment and 37.9 percent of total payroll. These figures are from the U.S. Census Bureau Enterprise Statistics. The Office of Advocacy in SBA compiles enterprise information from business census sources by firm size.
15 In other words, the employment size of high-growth firms is an unstable category. For example, a high-growth firm may have fewer than 20 employees for several years until it enters its high growth stage. Within a year or two, it may have over 100 employees. Thereafter, it may enter a maturing stage during which employment growth occurs gradually. As a "small business," it experienced highly variable rates of employment growth. Focusing on a firm's transitory employment size is both confusing and irrelevant.
16 One of Adam Smith's most basic insights is that the division of labor is limited by the extent of the market.
17 Wages, hours, working conditions, fringe benefits, and advancement potential are also typically better in well-established corporate enterprises. Further discussion of small business development strategies can be found in the Winter 1992 edition of *Economic Development Review* (Volume 10).
18 Microenterprise loan programs, for example, use training and peer support groups in an attempt to create local entrepreneurs, although evidence suggests that most of the individuals participating in these programs tend to establish retail or personal service businesses with minimal growth potential. Ideally, younger persons should be able to pursue careers locally rather than migrate elsewhere to find economic opportunity.
19 The Great Recession was triggered by irresponsible behavior in the financial sector which underscores the importance of ethical standards and the serious damage that can be caused in their absence.
20 The neoclassical growth model ignores the money sphere assuming that real saving will finance direct investment conducted with perfect foresight. Schumpeter sees the money sphere as centrally important. He was well aware of the role of finance in the economy and served as the Austrian finance minister after World War I. For an outstanding book

on Schumpeter's life and work, see Thomas McCraw's (2007) insightful biography of Schumpeter.

21 Schumpeter defines development as "a distinct phenomenon, entirely foreign to what may be observed in the circular flow or in the tendency towards equilibrium. It is spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing (1934, p. 64).

22 From the perspective of having foresight, Schumpter's innovating entrepreneur can be seen as one manifestation of Kirzner's forward-looking arbitrageur who seeks any possible opportunity for profit (Kirzner 2009).

23 The auto industry, for example, may have offered cheaper and higher quality cars in the 1920s as an oligopoly than it had offered previously as a more competitive industry. Competition and the advantages it provides are found not only in the market for existing products but in the arena where the threat of new products and industries provides competitive discipline to existing firms.

24 Multinational corporations have advantages in the area of technological innovation because these firms have greater experience in the management of research and development, a lower cost of capital, and a lower discount rate for evaluating the present value of R&D (Leff 1979).

25 Kilby (1988) believes that there is an enormous backlog of new technological products and unapplied production techniques both in the developed industrial economies and in the less developed economies.

26 Adapting techniques and organization, maximizing factor productivity and minimize costs, securing working capital finance, and improving substitutes for non-available skills and materials are the tasks on the production side that will more often than not represent the critical entrepreneurial function in the modernizing economy of the late twentieth century (Kilby 1988).

27 According to Schumpeter, not only does capitalism produce commodities, it also produces culture. As rationalization becomes dominant, capitalist development begins to undermine the institutions of property and contract. Socialism becomes increasingly possible. Schumpeter was not completely serious with this analysis but was preaching doom to thwart the threat of socialism he perceived after World War II.

28 She identifies three types of entrepreneurs: self-actualizers, people driven by negative circumstances, and followers of family tradition. After examining the spatial distribution of such entrepreneurs and the characteristics of the environments in which they operate, she argues that the barriers to increased entrepreneurial activity vary both by personality and by place. For example, self-actualizing entrepreneurs may face strong cultural barriers in a parochial region that a family-tradition oriented entrepreneur would find very receptive. This variation implies that local developers should identify local impediments that are, in some sense, personality-specific.

29 One useful distinction is between new firms that serve the local market and others that export from the region and therefore have much greater growth potential. MSAs with higher incomes and more growth stimulate locally oriented startups (demand-pull). On the other hand, factors that pertain to industry mix, workforce talent, and related localization economies associate with high-tech startups (supply-push). See Motoyama and Malizia (2017).

30 This educational program could encourage banks to offer more debt capital, but it is not likely to provide a source of patient money or risk capital. The best way to finance innovation is the subject of long-standing debate. Options include relaxing regulations on financial institutions, creating new secondary markets for small-company securities, changing the taxation of dividend income and capital gains, and providing tax credits for qualified investments in young companies.

31 Possibly, the survival rate of new companies or their diversity across industries or the capacity of young firms to export would be more useful measures. More broadly, assessments of the regional entrepreneurial ecosystem may provide insights.

32 David Birch identified creatures in the animal kingdom to distinguish among firms. Most firms are mice; they are small at birth, remain small, and have short lives. In comparison to the multitude of mice, there are a few elephants; elephants grow to be large and live for a long time. The few rapidly growing firms, "the gazelles," survive through alertness and speed. Gazelles appear to illustrate Shapero's research on entrepreneurs. They are motivated primarily by insecurity and live in constant fear of being eaten by large felines (what has been called entrepreneurial terror). Economic developers want to catch some gazelles. Unfortunately, they usually cannot recognize them until they go speeding by heading for greener pastures.

33 The high cost of permanent employees has motivated many companies to limit such hires and fill many positions, especially entry-level, high-turnover ones, with independent contractors. Companies can pay these employees attractive salaries and still save significant sums by not being responsible for social security taxes, health insurance, retirement packages, or other fringe benefits.

34 The Kauffman Foundation has a series of reports on entrepreneurial ecosystems in Kansas City, Indianapolis, Chattanooga, Durham, and other cities.

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8

REGIONAL INNOVATION THEORIES

In a now classic paper on the nature of innovation, Kline and Rosenberg (1986) wrote that there is "no need to belabor the point that technological innovation is absolutely central to economic growth and to improvements in efficiency" (p. 279). What matters is developing an understanding of when, how, and where innovation occurs among firms, industries, and locations; under what conditions it may stall; and how it may be fostered through planning or policy. Also important is the practical and normative implications of innovation for individual and regional incomes, the evolving development paths of nations and regions, and the prospects of addressing serious societal concerns like inequality and environmental sustainability.

Work along these lines in the literature on regional economic development and growth began to expand in the 1980s and then exploded in the 1990s and 2000s. Until the mid-1980s, the innovation process was largely treated as a black box, exemplified by the increasingly acknowledged but little explored role of technological change in neoclassical growth theory, or as driven by human capital or general knowledge spillovers in endogenous growth theories. What characterizes theories of regional innovation today is that they are based on deconstruction of the innovation process itself, including the complex roles of a variety of actors and institutions interacting in different ways and degrees at local to global scales.

The focus of this chapter is on theories that seek to explain how the pursuit of novel processes and products occurs and influences the comparative prosperity of different regions. In general, the theories focus the economic developer's attention on the organizational features of the regional economy, from the organization of production within resident firms to the means by which firms manage their relationships with other business enterprises, build and manage their supply chains, link into global value chains, engage with universities and government laboratories, and draw on local infrastructure and the labor market. The theories also highlight

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the significance of formal and informal institutions and the embeddedness of economic relationships in broader social and political contexts. In general, regional innovation theories demonstrate how social, cultural, and political relationships and institutions have an important influence on the performance of local firms individually and as actors in broader networks, districts, and clusters.

In terms of application, such theories suggest that local economic developers should take a coordinating role in setting up formal mechanisms for knowledge and technology transfer among firms, and among firms and other organizations (e.g., universities and government labs). They should also identify and address significant barriers to the adoption of new technology and knowledge among local businesses (particularly small businesses) and target recruiting and existing industries programs wisely to facilitate the continuing successful evolution of competitive regional clusters. If there is a general theme in the latest research on innovation and its implications for policy, it is that strategies are best differentiated to specific regional conditions and often to the unique characteristics of different economic specializations within the region. Moreover, economic development must be viewed as a broad arena of professional practice that involves diverse organizations from development agencies, private business services and consultancies, and industrial extension agencies, to universities, community and technical colleges, and national and state or provincial laboratories.

After a brief discussion of the innovation process itself and the foundational influence of evolutionary economic thought, the "Theories" section of the chapter summarizes the primary features of three core theories of regional innovation: regional innovation systems, the theory of flexible specialization, and territorial innovation models. The section "Applications" outlines several applications of regional innovation theories: manufacturing modernization and networks, industry clusters, the diagnosis and redress of innovation system failures, and constructing regional advantage and smart specialization approaches common in European economic development practice. The section "Elaborations and criticisms" elaborates on regional innovation by first exploring the concept of flexibility itself according to three scales identified by Gertler (1988): (1) flexibility in machinery, (2) flexibility in the organization of work within the firm, (3) and flexibility at the level of the economy. It then discusses the role of transactions costs and the implications of innovation for cumulative regional growth.

Theories

Innovation activity—particularly that associated with technology-intensive industries—is highly uneven geographically (Moretti 2012). Successful high-technology hubs like Silicon Valley in California, the Boston region's Route 128, the Research Triangle in North Carolina, the greater Toronto region, and Cambridge in England are highly visible and the subject of much press attention and academic research. Such regions also enjoy a diversity of industries, thick labor markets, robust venture capital, leading universities, and corporate and government laboratories.

With their specializations in science-based industries like biotechnology and information technology and their complement of research institutions, one could easily conclude that the ongoing success of leading technology hubs is grounded fundamentally in scientific research that uncovers novel technologies and products, which are then brought to market by savvy entrepreneurs and their venture capital backers. A natural policy conclusion is that fostering more research and development directly (e.g., via subsidies, tax credits, or public research spending) or indirectly (e.g., via supporting universities and labs) will ratchet up the regional rate of innovation and technology-based economic growth, especially when one considers that research is a public good that is likely underprovided by the private sector. Another conclusion one might draw is that regions without such rich technology-related endowments, such as older industrial centers, smaller metropolitan areas, or sparsely populated rural areas, have little prospect of succeeding on the basis of economic development strategies focused on innovation.

This implied view of innovation as applied science is called the "linear model" by Kline and Rosenberg (1986, pp. 286–287): research leads to development, then to production, and then to marketing, with little feedback among the various steps. Kline and Rosenberg contrast the linear model with an alternative perspective, where the starting point in a chain of relationships among research, invention, and production is most often the identification of a potential market need or source of demand. Invention and design follow to meet the need, provided appropriate technology is available, first from the existing stock of knowledge and then—and only if necessary and prospective returns merit—through new mission-oriented research. Designs are refined as technical solutions and related market viability are tested and re-tested. Furthermore, process innovation occurs through lessons learned from actual production and distribution.

A key feature of the model is that science is not a starting point in a hierarchy of relationships but lies "alongside the development process," most importantly as an accumulated store of knowledge and secondarily as research activity. With respect to research, innovation itself drives scientific research, and different kinds of science are needed at different stages in the innovation process. For example, basic research is more often needed at the invention and design phase, a focus on systems is often needed at the development stage, and process-related research is more likely to be of value at the production stage. Throughout, the capacity to tap and absorb useful knowledge is crucial, "knowing where to look," and "with whom to talk" in all phases of the innovation process. Innovation results from continuous and interactive feedback, refinement, and learning among the different steps required to bring a new product or service successfully to market.

While Kline and Rosenberg's proposed view of innovation is not definitive,[1] it has had a fundamental influence on modern regional innovation theories. Kline and Rosenberg's foregrounding of feedback loops, interactive learning, knowledge sourcing and sharing, demand-driven research, types of science, and the way new tools and instruments that are developed in the innovation process subsequently help foster new scientific frontiers has shaped subsequent work on innovation,

especially innovation systems theory. Imagining the various stages of innovation being conducted not within a single firm but with the involvement of networks of actors—producers, independent contract labs, government labs, universities, advanced business services providers, consultancies, and the like—raises immediate questions about the effective functioning of those networks so that learning is maximized and promising opportunities are captured. Effective functioning will, in turn, likely be influenced by hard and soft institutions (including laws, regulations, and social norms) and evolving means of engagement and communication.

Also foundational in regional innovation theories are related ideas in evolutionary economic thought, and specifically the thesis that economic growth is the result of "the co-evolution of technologies, firm and industry structures, and supporting and governing institutions" (Nelson 2008, p. 13). Influenced heavily by Schumpeter's (1934, 1950) focus on uncertainty—that often there is insufficient information to predict with any reliability the result of trying something wholly new—evolutionary economic theory rejects the equilibrium perspective of neoclassical theory and its underlying assumption of actors who make optimal choices among well-understood and predictable options. Instead, evolutionary theory claims that actors make rational or sensible choices by relying on routines, which may or may not fail them in times of considerable flux. At any given time, some actors may try something new, thereby becoming a source of innovation, creating winners and losers among firms, industries, workers, and places. The effect of such innovation is what Schumpeter called "creative destruction," the key motive force driving growth and development.

From the evolutionary perspective, the economy is always changing, both from internal and external influences. Relatedly, there is no ideally functioning market tending toward equilibrium, and thus the concept of market failure as a justification for public intervention to foster innovation lacks meaning. Instead, evolutionary economics thinkers justify innovation and other industrial policies on the basis of their social and economic returns (Nelson 2008, p. 12). This basic idea would come to influence much of current thinking about the appropriate role of government in supporting national and regional innovation, particularly the "constructing regional advantage" and "smart specialization" frameworks shaping European policy.

Regional innovation systems

Implicit or explicit in various models of interactive innovation and evolutionary economic thought are the three core elements of innovation systems: actors, networks, and institutions (Asheim et al. 2019). Theories of regional innovation systems have their origins in the theory of national innovation systems (NIS), which developed in the 1980s as a way of formulating competitiveness strategies and policies to advance economic and societal learning and innovation and, therefore, economic growth. The "system" consists of formal and informal linkages among actors networked and engaged in innovation as well as the institutions that govern these linkages. NIS ideas were a purposeful counter to the view that national

competitiveness is a function mainly of trade, comparative advantage, and relative cost efficiency (Lundvall 2010). The context is important. NIS ideas have been most influential in Europe. Like their counterparts in the United States, in the 1980s European leaders were concerned about the rapid rise of Japanese and Korean producers in key industries like automobiles, electronics, and steel. It was a rise fueled by an openly activist developmental state (Block 2008). Unlike the United States, Europe viewed its science infrastructure and level of R&D as lagging.

NIS is both a theory and an industrial policy approach, with the latter focused on diagnosing and seeking redress of various system failures that purport to restrain innovation activity. As noted by Asheim et al. (2019), Michael Porter's theories of competitiveness and industrial clusters, which in his initial earlier work lacked a spatial component, are fully consistent with the NIS focus on innovation as the primary source of a nation's competitive advantage. Porter's policy prognoses differ substantially, however, as they are based primarily on a neoclassical rather than an evolutionary view of the causes of economic growth and development.

Firms and other actors may be part of multiple, overlapping innovation systems: national, regional, sectoral, and technological (Malerba 2004; Weber and Truffer 2017). Regional innovation systems recognize the influence of proximity as well as local context, norms, and history on behavior among networked actors. The exchange of complicated, uncodified knowledge may be easier through face-to-face interaction; the trust that necessarily underlies forms of cooperative competition is likely to be more robust among actors in the same locality; and levels of interactive learning and feedback in an innovation process may be greater when firms and other participating organizations are nearby. System failures may be traced to multiple factors, including a low level of relatedness among industries in a region, a thin local labor market, weak population size and urbanization economies, the limited availability or low quality of regional infrastructure, and the inadequate functioning of territorially defined institutions. The list of potential system failures is long, but the advantages of spatial proximity are apparent.

Theory of flexible specialization

Concurrent with the early development of NIS and RIS ideas, Michael Piore and Charles Sabel argued in an influential book published in the mid-1980s that the post oil-crisis industrial economies were crossing a second "industrial divide," a period of profound uncertainty where the direction of technological development was shifting (Piore and Sabel 1984). The first industrial divide, which occurred in the 19th century, marked the emergence and subsequent dominance of mass production methods over more craft-based modes of economic organization. Henry Ford's pioneering and widely imitated method of production—the assembly line—drew its strength from massive economies of scale, standardization, an internal division of labor, and large and stable sources of demand. This technology and organization of production eventually drove smaller, craft-based producers out of business; indeed, the literature characterizes these modes of production as "Fordist."

Piore and Sabel argue that by the late 20th century, mass production itself was in crisis, with its rigidity and large scale insufficient to respond effectively to fundamental changes in the nature of demand. The thesis was put forward during a time of relative economic stagnation (the mid-1970s to early 1980s), when few major industrialized countries outside of Asia were performing particularly well.

Piore and Sabel described one alternative to the crisis based in Fordist methods as a continued reliance on mass production techniques but with the extension of Keynesian-type macro-regulation to the international level, with the aim of increasing the purchasing power of consumers in underdeveloped economies. This would, in effect, build markets for mass produced goods, maintaining the competitive viability of large-scale, standardized production. Another alternative, one they found more compelling based on the evidence they assembled, is the spread of "flexible specialization." Flexibly specialized production is a partial return to a less rigid and more craft-based technological model characterized by a type of cooperative competition among smaller firms, the use of flexible manufacturing equipment and techniques to create greater agility and customization, and a greater reliance on social relationships and institutions (e.g., norms and trust) as a means of organizing transactions (Best 1990). To illustrate this model, they cited successful regional economies in Europe and the United States that are comprised of small, networked enterprises. They argued that small- and medium-sized firms (SMEs) in such regions had found ways to coordinate production and innovation in order to serve rapidly changing niche markets and out-compete large scale producers. The SMEs were also closely tied to their regions, unlike the branch plants of large multinational companies.[2]

Some viewed the regions where these firms are prevalent as models of development worthy of replication in other places. In the late 1980s and early 1990s, a significant share of the research activity in economic development focused on identifying and confirming Piore and Sabel's hypothesized shifts in the basic organization of firms and industries. The flexible specialization perspective fueled related literatures on the adoption of flexible manufacturing techniques, the link between industrial organization and agglomeration, and external economies in "new industrial districts" comprised largely of SMEs. New industrial districts, discussed in the following section, are modern versions of the 19th-century industrial districts described by Marshall (1890 [1910]). Practical applications of the ideas are found in modernization programs, the cultivation of industry clusters, and the organization and management of formal interfirm networks. The view that flexible specialization represented a certain route to competitiveness became so prevalent in the economic geography and regional development literatures in the 1980s and early 1990s that some characterized it as the "new orthodoxy" (Amin and Robins 1990).

In the latter half of the 1990s, research on flexible specialization shifted toward an examination of some of the potential negative impacts of flexible production regimes. Harrison's (1994) critique of labor practices in many prototypical industrial districts and subsequent researchers' examination of asymmetries of power between buyers and suppliers (often between large buyers and their smaller and

dependent subcontractors) helped spur more balanced inquiry into flexible specialization as a particular form of industrial-spatial organization. Cooperation among contracting firms does not necessarily imply an even playing field among partners. Thus, some firms may require development assistance of various kinds in order to remain competitive.[3] It became clear that the development practitioner interested in applying these ideas needs to develop a sophisticated understanding of not only markets and industries relevant to her region but also internal corporate strategy, interfirm business relationships, and the specifics of production technologies.

Territorial innovation models

Industrial districts are a type of territorial innovation model. Others are the French concept of innovative milieu, regional industry clusters (discussed in more detail in Chapter 9), and technopoles (Scott and Paul 1990). Territorial innovation models incorporate many of the locational dynamics explored in theories of regional innovation systems and flexible specialization.

The concept of the industrial district originates with Alfred Marshall's *Principles of Economics* (1890 [1910]). In his *Principles*, Marshall described the advantages smaller firms derive from locating in spatial proximity, in dense industrial complexes. The advantages are a function of dynamic external economies (see Chapter 9). As the local economy grows, so does the availability of inputs, the pool of skilled labor, and the volume of knowledge spillovers. Rabellotti (1995) characterizes the industrial district as a spatially concentrated cluster of sectorally specialized firms, with a strong set of forward and backward linkages, a common "cultural and social background linking economic agents and creating a behavioral code, sometimes explicit but often implicit," and a network of public and private supporting institutions (p. 31).

The industrial districts literature focuses foremost on examining certain dynamic regions for evidence of these characteristics. Although regions in northern Italy have received most of the attention, the number of case studies of other regions and countries is large. One can find studies of the usual suspects in the United States (e.g., Silicon Valley, Boston), as well as Asia and the developing world (Mexico, India, Brazil, to name a few).[4] These cases have played a strong role in motivating economic development strategies related to industry clusters in the United States and Europe (Rosenfeld 1995).

Early work defined industrial districts as places where the dominant industries employ flexible specialization methods *and* are highly competitive. Few studies identified specific characteristics of a flexibly specialized economy and then examined their incidence across a large cross-section of areas, an approach that might have turned up places that followed the pattern of flexible specialization yet performed poorly economically. Indeed, in a case study of Seattle, Gray et al. (1996) suggested that there are many regions in the United States with industrial structures and cultures that do not align with flexible specialization or industrial district archetypes and yet are economically resilient. In a particularly influential paper, Markusen (1996) broadened the definition of industrial districts, defining them as

"sticky places." Industrial districts as sticky places are regions that can attract and keep industrial activity over time despite the increased mobility of business. She provides a typology that describes the most common regional industrial structures: (1) the Marshallian, (2) the Italianate variant to the Marshallian, (3) the hub-and-spoke, (4) the satellite industrial platform, and (5) the state-anchored industrial district. The core features of each type are summarized in Table 8.1. Markusen found evidence of each type after examining a subset of dynamic metropolitan economies in the United States, Japan, Korea, and Brazil.

Markusen's typology implies that many of the characteristics of the traditional Fordist model remain relevant. For example, the hub-and-spoke district is dominated by one or two large, vertically integrated manufacturers (e.g., Boeing and Microsoft in Seattle) that arguably enjoy significant internal economies of scale. These firms have not spun off much of their production, even as their region and the world economy have grown. Clearly, there are still advantages associated with large scale. The lesson for the local economic developer is that while industrial

TABLE 8.1 A typology of five industrial districts

Marshallian	Business structure dominated by small, locally owned firms
Examples: Late 19th century Lancashire, Manchester, Sheffield, UK	Firms enjoy few internal scale economies Substantial local interindustry trade Long-term buyer-supplier contracts and business partnerships Few linkages with firms outside the region
Italianate	Characteristics of Marshallian plus:
Examples: Third Italy	Exchanges of personnel between buyers and suppliers common Cooperation between competitors to share information, risk Strong R&D, design function Strong role for government in regulation and boosterism
Hub-and-spoke	Business structure dominated by one or several, vertically integrated firms
Examples: Seattle; central New Jersey; Toyota City, Japan	Dominant firms focus is on global, not local, community Investment decisions, with global effects, made locally Dominant firms maintain strong external rather than internal linkages Internal economies of scale important
Satellite industrial platforms	Business structure dominated by large branch plants Internal scale economies important
Examples: Research Triangle, North Carolina; Kumamoto, Japan	Minimal local interindustry trade Key investment decisions made elsewhere Labor market external to the region
State-anchored districts	Business structure dominated by public sector institution(s)
Examples: Santa Fe; San Diego; Madison, Wisconsin	Local firms serve as suppliers to dominant institution(s) Low rates of turnover among local businesses Short-term contracts between institutions and suppliers Disproportionate shares of clerical and professional workers

Source: Adapted from Markusen (1996) Table 1. See source for full list of characteristics.

organization matters, the type of organization that is most successful in particular places and for particular industries and products varies. When designing ways to help local industry reduce costs, increase innovation, and become more productive, developers must not imagine that one type of business structure and organization is ideal.

Another influential analysis of territorial innovation is Saxenian's (1994) comparison of the high technology-oriented regions of Route 128 near Boston and Silicon Valley in California's San Francisco Bay Area. Studying those regions' structures in the 1980s and early 1990s, she described the former as a place dominated by vertically integrated and self-sufficient companies concerned with maintaining proprietary control over innovations and technology. This control orientation was manifested even in the spatial dimension; the companies along Route 128 are located on large, self-contained, and campus-like tracts of property. Few informal institutions existed where workers from different companies can mingle and exchange ideas. In contrast, the history of Silicon Valley is one of the independent, garage-based entrepreneurs. Even today, after these entrepreneurs have developed their own large companies and associated facilities, the business environment remains more informal and workers often move between employers, taking their accumulated knowledge and ideas with them. Again, the spatial environment plays a role. The sprawling development patterns of the South Bay area encourage the high degree of social networking that has become the region's hallmark. Saxenian concluded:

> Silicon Valley continues to reinvent itself as its specialized producers learn collectively and adjust to one another's needs through the shifting patterns of competition and collaboration. The separate and self-sufficient organizational structures of Route 128, in contrast, hinder adaptation by isolating the process of technological change within corporate boundaries.
>
> *(1994, p. 161)*

As it turns out, the Route 128 innovation economy substantially reinvented itself over subsequent decades, becoming the highly dynamic home of new industries in biotechnology, medical technologies, and other fields (Asheim and Gertler 2005; Best 2001). This raises the question of what factors influence the evolution of specific districts or innovation systems and also exposes the risks of reasoning drawn from a few highly selective regional examples.

Applications

Many local development applications and strategies are informed by regional innovation theories. At the first level of the flexibility hierarchy are initiatives designed to increase the adoption of advanced production machinery and techniques (including quality and workforce management) that permit greater flexibility in improving or modifying existing designs, introducing new ones, and maintaining quality.

Modernization policy may be less concerned with industrial organizational issues than with the basic factors that prevent firms from investing in equipment upgrades and adopting state of the art management practices. These factors include unavailability of investment capital, lack of expertise, low levels of workforce skill, and difficulties in getting new systems up and running properly. Nevertheless, advanced equipment and practices are crucial elements in achieving greater flexibility.

Many efforts to boost regional innovation focus on supporting industry clusters, a method of understanding and promoting key regional strengths popularized by Michael Porter's (1990) *Competitive Advantage of Nations* and less directly by Piore and Sabel (1984) and the related new industrial districts literature. Closely related to industry cluster strategies is the establishment of formal interfirm networks. In fact, clusters are essentially networks of producers, linked either through formal trading relationships or through shared factors or knowledge. We consider each of these areas of application first before turning to innovation systems failures, constructing regional advantage, and smart specialization frameworks that inform much of European regional innovation policies and practice.

Manufacturing modernization and networks

Federal and state policymakers in the United States and policymakers in Europe, Japan, and Korea, among other countries, have developed a variety of support programs intended to address barriers manufacturing firms face in upgrading their facilities with state-of-the-art production technology and practices. Initially, attention was focused primarily on the rates of adoption of production equipment, but workforce management, quality management, and buyer-supplier contracting practices have received attention as well. Much of the focus is centered on SMEs, on the basis that smaller firms face greater difficulties in obtaining access to, purchasing, and implementing advanced technologies and practices. In the United States, the federal government, through the National Institute of Standards and Technology (NIST), has partially funded a national manufacturing extension service (manufacturing extension partnership, or MEP) that is implemented by state and local government agencies, universities, and local nonprofits. The network of centers extends to all 50 states and Puerto Rico and includes hundreds of field offices. MEP centers essentially provide two broad kinds of business assistance: "brokerage" services that connect businesses and third-party service providers and direct assistance via field agents (Brandt et al. 2018; Poole and Buff 2018). Services may fall into the areas of quality assurance, production process improvements, information technologies, marketing, design, regulatory issues, engineering, and workforce development.

A key rationale for public intervention to support SMEs is evidence of persistent differences between small and large manufacturers in their levels of productivity, level of investment in research and development, and average wages (Wessner 2013). In an analysis of approaches to delivering services by MEP centers in the United States, Brandt et al. (2018) find that the most effective and enduring relationships

between businesses and the centers are developed when MEP personnel act as brokers attentive to supporting manufacturing networks that include manufacturers and third-party providers. High levels of trust between MEP personnel and businesses are associated with the latter maintaining an ongoing relationship with the center (Brandt et al. 2018, p. 296). This research highlights the potential positive role of government in supporting networked production through MEP agents who build sustained relationships with regional manufacturers.[5]

Industry clusters

Traditional economic development practice focuses on the needs of individual firms, in terms of assistance for locating sites, providing worker training, and constructing and maintaining infrastructure. Beginning in the 1990s, many cities and states began implementing industrial cluster strategies, which are essentially economic development initiatives targeted to groups of linked firms (see Chapters 1 and 9 for additional discussion).

Rosenfeld calls the policy interest in industry clusters "a radical departure from traditional economic development strategy, which, whether aimed at business development or business retention, is always applied firm by firm" (1995, p. 7). Cluster strategies recognize that the fortunes of individual businesses are in many ways defined collectively, given that they depend on common factors (inputs and labor), improvements in technology, and the growth of the economy as a whole. Clusters are also a departure from the standard neoclassical view of market economies, which emphasizes fierce competition between atomistic producers. Traditionally, cooperation has been viewed in terms of price fixing and collusion and was therefore considered detrimental to the overall performance of the economy. Clusters emphasize cooperation primarily around innovation, a recognition that knowledge spillovers help drive technological advance and ultimately economic growth.

In theory, clusters are a geographically concentrated group of firms that are essentially interdependent along one or more of the following dimensions: (1) presence in the same value chain, (2) important similarities in technology or workforce requirements, or (3) part of the same knowledge networks.[6] Clusters are also characterized by the presence of related institutions, such as educational institutions, business associations, or formal networks (Feser and Bergman 2000). If they are not, this is often the first point of attack for the local developer, who might try to set up dedicated training programs in community colleges, establish a business advisory group to study ways to identify and solve problems jointly, or look for possible synergies between industry and R&D activity occurring in nearby universities (also see discussion in Chapter 9). In practice, because of a paucity of good data on local value chain linkages as well as a lack of agreement regarding how best to identify clusters for the purposes of policy, clusters are often poorly defined as regional industrial specializations. Moreover, little attempt is made to understand the social, cultural, and political factors and context that influence cluster success.

Feser (1998) identifies two types of cluster policy applications: (1) those that attempt to build particular clusters as an explicit goal of policy (cluster-specific strategies), and (2) those that use cluster concepts as a method to improve the implementation of standard or traditional development programs and initiatives (cluster-informed strategies). An example of the former is an attempt by a community to nurture a specific cluster identified by public officials and business leaders as an existing or emerging specialization. Such policies may include both demand-side and supply-side elements, as public sector attempts to stimulate demand for the various related outputs of the cluster (perhaps achieved through changes in regulation, focused government purchasing practices, or targeted consumer information programs) are coupled with programs designed to improve the competitiveness of cluster firms (e.g., technology adoption, business assistance, networks, etc.).

An example of cluster-informed strategies is the use of industry cluster analysis (the identification of different clusters and their member firms in given regions) to better focus modernization strategies. For example, local developers might seek to improve the adoption of advanced, flexible production technologies among regional manufacturers by focusing assistance and information provision on large, regional end-market producers. To the degree that technologies tend to diffuse backward through production chains, such producers may influence upstream suppliers and subcontractors to adopt compatible machinery and techniques. Information sharing within the cluster (e.g., through informal networking) may also help diffuse technologies even between firms not formally linked in the production chain. This is an example of how cluster policy as a way of implementing flexible production ideas may serve to leverage scarce development resources.

Redressing innovation system failures

An important element in innovation systems theory is the concept of a system failure that might be redressed through public intervention of some sort. Many different taxonomies of innovation systems failures exist (Asheim et al. 2019), but one of the most influential is that of Woolthuis et al. (2005). The authors describe four types of failure: (1) infrastructural development failures, such as transportation, communication, and energy systems that require public investment given their large-scale and public good features; (2) institutional failures, including inadequate laws, regulations and standards (so called "hard" institutions), and norms, values, and culture ("soft" institutions) that do not foster the kind of ease of transactions and trust in effective networks; (3) interaction failures, where networks may be either too weak and thus little supportive of knowledge exchange and learning or too strong and prone to contributing to shared myopia; and (4) capabilities failures, related to firms' capacity to create, access, and absorb knowledge. Systems failures taxonomies give regional policymakers and economic development planners a framework for diagnosing weaknesses in

industrial ecosystems that may be restraining interactive learning and associated innovation activity.

Constructing regional advantage and smart specialization

As noted earlier, regional innovation systems are not simply characteristic of economies dominated by high-technology industries. In fact, all industries undertake innovation of different kinds, a concept captured in the differentiated industrial knowledge base perspective outlined by Asheim and Gertler (2005) and Asheim et al. (2017). The idea is that different industries are characterized by different knowledge bases. The innovation activity of traditional high-technology industries such as biotechnology or information technology often draws most heavily on "analytical" forms of knowledge, characterized by formal models, concepts, and findings that are codifiable (e.g., in scientific publications), technologies that lend themselves to patenting, and licensing. Analytical knowledge is heavily science-based, and thus relationships with universities are important. Innovation in the industry as a whole is often driven by new firm formation via spin-offs from existing businesses. It is analytical knowledge—and the unique forms of interaction that give rise to it—that underpins well-known technology-based innovation hubs like Silicon Valley.

Other industries, particularly those in manufacturing, draw more heavily on "synthetic" knowledge. Synthetic knowledge is engineering-based, it arises often from new combinations of existing knowledge, it is heavily driven by practical problem solving, it is less subject to codification and therefore relies more on the exchange of tacit knowledge, and university-industry links matter but principally through applied research and development rather than basic science. A third kind of knowledge is "symbolic," based in artistry, design, and aesthetics. The innovation base of cultural industries, such as major media producers, is symbolic knowledge, which is also characterized more by its tacit features and for which social and cultural context and understanding are paramount. According to Asheim et al. (2019, p. 40), "all knowledge types can be the basis for industries pursuing an innovation-based competition."

The recognition that all industries may compete on the basis of innovation, and that the source and nature of that innovation varies, highlights the importance of customized regional innovation support strategies. The constructing regional advantage approach of Asheim et al. (2011) and the smart specialization model adopted under the European Union's regional cohesion policy (McCann and Ortega-Argilés 2011) share similarities in the guidance they offer development practitioners. Under constructing regional advantage, the aim is to tailor interventions to the specific knowledge bases dominant in a region's industry mix, with attention to "platform strategies" that stimulate knowledge flows across industries. The intent is to facilitate the evolution of industries toward a higher level of innovation and novel combinations of knowledge that open up new product opportunities or markets. In this way, economic development policy and practice seek to

shape the development path of the region toward a higher level of competitiveness. With smart specialization, one might build a local customized strategy that is widely shared among stakeholders, including analysis of the regional context and potential for innovation, development of inclusive governance, and development of a shared vision and priority setting for the region. Both the constructing regional advantage and smart specialization approaches underscore that there is no ideal-type intervention, such as supporting science-based R&D or university-industry linkages.

Elaborations and criticisms

Any production technology involves the direct physical combination of materials, labor power, and equipment to manufacture goods, as well as the coordination of relationships. These relationships may be internal to the firm (such as between different functions, e.g., production and R&D) or extend outside the firm (relationships with suppliers of intermediate goods and capital equipment, or with customers or competitors). Because different production technologies combine factors and manage relationships differently, they also have different implications for geography and spatial relationships. The debate over Fordist versus flexible manufacturing essentially constitutes a debate over trends in industrial organization and their impact on the development prospects of particular regions. The debate is carried on at a fairly abstract level; clearly it is a simplification to reduce all production technology to two general paradigms. Nevertheless, the flexible specialization approach has succeeded in making industrial organization a central concern in economic development. Local developers benefit from thinking not only about the basic locational needs of industry (quality labor, infrastructure, regulation, and taxes) but also about ways local firms can increase innovativeness, quality, and flexibility through their adoption of advanced process technologies, their R&D activities, and the ways they choose to manage linkages with suppliers and customers.

Machines, intrafirm systems, interfirm systems

Early writing on flexible production focused on broad shifts in technology, that is, the question of whether the most competitive businesses are, in fact, replacing the standardized production-oriented technologies with new, more flexible technologies. But what is flexibility? Gertler identified a "hierarchy of flexibility stretching from the individual machine on the shop (or office) floor to the very basis of organization within the economy and the society in which it is embedded" (1988, p. 420).[7]

At the first level of the hierarchy is flexibility in production machinery. New types of capital equipment that take advantage of computer technology allow producers to re-program rather than completely re-tool as they introduce qualitative changes in products or even wholly new products. The result is that plants are becoming obsolescent at a slower rate. Perhaps, more importantly, it is becoming

easier for companies to introduce variations in product to meet niche markets, a type of customized mass production. In some cases, this means the time from plant set-up for a new product and actual production is reduced; in other cases, plants are able to vary products significantly in real time. The study of the rates at which firms were adopting new technologies was especially common in the 1990s. Governments administered surveys designed to gauge the degree to which producers were incorporating new technologies, with the results informing manufacturing extension programs and other modernization efforts designed to diffuse new technologies throughout the economy.

Individual pieces of flexible machinery do not operate in a vacuum. The second level of the "flexibility hierarchy" involves the combination of machinery and business functions into an integrated system within the firm, drawing on tools and techniques in computer-integrated manufacturing, computer-aided design, computer-aided engineering, robotics and autonomous systems, material handling systems, and networks linking procurement, design, and production. Flexibility in production is also improved through relationships with outside suppliers and customers. It is through the linkages between firms that spatial implications become manifest. Firms may use just-in-time scheduling and delivery systems to reduce inventory costs and interfirm computer networks to manage this process through the electronic exchange of data related to design specifications and order delivery.

The third level of the flexibility hierarchy is strategy and management within and among firms. Contracts negotiated between buyers and suppliers, and the management of related transactions, are tied to the general strategy on which a given firm chooses to compete. Flexible specialization theorists such as Piore and Sabel (1984) argued the days of mass markets of consumers with undifferentiated tastes were ending and that firms must increasingly specialize in niche markets. Firms can serve niche markets better by working closely with suppliers, perhaps even outsourcing a greater share of the production of a given good, to produce a greater variety of goods in smaller quantities. The need for continuous innovation also dictates coordination with suppliers. Successful implementation of this strategy may require longer-term, stable relationships with business partners rather than the arms-length, least-cost type of transactions presumably common in large-scale manufacturing. The strategy suggests that smaller firms will be able to compete more effectively than ever before with larger firms. The greater the degree to which firms outsource production, the more apparent is the fact that one firm's competitiveness depends crucially on its partners' competitiveness.

Crucial to the success of flexibly specialized firms are cultural and social norms that foster trust between contracting parties.[8] The means by which contracts are governed is important. Trust-based transactions were found to be particularly apparent in industrial districts in northern Italy, where long-standing familial ties, a close meshing of business and social relationships, and the sense of community that these dynamics engender are common. The economic structure of northern Italy became a model that development analysts attempted to export to other places. The major difficulty with such efforts, however, was that the economic and social

structures go hand in hand. Exporting a social structure, embedded as it is in local context and history, is a near impossible task, even if it is considered desirable.

Transactions costs and regional industrial organization

Transactions costs theory focuses on the factors that determine whether a firm chooses to produce a certain good itself or instead contracts with another firm to produce the good (Coase 1937; Williamson 1975; Williamson 1985). Businesses have a choice of organizing production through the market (e.g., outsourcing inputs) or internal hierarchies (establishing its own division for the manufacture of the input). The firm's choice depends on the costs of the transactions associated with each alternative. In conditions where there is a high degree of uncertainty in terms of the type, quantity, or quality of inputs required, firms might choose to produce that good internally. Alternatively, when intermediate inputs are standardized, the firm may find it cost-effective to use the market (other firms) as its source. The study of transactions costs is the study of the conditions under which one alternative is better than the other. Clearly, the superstructure of laws, regulations, and social norms that govern market activities are a critical element. Firms may choose one course of action in one country that would be extremely costly in another. To a more limited degree, this situation may also exist across regions in the same country. Although we have cast this discussion in terms of manufactured inputs, it may also be applied to other types of factor requirements.

Scott (1986, 1988, 1992) applied the modern theory of transactions costs to the analysis of regional industrial organization, drawing on the division-of-labor framework of Stigler (1951). As alluded to previously, one can think of a firm as composed of several distinct functions: production, administration, management, research and development, and so on. (Robinson 1931). The activities of the typical firm may be further subdivided within each of the broad functional areas. For example, some firms may produce in-house a large share of their needed manufactured inputs. When this is the case, the firm effectively produces multiple products, some for final markets and some for intermediate markets, for which the only customer may be itself. The cost-minimizing scale (level of output) of production of each good may vary significantly. For example, it may cost a firm less to subcontract duplicating and printing services to outside companies than it does to maintain its own printing office. Print shops, by serving a larger customer base, are able to attain economies of scale that the individual firm cannot. The same may be true with certain manufactured inputs or other business functions.

In a relatively less developed region or economy, and/or where formal or informal institutions governing relationships are weak, the typical firm may have to produce most of its own inputs and handle most of its basic functions in-house. The market may not be large enough to support other companies focused exclusively on duplicating and printing, booking travel, managing secretarial tasks, conducting R&D, or producing intermediate inputs of various kinds. Or, transactions costs in managing relationships may be too high. This problem is typical of nascent

economies in many parts of the world. However, as the market expands with economic growth and as institutions strengthen, the establishment and survival of specialized firms becomes viable. The original firm therefore gains the option of spinning off many of its internal activities as long as it is cost-effective to do so. Adam Smith described the advantages of division of labor internal to the enterprise in terms of a pin factory, where the firm reduces costs by specializing tasks (one worker makes the pin shaft, another the head, a third joins the two, etc.). But with the growth of the market and the growing sophistication and stability of institutions, the internal division of labor may be converted to an external one; tasks may be spread among multiple firms. This idea was originally outlined in a rigorous fashion by Stigler (1951) based on Young's (1928) discussion of the link between the division of labor and economic growth.

As the degree of global competition increases, making it more difficult for firms to predict demand, and as savvy consumers seek more customized, higher quality goods, firms may achieve more flexibility by spinning off in-house functions and relying to a greater degree on contract suppliers. But to maintain a high standard of quality and a continuous process of innovation, businesses must work closely with their partners, not simply place orders for given quantities of goods but to have them delivered at stated times with agreed-upon rates of defectiveness. Proximity becomes increasingly important because it facilitates the face-to-face contact needed for mutual, interactive learning.

Link to cumulative growth

To the degree that firms in a value chain benefit from locating in proximity, this idea has clear implications for regional growth. The possibilities for a finer division of labor are improved as a metropolitan area grows in size and sophistication regarding infrastructure and institutions. Enterprises in the large and growing region enjoy advantages vis-à-vis those in smaller or rural areas. As a result, industries in large, growing places are able to increase their competitive edge, thus spurring more growth. This is, in effect, a cumulative causation argument consistent with spatial polarization models, post-Keynesian and new endogenous growth theories, and new trade theory. At issue is to what degree the forces encouraging agglomeration by firms (e.g., the importance of proximity for ensuring flexibility in production between linked firms, face-to-face interaction, etc.) outweigh sweeping general improvements in technology and infrastructure that would seem to encourage (or at least permit) greater spatial dispersion (e.g., advances in telecommunications technologies).

Researchers have sought to understand the offsetting effects different means of organization and technologies may have on concentration and dispersion by studying whether just-in-time inventory and delivery systems (JIT) lead to tighter colocation of suppliers and their customer firms. JIT attempts to improve the quality of final goods by using smaller batch runs that permit the quicker identification of problems in the production process. Not only are defects and errors determined

more rapidly but their costly and disruptive consequences are limited. The system also minimizes inventory as suppliers ship goods to the end-market producer with greater frequency rather than intermittently and in large quantities. The objective is to approximate, to the extent possible, a continuous manufacturing process throughout the entire production chain. As noted by McCann and Fingleton (1996, p. 494), "it is necessary for the customer firm to have individual shipments of goods delivered in exactly the size and frequency it requires, otherwise its internal production operations may become hampered."

The nature of JIT suggests that coordination and transportation costs may be significant enough to necessitate closer proximity between firms adopting the system. And, if such a technique became widespread in the manufacturing sector, we might expect to observe a general re-agglomeration or clustering of industry. One particularly rigorous test of these propositions was undertaken by McCann and Fingleton (1996), who found tighter spatial linkages following JIT adoption among a small sample of Scottish electronics firms.[9]

Summary

Regional innovation theories are consistent with a general trend in regional development thought toward a focus on industrial organization and structure, interindustry linkages, and externalities and agglomeration economies. Theories of concentration and diffusion (growth poles, unbalanced growth, cumulative causation, core-periphery), new growth and trade theory, and entrepreneurship and innovation theories all focus to one degree or another on the way work is organized and managed between and within firms. This organization, in turn, has implications for spatial development patterns, generally through its influence on spatial externalities (spillovers) and innovation. This is a stark contrast to economic base, neoclassical growth, and neoclassical trade theory. In economic base theory, the focus is on macroeconomic aggregates (basic versus non-basic employment), while neoclassical theories analyze the workings of the price mechanism in a world of constant returns and atomistic producers. Regional innovation theories imply neither an export-focused nor hands-off approach, but one which attempts to build the capacity of firms in a given region to continuously innovate, learn, and adapt to rapidly changing economic circumstances.

Discussion Questions

1 Regional innovation theories consider production equipment, methods of organizing production, and worker management strategies. Development strategies aimed at increasing firms' adoption of advanced production equipment are common. But should local developers also attempt to improve the adoption of improved workforce management techniques? How might such a strategy be pursued?

2 Identify several benefits available to enterprises through formal interfirm networks.
3 Are there any ways that the local political context might influence the means by which regional firms organize production? Is the national political context likely to be the biggest influence on production organization?
4 How does the dominant industrial culture of an area (e.g., energy in Houston, automobiles in Detroit, computers in the San Francisco Bay area) influence the competitiveness of local producers in the dominant sectors? In what ways might the influence be different for firms in other sectors?
5 The adoption of flexible production technologies does not ensure that firms will continuously innovate and develop new products. Are there ways that local developers can influence firms' propensity to innovate?
6 Is there such a thing as cooperative competition? That is, how might highly competitive firms also seek ways to collaborate?

Notes

1 The literature on innovation models is vast. See Fagerberg et al. 2005.
2 The question of whether flexible specialization would replace Fordism as a dominant mode of organizing production generated a spirited debate, where early adherents to Piore and Sabel's thesis were actually bolder in their predictions about outcomes than the original authors themselves. See Holmes (1986), Scott and Storper (1987), Schoenberger (1988), Gertler (1988, 1993), Amin and Robins (1990), Martin (1990), and Sayer (1990).
3 For example, some flexible manufacturing technologies, such as just-in-time (JIT) sourcing, imply contracting practices that tie suppliers closely to their customers. Under JIT, large assemblers may opt to maintain longer-term relationships with a few key suppliers rather than purchase components from a larger number of competing firms. The small group of select suppliers are favored, but they are also dependent if they are discouraged from selling to multiple producers (as research has shown is sometimes the case). This may have important implications for regions with particular industry and firm structures. A region dominated by small- and medium-sized firms may appear to fit the profile of the Marshallian industrial district from a cursory point of view. But if those firms are suppliers serving non-local firms, the flexible production model of continuous innovation, networking, and information sharing may mean less for explaining regional fortunes than the decisions of one or a few large final market (and often multinational) companies.
4 See also Harrison (1992).
5 One source defines a network as "a form of associative behavior among firms that helps expand their markets, increase their value-added or productivity, [and] stimulate learning [to] improve their long-term market position" (Bosworth and Rosenfeld 1993, p. 19). Firms in a given network may or may not serve similar markets or be members of the same product chain. Boswell and Rosenfeld describe three basic types of networks. Vertical networks consist of firms at different stages of the production chain or in the same markets that form an association to engage in joint marketing or share information regarding production or product development. Horizontal networks are made up of firms that share similar technology or service needs, whether or not they are in the same product chain. In practice, the organizational structure of the networks varies significantly, as does the degree of formality involved. A third type of network is a knowledge network, made up of firms with few commonalities in terms of product chain or market that band together to share information regarding business practices. These firms meet to identify and solve common problems, exchange information, and stimulate continuous learning

and improvement. The knowledge network is effectively a special type of the horizontal network.

6 Clusters are typically defined as establishments in related industries that are linked in some way (e.g., through buyer-supplier relationships) and that tend to co-locate in geographic space. In a test of spatial and economic clustering, Feser and Sweeney (2000) found evidence that linked firms (particularly those in technology-oriented sectors) actually do have a greater propensity to cluster geographically. In earlier work, Sweeney and Feser (1998) tested whether small, single establishments have an "above average" tendency to co-locate, a key postulate of many flexible production theories. That study found evidence of spatial clustering by establishments employing between 10 and 50 workers; no spatial clustering was found for the very smallest or larger (over 50 workers) plants.

7 It should be noted that although much of the flexible production literature focuses on small firms and often customized or batch producers, large mass producers may also adopt flexible manufacturing techniques. In fact, some evidence suggests that the highest rates of adoption of flexible techniques and practices are among larger producers (Bergman and Feser 1999).

8 This is often described as the concept of "embeddedness" (see Granovetter 1985; Harrison 1992; Asheim 1996). Ettlinger (1994, pp. 161–162) argues:

> Critical ingredients of long-term localized development, regarding both productivity and social welfare, include a production system and set of social relations suited to partnership principles of cooperation and collaboration, appropriate organization of local interests to achieve consensus, and finally, an active local government that articulates the needs of workers and firms through both supply-side policy (education, training, service provision) and indirect relations with the private sector through incentives that influence competitive firm behavior amid competing production systems in the global economy.

9 The strong comeback many downtowns and other denser employment centers have made across the United States and Canada may provide additional evidence about the value of proximity. Chapter 9 provides thorough coverage of this topic.

9

THEORIES OF AGGLOMERATION

This chapter explores how agglomeration relates to economic development. Agglomeration is a tendency for items to group together spatially or physically. In economic development, we are interested in the agglomeration propensities and observed agglomeration patterns of firms, workers, related organizations and institutions, and economic activity. Agglomeration economies refer to the benefits and costs that come about from agglomeration: from people, firms, and economic activities locating near to one another.

The benefits and costs of agglomeration are called by different names in different literatures. "Spillovers" is often the term of choice in economics, whereas geographers prefer "interdependencies." External economies or externalities are spillovers that occur outside firm boundaries and are not compensated; agglomeration benefits (or costs) are positive (or negative) externalities. Categories of agglomeration economies also receive multiple designations, such as market versus non-market spillovers, which are labelled as traded versus untraded interdependencies in geography; compensated versus uncompensated spillovers; and pecuniary (or market-transacted) versus technological (non-market) externalities. Amid this wash of vocabulary, we mainly will employ "agglomeration economies" as our term of choice.

Why did we place consideration of agglomeration and its role in economic development as the last chapter devoted to a particular theory or cohesive set of theories? Agglomeration is a fundamental phenomenon, providing some of the underpinnings and mechanisms for other economic development forces, including the subjects of the previous two chapters, entrepreneurship and innovation. Moreover, as with entrepreneurship, agglomeration delivers a link between the concepts of economic growth and development. By positioning the discussion of agglomeration theories and its applications here, we draw upon earlier portions of the text in relating linkages and explaining applications with reference to other theories of economic development.

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Theories

We first present the factors that generate agglomeration economies. We then discuss their articulation in industrial districts, central place theory, and industrial clusters, within each of which space and place are of primary importance.

Sources of agglomeration economies

Agglomeration is one of the prominent explanations for the origin of cities (also see cumulative causation theory in Chapter 6). In some sense, cities are defined by proximity; it is precisely the density of habitation and human activity that distinguishes urban from non-urban regions (Glaeser and Gottlieb 2009). In societies in which businesses, workers, and organizations make individual choices about where to locate, cities must present some kind of advantage in order to arise and persist (Duranton and Puga 2004).[1] Understanding and distinguishing the sources of urban advantage enables economic developers to anticipate and act upon regional advantages, to develop policy and strategies in order to support or enhance local economic desirability, and to assist businesses and individuals to take advantage of the benefits of agglomeration.

Alfred Marshall receives credit as one of the first to identify and explain benefits that proximity of location and spatial density provide to economic actors. Marshall (1890 [1910]) identified three major sources of agglomeration economies that accrue to businesses that locate near to each other. The first is specialized inputs. The larger an industry is locally, the more aggregate demand it generates for its inputs, and the more feasible and efficient it is for suppliers to specialize in producing the inputs for that industry. In addition, concentrated demand or purchasing power is a powerful factor impelling local suppliers to cater to the particular needs of that industry. Consequently, agglomerated industries enjoy both greater access to and lower cost of inputs tailored to their production activities.

Labor pooling is the second of the Marshallian agglomeration economies. A spatial concentration of businesses with similar or complementary labor needs creates both sizable demand for and supply of qualified labor. This large labor market increases job opportunities for workers with specialized skills and improves the chances of achieving a high-quality match between employee skills and employer requirements. Employee turnover is less problematic for employers, as large labor pools reduce the time and effort needed to recruit suitably skilled individuals or train new workers.

Finally, Marshall recognized knowledge spillovers across firms as an important benefit generated through agglomeration (Chapter 7). Where many firms are engaged in similar or complementary activities, great potential exists for useful exchanges of information and expertise, whether intentional or via indirect channels such as employees switching jobs. This circulation of knowledge and know-how can spur innovation, increase learning and productive exploitation of information, and ultimately speed technological progress (Cohen and Levinthal

1989; Aghion and Jaravel 2015). Marshall's famous description of the mechanism of knowledge spillovers is that where a particular industry concentrates, "mysteries of the trade become no mysteries; but are as it were in the air" (1890 [1910], IV.x.3, p. 271). In other words, the precise means by which knowledge flows among businesses may not be evident, yet information is bound to diffuse among agglomerated firms. Knowledge spillovers produce benefits at the scale of individual inventors and innovators as well as for firms and industries (Lucas 1988; Moretti 2019).

Marshall's conception of agglomeration economies has proven remarkably durable. Subsequent theoretical and empirical work on the subject has served to clarify the original three Marshallian sources of agglomeration economies and extend the list of sources (Feser 1998a). Ohlin (1933) and Hoover (1937) usefully distinguished agglomeration economies arising because of localization from agglomeration economies due to urbanization. Localization economies are the advantages that accrue to co-located firms operating in the same economic market, such as within one specific industry, whereas urbanization economies are the benefits gained by all types of firms agglomerated in one location. Marshall's three kinds of agglomeration economies operate predominantly as localization economies. Examples of urbanization economies include mass transportation infrastructure, reduced transportation costs from shorter average distances, wholesaling and storage facilities, general producer and business services, and ready access to higher levels of government (Isard 1956; Lichtenberg 1960; Carlino 1978). General supports for entrepreneurship, such as the availability of shared space, networks of active and potential entrepreneurs, and opportunities to obtain experienced mentorship, tend to be related to the size of a place and so may be considered to be urbanization economies as well (Chapter 7). Because urbanization economies of agglomeration arise from unspecified (though diverse) patterns of growth yet provide pathways to new types of economic opportunities, they comprise an important bridge between the processes of economic growth and economic development (Chapter 2).

On the opposite side of the customer-supplier relationship, demand or customer pooling denotes the advantages that businesses realize by locating in proximity to potential customers (Feser 2002). Demand pooling may arise from locating near to either a large quantity of potential purchasers or a small number of discrete customers that represents a substantial amount of total demand. Robinson (1931) differentiated between mobile and immobile knowledge spillovers, arguing that the latter do not diffuse across space or do so only sluggishly and with great difficulty, perhaps due to a tacit characteristic that is not easily codified. Another distinction separates static agglomeration economies that are short term and typically reversible from dynamic agglomeration economies, which are advantages requiring relatively long periods of time to achieve, such as heightened technological learning (Glaeser et al. 1992; Harrison et al. 1996b).[2] In terms of rationales for the existence of cities, agglomeration economies may be enjoyed by consumers as well as producers, providing incentives for residential clustering (Jacobs 1961; Fujita and Thisse 2002).[3] Scholars in various disciplines continue to refine and explore the sources of

agglomeration economies in various settings and contexts (e.g., Koster et al. 2019; Yin et al. 2019).

Agglomeration may generate costs or disadvantages alongside benefits. Some of the most widely described and researched kinds of agglomeration costs are those that arise generally from urbanization and therefore are labelled urbanization diseconomies. Examples include congestion and its attendant drawbacks and irritations (traffic, crowding, queuing, etc., resulting in inconvenience and time spent), pollution, and opportunities for rent-seeking (Strange 2008).[4] In parallel, localization diseconomies are those costs associated with spatial groupings of similar firms, such as competition for specialized inputs elevating factor prices and increased opportunities for labor poaching.[5]

One of the major debates in the literature on agglomeration economies concerns the kind of configuration of firms and industries that is most advantageous for generating and capturing benefits from knowledge spillovers. The first two of Marshall's agglomeration economies, labor pooling and specialized inputs, unambiguously favor agglomerations of businesses that are engaged in similar production processes or that share similar supply needs. But whereas Marshall also conceived of knowledge spilling across businesses and workers engaged within a particular trade or production process, Jacobs (1969) instead highlighted the possibility of cross-fertilization of ideas across diverse industries. She stressed such cross-industry knowledge spillovers as being a crucial ingredient for innovation and dynamism in local economies. (See the following Criticisms and Elaborations section in this chapter for more discussion of Jacobs' ideas.) This notion of "Jacobs externalities," that knowledge spillovers that occur across industries benefit firms, and in the aggregate produce advantages for regions, has been tested repeatedly against Marshall's concept of intra-industry knowledge spillovers. The latter often is referred to as "Marshall-Arrow-Romer externalities" or "MAR externalities" to credit the influential formalizations of the economic benefits of knowledge presented by Arrow (1962) and Romer (1986).

A plethora of studies investigate the impacts of Marshall-Arrow-Romer versus Jacobs knowledge spillover externalities. Evaluated en masse, these analyses do not produce a satisfying answer to the question of the relative influence of these two types of agglomeration economies. Whether empirical research shows that economic performance is more closely linked to the potential for Marshall-Arrow-Romer externalities or for Jacobs externalities appears to depend on numerous research design factors, including the type of indicator or measure used for each type of agglomeration economy, the industrial sector, the particular outcome (e.g., economic growth, productivity, innovation), the geographic scale, and the level of industry detail examined (de Groot et al. 2016; Beaudry and Schiffauerova 2009; McCann and van Oort 2009; Melo et al. 2009). This research does, however, support the existence and importance of both types of agglomeration economies across a wide range of geographic settings and methodologies.

The idea of related variety attempts to achieve a balance between the extremes of Marshall-Arrow-Romer and Jacobs externalities (Frenken et al. 2007).

Cross-industry knowledge spillovers are important, but not all pairs of industries are equal in this regard. The agglomeration economies that are best positioned to transpire, or to be of lasting economic benefit, arise between industries that possess some degree of similarity or relationship. Empirical analysis of related variety exhibits some promise in revealing the features of industrial composition—that is, the kinds of industrial diversity—that best produce Jacobs externalities, but is constrained by data limitations, particularly industrial and patent classification systems (Content and Frenken 2016). Although the research remains unsettled, the variety of potential sources of agglomeration economies offers economic developers many avenues for thinking about the specific advantages of their regional economies.

Industrial districts

After more than 125 years, Marshall's conception of agglomeration economies still is heavily referenced and applied to understand the activities and advantages of spatial groupings of firms. The kind of business agglomeration that Marshall envisioned and characterized is a collection of small, locally owned firms located near to each other, producing goods for export, and operating in a fashion largely separated from the rest of the world. This Marshallian industrial district contrasts with other varieties of business agglomerations that nevertheless share the fundamental feature of gaining economic benefits from co-location. Markusen (1996), for example, lists four additional types of industrial districts (Italianate, hub-and-spoke, satellite industrial platforms, and state-anchored) that she defines according to their organizational, structural, and transactional characteristics, factors that derive in part from how firms take advantage of the potential benefits of agglomeration (Chapter 8). Clark et al. (2010) extend Markusen's approach by classifying agglomerations based on the characteristics of their innovation systems, distinguishing them according to their industrial diversity, organizational structure, and patenting rates.

The notion of flexible specialization, described as an alternative to the Fordist or mass production-focused arrangement of industrial organization, is predicated on agglomeration economies as well (Piore and Sabel 1984) (see discussion in Chapter 8). Agglomeration economies, derived from the spatial concentration of firms and other industrial actors within a specialized economic niche, are what enable small and nimble businesses to compete effectively in the larger marketplace (Storper and Christopherson 1987). Shared information, networking, innovation, and problem-solving constitute an intentional form of knowledge spillovers. The efficient use of large-scale inputs such as expensive equipment or transportation infrastructure or the support of workforce training through cooperative arrangements among numerous small enterprises demonstrates intentional construction of the specialized inputs type of agglomeration economies. "New industrial districts" research in the 1990s focused on investigating the locational and organizational characteristics of regions thought to exhibit some or all of the features of flexible specialization (Park and Markusen 1995). The name ascribed to this branch of the literature underscores its origin in Marshall's description of industrial districts, and

especially the central role of agglomeration economies (Storper 1995; Feser 1998a; Raco 1999).

Central place theory

Moving from the scale of an individual city to systems of cities, agglomeration economies supply the logic underpinning central place theory along with related ways of conceptualizing urban hierarchies. Formulated by geographers to explain an observed association between the size and rank-order of urban areas, central place theory models the system of urban areas by considering the efficient spatial range of distribution of consumption goods and services (Christaller 1966).[6] Consumer products for which there is frequent, consistent demand can be provided in many "low order" locations, sustaining numerous small urban areas that collectively serve a widespread population. Commodities for which demand is relatively rare require a comparatively large spatial extent in order to assemble a sufficient quantity of consumers for efficient provision; the supply of such "higher order" goods and services congregates in and enlarges a select set of urban areas. Thus, the city hierarchy consists of a small number of large urban areas supplying a wide variety of both frequently and infrequently demanded consumer goods and services, a greater number of middle-sized urban areas offering an abridged range of consumption items, and many small urban areas offering only the most fundamental and commonplace consumer goods and services.

Although not typically described in this way, agglomeration economies provide the crucial rationales for central place theory. Each category of consumer item is associated with a spatial market area of sufficient breadth to support an efficient scale of production, an outcome arising as a logical consequence of demand pooling. The producers of higher-order goods, rather than distributing themselves across many smaller cities, choose to locate together in order to generate and take advantage of the urbanization economies of large cities, including the Jacobs-type knowledge spillovers prompted by industrial diversity. Consumers, also realizing urbanization economies, including multipurpose shopping, tend to prefer these more sizable locations, thereby enlarging markets and further enhancing the lure of larger urban areas (Fujita and Thisse 2002). The aggregation across all goods and services in the economy yields the observed inverse relationship between the size of cities and the frequency of cities of that magnitude within the urban system.

Central place theory applies most neatly to the distribution of market towns of varying sizes across otherwise primarily undifferentiated regions, and the underlying agglomeration economy rationale holds best for relatively closed systems, in which localized transportation dominates. Long-distance trade and travel, multi-locational firms, and intangible products and services that do not require a particular location of delivery erode the advantages of demand pooling. Yet related concepts of urban diversity and importance that give rise to more complex understandings of urban hierarchy are also based, at least in part, on the logic of agglomeration economies. Leading locations within the global urban hierarchy, such as described by Sassen

(1991) and Castells (2000) among others, are typified by company headquarters or other dimensions of command and control for industry and government. The existence of these higher-order places is predicated on the presence of specialized businesses that facilitate or direct flows of information and financial resources. Such businesses choose to locate where they can gather sufficient demand for their specialized products and have access to robust transportation and telecommunications infrastructure, following the agglomeration economies of customer pooling and urbanization economies, respectively.

Industrial clusters

An industrial cluster is a group of companies, institutions, and other economic actors that are both interconnected functionally and located in geographic proximity (Porter 2000). The functional connections within clusters may be generated by different types of linkages, such as supply and purchase relationships, similarities in production technologies (including the usage of public assets), or shared labor and/or knowledge needs. The required proximity of actors within clusters may be reflected at various spatial scales, ranging from tightly constrained local areas to quite expansive regions or even nations, depending on how distance and geography impact the functional interrelationships (Feser 1998b).

The role of industrial clusters in economic development draws primarily from the comparative advantages that clusters bring to constituent firms and organizations. Porter's (1990) influential "diamond model" of competitiveness delineated four categories of advantage arising from cluster membership: factor conditions, demand conditions, related and supporting industries, and firm- and regional-level structure.[7] At the regional scale, the first three categories relate very closely to Marshall's agglomeration economies.[8] Factor conditions refer to the accessibility and cost of inputs into production, including material resources, human resources (i.e., labor), knowledge resources, and infrastructure. Demand conditions reflect to the nature and composition as well as the size of the customer base, which adds some differentiation to the concept of demand pooling. Advantages from related and supporting industries are those generated by localized relationships with intermediate suppliers and purchasers. Structure, the fourth category of Porter's model, adds the influence of inter-organizational strategy and rivalry. Competition boosts competitiveness by compelling companies to develop and maintain their distinct strengths and capabilities, to innovate, and to continually seek improvement, activities that themselves benefit from clustering (i.e., dynamic agglomeration economies). Examples include frequent interactions with customers and competitors that can reveal changing consumer preferences and knowledge spillovers within clusters that provide early information about rapidly advancing technologies or industry-specific trends (Pike et al. 2017).

The idea of industrial clusters is akin to several of the notions described earlier in this chapter, resting on much the same explanations of economic advantage derived from agglomeration economies. The concepts defining industrial clusters have long

existed in various semblances, stretching at least as far back as Marshall's industrial districts, and with strong similarities to the aspatial growth poles of Perroux (1950b) and Chinitz's (1961) description of regional inter-sectoral dependences, among many other notions (Motoyama 2008; Smit 2010). Indeed, one might question what industrial clusters add to previous understandings in regional economic development. One answer is that clusters provide a mechanism for grouping firms, industries, and other actors based on the types and extent of the advantages they gain from agglomeration. Although not theoretically unique, the concept of industrial clusters is understandable and adaptable, and it urges an orientation toward external competitiveness (Motoyama 2008).

A second response might emphasize the addition of industrial organization to the consideration of agglomeration economy advantages. While not deriving directly from agglomeration, regional competitive circumstances are determined by the locational patterns of firms and are an important driver of firm behavior and outcomes (Beaudry and Schiffauerova 2009; Drucker 2015). Moreover, industrial organization at the regional scale may impact economic performance by affecting how businesses capture the benefits of agglomeration economies (Henderson 2003). The empirical research on the topic concurs that a lack of local competition (i.e., excessive concentration within a regional industry) impairs productivity and other economic outcomes (Feser 2002; Drucker and Feser 2012; Drucker 2013; Li et al. 2019). The evidence is mixed, however, as to whether the effect is due to insufficiently competitive environments limiting the locally available advantages from agglomeration.

Michael Porter deserves considerable credit for the enduring popularity of industrial clusters in economic development. Although he did not originate the notion of industrial clusters, Porter coalesced the bundle of ideas that existed in several fields, such as geography, regional science, and economics, and translated them into the language and approach of business strategy. This interpretation rendered clusters an attractive and accessible framework for economic development professionals and policymakers seeking to cultivate or strengthen regional comparative advantages. Clusters fit well with the economic development approaches prevalent in the 1990s, both traditional and new. Entrepreneurship and human capital development strategies, which were rapidly gaining adherents at the time, can be advocated as supporting the labor- and knowledge-based linkages that tie many clusters together, as well as promoting dynamism and adaptability to strengthen competitiveness across the component industries and organizations of all clusters (Martin and Sunley 2003). Clusters offer a persuasive justification for industrial targeting—the long-standing practice of concentrating economic development effort and resources toward particular industries or economic sectors—in that a focus on enhancing sectors that possess local competitive advantages is likely to produce relatively high rates of return on public investment of resources (Voytek and Ledebur 1997).[9] Additionally, Porter elevated the visibility of cluster analysis through vigorous promotion, consulting, and illustrations of numerous cases. Since the late 1990s, industrial clusters have been an established and committed segment of mainstream local and regional economic development practice.

Applications

Economic developers armed with broad understandings of the sources of agglomeration economies are well-positioned to analyze their individual regions and assist companies to realize and take advantage of local agglomeration advantages. They may do so through actions ranging from providing information to having direct interaction with businesses. Campaigns to attract potentially relocating businesses—one of the most traditional of all economic development activities—may be helpfully structured around the advantages produced by local and regional agglomeration economies. (See Chapter 3 for a discussion of industrial recruitment strategy.) A general information campaign designed to be broadcast widely might concentrate on urbanization economies, features such as transportation infrastructure and the availability of diverse business services that appeal to a wide spectrum of firm types and industries. More targeted recruitment would be efficiently tailored to convey positive information regarding the specific advantages likely to entice narrower groupings, constellations of firms with similar needs or opportunities (i.e., localization economies). The latter approach often should prove more convincing to targeted organizations and, if successful, would further amplify the attractive agglomeration economies through adding the activities of the newly relocated businesses. Of course, developers need not restrict their marketing of agglomeration economies to businesses being recruited from outside the region. Local and startup companies also may learn about how to take advantage of resident opportunities through distribution of economic development materials and information.

A somewhat different type of economic development approach focuses on augmenting agglomeration economies through improving their operation. Encouraging more interactions among businesses and employees of different companies may intensify knowledge sharing, establish supportive mentoring relationships, maximize local interindustry linkages, and expedite efficient matching of employees and employers (see the following Criticisms and Elaborations section). Programs that can foster such interactions are nearly as diverse as economic development activities in general. From non-profit institutes that work to compile and disseminate best practices to recurrent or one-time networking events, the feature that distinguishes these strategies is the attempt to lower barriers to interaction or directly produce the interrelationships that lead to shared benefits from agglomeration.

More generally, theories of agglomeration serve to focus attention on spatial relationships, drawing closer links between urban economics and the fields of geography and urban planning. Urban economists generally concentrate their attention on widespread urban spatial patterns, such as transportation costs, land use allocation and development, and migration. Geographers, planners, and others interested in urban form and the built environment often stress perceptions of livability, enjoyment, safety, and aesthetics. Agglomeration economies occur in locations in which production, consumption, residence, transportation, recreation, social interaction, and governance all tend to take place in close proximity.

The spatial juxtaposition of diverse aspects of the urban environment creates recurrent competition and prompts consideration of interactions (Duranton and Puga 2004; Malizia and Chen 2019). The potential for conflict should motivate local economic developers to work with and support urban planners who are responsible for managing land use development and change and who normally act to mitigate conflicts in the urban environment.

Supporting and promoting industrial clusters is probably the most common local and regional economic development application of agglomeration economies. Clusters offer a ready framework for creating and administering policies designed to enhance the operation of agglomeration economies. Cluster policy typically begins with an analysis stage, which seeks to depict and categorize the components of one or more local or regional industrial clusters: the population of businesses and their sectoral structure, the types of connections among the firms and other relevant organizations, the stage of development, and their intraregional patterns of spatial location (Pike et al. 2017). With regard to development stages, clusters usefully may be classified as existing (growing, stable, or declining), emerging, or nascent (also called potential or latent) (Rosenfeld 1997).[10] The aim of the investigation is to reveal locally specific features of how the clusters operate, such as distinguishing aspects of the mixes of economic activities, functional gaps in the local networks of relationships, linkages across clusters, and how each of the clusters are evolving over time. Once the local clusters are mapped and evaluated, their distinctive traits and dynamic attributes guide the development of plans to enhance their agglomeration advantages or to redress observed vulnerabilities.[11] Strategies typically include efforts to reduce transaction costs, encourage communication, instigate and sustain selective collaborations, and establish various sorts of regional-level support systems (also see discussion in Chapter 8).

Industrial clusters also may be valuable as vehicles for implementing economic development policies (Waits 2000). The relationships and interdependencies within a cluster present potential channels for spreading the delivery of development initiatives. Conferences, working groups, standing networks, and other conventions of representatives of an industrial cluster may facilitate collaborative action by contributing to the process of shaping development programs and/or assisting in introducing and promoting them throughout the cluster membership. Even the preliminary step of recognizing a cluster as a focus of attention may provide significant motivation for private sector members to support economic development efforts.

Agglomeration policies grounded in the framework of industrial clusters characteristically are being directed toward a circumscribed assemblage of interrelated economic actors. As with industrial targeting, customization for a particular audience makes such efforts more likely to be efficient and effective. On the other hand, these policies are susceptible to practical issues associated with identifying and analyzing industrial clusters, as discussed in the following section.

Criticisms and elaborations

This section first describes criticisms of the agglomeration-related topics presented earlier and then explains some of the different ways in which these concepts and theories have been elaborated to offer additional insights regarding regional economic development.

Criticisms of agglomeration

Although agglomeration economies may seem to be notionally straightforward, they are remarkably difficult to study or analyze directly. Several of the key concepts involved are intangible or not easily measured, such as knowledge spillovers or labor skill requirements. The appropriate spatial units within which to observe and measure agglomeration economies may vary by their sources or the geographical setting (Cottineau et al. 2019). Agglomeration advantages often are evaluated relative to an unrealistic state characterized by the absence of all agglomeration, largely because there is no well-defined alternative counterfactual situation. Perhaps most important is that the benefits that economic entities capture from agglomeration usually are not distinguishable observationally from other factors that impact economic performance. Most empirical research avoids this problem by gauging the *potential* for agglomeration benefits rather than their realization and relating them to outcomes, such as prices, wages, and various facets of business performance. Potential benefits can be estimated based on measures of theoretically identified sources of agglomeration economies (Richardson 1974). Even so, appropriate data regarding some agglomeration economy sources, particularly knowledge creation and spillovers, are notoriously rare.

The usual distinctions among types of agglomeration economies may not be consistently helpful in guiding local economic development practice. The commonly applied division between localization and urbanization economies does not rely on any strong underlying theoretical distinction. Rather, it is convenient as a basis on which to structure empirical analysis. The partition between within-industry (localization) and across-industry (urbanization) interactions will fluctuate according to the classification scheme and level of aggregation by which those industries or sectors are defined. Yet the proper scale of industrial aggregation is not clear. An industry sector defined at too aggregate a level combines establishments that generate and experience agglomeration economies in different fashions and to different degrees, whereas a sector constructed too narrowly excludes businesses similar enough to interact with each other to produce localization benefits (Moomaw 1998). Typical industrial classification systems, such as the North American Industrial Classification System (NAICS), are based principally on the similarity of primary products, a criterion that is not necessarily congruent with the production technology, labor needs, or input requirements that lead to agglomeration economies. The demarcations between industries also determine the separation of Marshall-Arrow-Romer (own-industry) from Jacobs (industrial diversity)

knowledge spillover agglomeration economies, concepts that themselves reasonably may diverge across industries or economic sectors. Similarly, the boundaries between static and dynamic agglomeration economies and even between the producer and consumer sides of urbanization advantages are mutable and depend on the specific categorizations of economic actors and time scales.

Variable spatial processes further complicate agglomeration economy classification (Martin 1999a). It is not the proximity to other businesses that directly benefits firms but the cost reductions, spillovers of knowledge, and other interactions that are enabled by spatial groupings of businesses. Therefore, the appropriate geographic scales at which to operationalize and measure concepts such as urbanization and localization economies ought to vary across locations, industries, and even firms (e.g., Feser 2001; Rosenthal and Strange 2003; Drucker and Feser 2012).

These issues lead to the valid caution that understandings of agglomeration economies frequently are dependent on the context and on the analytical choices made. Imprecision in defining and appraising different kinds of agglomeration economies can yield ambiguity and confusion in application, and therefore economic developers should be thorough and as clear as possible in elucidating policy justifications that rest on agglomeration economies (Parr 2002a).

Criticisms of clusters

Critiques of industrial clusters come from both theoretical and practical standpoints. Because the underlying ideas have amassed over time from varied historical theories sourced from many disciplines, detractors judge the notion of an industrial cluster to be vague and even "chaotic," difficult to pin down in order to apply in practice (Gordon and McCann 2000; Martin and Sunley 2003). The concept of an industrial cluster has accumulated many related but distinct meanings, with differences in the various types of relationships that link members, the treatment and extent of geographic proximity, whether linkages among actors must contain an element of purposefulness or may arise unintentionally from independent decision-making, and numerous other, often subtle, distinctions.

Industrial clusters, like agglomeration economies, may relate to various spatial scales, levels of classification and aggregation, and degrees of competition versus cooperation. There is no threshold density of businesses or interactions that has been established or that is accepted consistently as sufficient to define an industrial cluster. The boundaries between cluster members and non-members, and among the entities that comprise multiple clusters, are indistinct and shift across applications. Multiple connections among industrial clusters and diverse kinds of agglomeration economies yield ambiguous and potentially contradictory implications for how industrial clusters function and relate to different levels of governance, and therefore for constructing appropriate and effective economic development policies (Duranton 2011; Pike et al. 2017; Motoyama 2008).

Porter's conception of industrial clusters never was intended to resolve the imprecisions of the notion of industrial clusters. In describing and industriously

promoting a generic vision of industrial clusters, Porter aimed to develop a brand, rather than distinguish an intellectually rigorous concept. He succeeded in designing an extremely versatile product that can be applied to the widest possible range of communities of various sizes, locations, and economic circumstances (Martin and Sunley 2003).

The principle of near-universal applicability is reflected in the practice of cluster analysis and economic development policy. With industrial clusters as an expected framework for economic development policymaking, analysts and developers encounter pressure to uncover clusters worthy of attention and support in every region. Too often, the clusters are predetermined, set by the desire to follow the latest vogue. If industrial clusters' histories are not included in the analysis, current conditions erroneously may be equated with the factors that propelled early cluster development (Motoyama 2008). Tautological reasoning is common as well: analysts frequently identify industrial clusters according to the gains that firms receive from agglomeration while simultaneously explaining the existence of the cluster according to those same beneficial agglomeration economies (Feser and Luger 2003). These issues have resulted in dubious development objectives such as large numbers of locations focusing on the same clusters (e.g., information and communication technologies in the late 1990s and biotechnology in the 2000s) while neglecting unique or niche specializations more likely to flourish in competitive economic environments. It may even be the case that industrial cluster development is sufficiently idiosyncratic, path-dependent, and region-specific that developers should rethink the practice of directing economic development resources toward particular industrial clusters (Feldman and Francis 2004). Instead, it may be more worthwhile to focus on general underlying conditions and factors beneficial to a wide range of industries and sectors and to spend time better understanding the economic history of the region.

Successful cluster development strategies—those that achieve their aims of promoting the growth, productivity, or interconnectedness of local economic clusters—carry risks of substantial negative consequences (Rosenfeld 2002). Productivity improvements may detract from policy goals such as increasing employment or retaining the local anchoring of businesses. Policies to boost industrial clusters suggest the marginalization of other economic sectors, with many businesses and residents excluded from the benefits of economic development. At the interregional scale, the widespread adoption of cluster strategies may have the effect of advancing those places that already possess strong industrial clusters at the expense of areas with fewer or weaker clusters, thus exacerbating inequities in development.

This multitude of criticisms is not fatal to the application of industrial clusters in economic development. On a pragmatic level, clusters are securely entrenched in practice—they are here to stay. If applied suitably, the industrial cluster framework can be a powerful tool for identifying agglomeration economy advantages and for guiding industrial targeting approaches. Cluster analysis may lead to crucial support for an emerging or fledgling cluster or convince a location lacking existing healthy

industrial clusters to connect to, and thereby strengthen, clusters in neighboring regions.

Feser and Luger (2003) build from the notion of industrial clusters as valuable for the process of economic development to propose treating clusters as sources of information. Instead of considering cluster analysis to be a method for revealing the best or "correct" targets for economic development attention, Feser and Luger suggest treating the valuable information obtained through examination of local industrial clusters as the primary objective: the different types of interrelationships that connect firms and industries, potential strengths and weaknesses of the regional economic structure, and the development implications of local development goals and values. As mentioned earlier, cluster linkages offer a pathway for economic development implementation, and cluster members are potential program advocates or champions. Informing practice in these ways may improve the effectiveness of economic development more than strategies intended to enhance clusters.

Agglomeration mechanisms

As an alternative to delineating the sources of agglomeration economies, urban economists have explored the fundamental mechanisms through which agglomeration economies occur. Duranton and Puga (2004) classify the theoretical microfoundations of agglomeration economies into three types: sharing, matching, and learning.[12] Sharing mechanisms are those in which indivisible infrastructure, facilities, or services are supported and used jointly by multiple economic actors. Such indivisible (or "lumpy") assets encompass many of the items described earlier as sources of agglomeration benefits, including industry-specific specialized inputs, mass transportation systems, wholesaling and storage facilities, shared entrepreneurial space, and government facilities and services. Matching mechanisms (also known as sorting mechanisms) are those by which agglomeration increases the probability of a match being made, enhances the quality of matches, or does both. Labor and demand pooling agglomeration advantages result from improved matching between employers and employees in the labor market and between demand and supply in consumer markets, respectively. Finally, learning refers to the processes of creation, diffusion, and absorption of knowledge. Localized trust and social capital in general might be categorized as forms of learning as well (Andersson et al. 2016). These three types of mechanisms cut across the categorizations of the sources of agglomeration economies described earlier, such as localization versus urbanization or dynamic versus static.

The new economic geography is a noteworthy branch of economics that is predicated on agglomeration economies derived from sharing mechanisms. Launched by Krugman (1991a, 1991b), new economic geography theorizes and develops mathematical representations of how location choices and the siting of production lead to patterns of geographic concentration, with shared transportation costs and other agglomeration economies generating productivity gains, increasing returns to scale, and spatial clustering.[13] Although the subfield has been criticized for

reworking ideas from other disciplines and relying on heavily stylized and unrealistic models, it has produced or rediscovered insights into assorted urban phenomena and interregional interactions, including trade, migration, and divergent development paths (David 1999; Martin 1999a). New economic geography introduced spatial considerations into mainstream economics (or perhaps inserted them more successfully than earlier attempts), and in so doing has expanded exchanges among economics, geographers, and regional scientists (Martin 1999b; Goodchild et al. 2000; Brakman and Garretsen 2003; Brakman et al. 2009; Martin 2010).

Focusing on the microeconomic mechanisms serves to emphasize process understandings of how agglomeration economies occur. Insights arise from recognizing the key actors involved and the interactions among them that produce gains or losses that are not directly traded or compensated in the marketplace.[14] Economic developers may consider the mechanisms of agglomeration economies to be another viable layer for analyzing regional attractiveness or for evaluating possible efforts to help firms generate and benefit from local agglomeration. This perspective also makes the scale and scope issues described earlier less mysterious. There is every reason to expect that essentially dissimilar mechanisms would operate at varying spatial and temporal scales and be impacted differently by degrees of similarity among industries (Duranton and Kerr 2018).

Jacobs and city development

Jane Jacobs penned some of the most original insights weaving together the fields of economic development and urban planning.[15] *The Economy of Cities* (1969) and *Cities and the Wealth of Nations* (1984) present her ideas about work and production as they occur in cities.[16] She portrays cities as the predominant sites of innovation, and innovation as a primary rationale for cities. Contradicting the conventional wisdom that increased agricultural productivity was a precondition for significant urbanization, Jacobs (1969) asserted that the rise of cities preceded and obliged improvements in agricultural productivity and technology, thereby enabling additional urban growth. The importance of Jacobs' assertion lies not in its historical accuracy (which is debatable) but in its perception that essential characteristics of cities, including agglomeration economies and networks of trade, stimulate the processes of innovation and economic development (Smith 2014).[17]

Through comparing the English cities of Manchester and Birmingham, Jacobs (1969) made a case for continual innovation as the key to adaptability and long-term economy resiliency. In the nineteenth century, Manchester was an efficient powerhouse of textile production and Birmingham was a city of small shopkeepers. Yet 100 years later Manchester was stagnating, incapable of adjusting to changes in textile markets and unable to compensate for lost work. Birmingham had become a thriving city, supported by its flexibility, variety of skills, capacity for improvisation, and resulting generation of new products. Jacobs' argument is that diverse economic places (cities) foster ideas that lead to new products, new economic activity, and wealth creation.

Jacobs' view of innovation is much like an evolutionary form of social learning, in contrast to Schumpeter's revolutionary episodes (Chapter 7).[18] Incremental improvisation is compelled by the need to overcome economic challenges and over time becomes embodied in new firms that gradually expand to form new industries or industrial sectors. Economic development is more likely to derive from such accumulation and combination of small-scale innovations than from narrowly focused routine specialization.[19] Industrial diversity supports this process through knowledge spillovers, and innovation in turn enriches diversity. Cities can grow by replacing imports with local products that are cheaper or better (i.e., higher quality, expanded functionality, more attuned to local preferences) (Jacobs 1984). Import replacement expands local markets, diversifies the employment base, drives improvements in local technology and producer services, expands local capital, and eventually forms the basis of new exporting industries.[20] Older forms of work and industries that are diminished in value may relocate to peripheral areas. The overall economic development process is cyclical, following "chain reactions"; economic development occurs in spurts.

Jacobs presents a coherent and dynamic theory of how economic development occurs in cities, but developers interested in applying her ideas may face resistance. Jacobs' view of economic development via import replacement is a lengthy process that involves steady guidance and alters the established economic order. This contradicts pervasive political and budgetary perceptions of economic development as a way to achieve quick and inexpensive fixes for short-term problems such as high unemployment or a shrinking tax base. Developers with the latitude to engage in long-term economic development approaches may benefit from tracking and benchmarking their locations against regions with similar compositions and functional specializations, paying attention to economic trends and practices in areas with the potential to undergo similar transformations.

Florida and the creative class

Richard Florida and his depiction of the creative class have had an outsized influence on local development practice in the current century. Florida's books (2002, 2005, 2008, 2010, 2017) draw on the theory of flexible specialization (Chapter 8) and a mélange of his and others' ideas about innovation and learning regions to connect the concept of creativity to agglomeration economies and the evolution of cities and local economies. The essential message conveyed to economic development practice is to broaden the dominant perspective beyond firms, industries, and clusters, to focus on people and the characteristics of place.

Unlike most factors of production that are exhausted as they are used to create output, the application of knowledge does not deplete its store. Creativity in particular is a form of knowledge that can be fostered and enhanced by sharing among a wide variety of people and actors. Florida perceives creativity not as an intrinsically individual enterprise but as one that is magnified by social interaction and so may be augmented through formal education and work experience—in

other words, through the learning mechanism of agglomeration economies. He argues that creativity is maximized where people and economic activity are concentrated in space, a conclusion mirroring the implication of knowledge spillovers considered earlier.

Florida distinguishes the broader creative class, accounting for approximately a third of all jobs in the U.S. economy, from the much smaller "super creative" core, which is comprised most notably of computer scientists, natural scientists and engineers, artists, musicians, and marketers. He recognizes the mutual attraction between creative people and certain types of places, which results in "thick" labor markets of specialized talent (i.e., labor pooling). Florida (2002) originally articulated the factors powering regional growth via the creative class as the "three Ts": technology, talent, and tolerance. Whereas the importance of technology and talent was accepted in formulations of regional growth already (Chapter 5), tolerance added a socio-cultural factor that generally was overlooked.[21] Creative people often are immigrants, ethnic or racial minorities, or social non-conformists who feel more welcome and comfortable in permissive or non-judgmental environments. Tolerant cities with universities, ample urban amenities (culture, arts, entertainment, etc.), and safe environments will emerge as the most competitive regional economies, according to Florida. When members of the creative class migrate to particular places, they add to diversity and promote broadmindedness. Universities may function as "talent magnets and aggregators," though the presence of higher education institutions is not by itself sufficient (Florida 2014, p. 200).

Florida's inferences have been debated from the outset, perhaps indicating their originality and certainly reflecting their widespread influence. One line of criticism questions whether creativity as a concept is worth distinguishing from human capital. Markusen (2006) argues that Florida's creative occupations simply serve as a proxy for educational attainment. The empirical evidence is mixed: the creative class sometimes explains economic development outcomes better than more traditional measures of human capital yet often does not explain them as well (e.g., Faggian et al. 2017; Marrocu and Paci 2013; Marrocu and Paci 2012; Hoyman and Faricy 2009; Donegan et al. 2008; Sands and Reese 2008; McGranahan and Wojan 2007; Rausch and Negrey 2006).

A second shortcoming of Florida's exposition is that, despite labelling the super creative core, he evaluates the creative class primarily as an internally homogeneous group, contending that places that attract and organize creative occupations will be the most competitive. Developers ought to work to entice and support creative workers, frequently by leveraging place-based amenities that cater to lifestyle preferences. Critics observe that artists, musicians, engineers, authors, architects, and professors tend to share few interests, behaviors, and lifestyle characteristics in common (Markusen 2006; Kratke 2010). The qualities that make specific amenities desirable reflect consumer tastes, income levels, household composition, and life cycle stages, as much as or more than occupations (Phelps 2010; Lawton et al. 2013; Van Holm 2014).

Creative class theory is simplistic in its ahistorical formulation and narrow focus on individuals as the sole locus and source of creativity. Concentrations of creative workers in large cities may have caused significant economic outcomes in the 21st century, but Florida fails to address why and how such cities arose in the first place (Storper and Scott 2009). Especially in his earlier work, beyond recognizing that creativity may be liberated or enriched through workplace interactions, Florida devotes almost no attention to firms or industries, and disregards their importance as generators of innovation, urban growth, and economic development (Storper 2013). Although the creative class may consist of eclectic occupation groups, the composition of occupations in a city is far from random; the occupational mix is shaped by the local production regime. Thus, the current industry mix and evolution of specializations that follow from the industrial legacy of the city matter. The agglomeration economies supplied by the city environment help to determine the productivity and success of firms and entrepreneurs along with creative workers.

Following much criticism (e.g., Leslie and Catungal 2012; Donegan and Lowe 2008; Parker 2008; Shearmur 2007; Peck 2005), Florida's more recent works attempt to come to terms with inequalities and the major structural changes occurring in the space economy. Florida (2010), considering spatial polarization in the post-recession U.S. economy, reaches the sober admission that creative place-making strategies alone cannot save smaller post-industrial cities or rural areas. Florida (2014) adds a fourth "T" to his framework, territorial assets, to account for space more explicitly. His most recent book *The new urban crisis* (2017) is devoted to the topic of intra-metropolitan inequality and the phenomenon of places experiencing creative class economic success adjoining larger areas of poverty and disadvantage. Cities with large shares of the creative class are among the most unequal and segregated in the United States. Such locations typically exhibit the highest costs of living, the least affordable housing, and extreme levels of segregation by income and/or race. Lower income households regularly are priced out of the local markets. Moreover, as inequality in the distributions of income and wealth are increasing, so are metropolitan areas diverging in growth and competitiveness. Because the highest value-added, most innovative-intensive industries often achieve their maximum performance in urban locations, these inequalities may undermine the urban revival that is critical to overall national competitiveness.

For the past 20 years, creative class theory probably has been misapplied more commonly than it has been properly applied. Both the ideas of and the prescriptions drawn from creative class theory are relatively simple, and align with other, more thoroughly evaluated, economic development approaches, such as investments in human capital, entrepreneurship, central city revitalization, the arts, and cultural amenities (Peck 2005). Certainly, many place-based strategies and projects designed to attend to the "people climate" in addition to business climate have been justified in large part as attempts to attract the creative class. Local economic developers and especially downtown development advocates have embraced these plans. Yet many locations latched on to efforts to lure the creative class that offered little chance of success. Numerous places, first across the United States (including

small and mid-size Rust Belt locations) and then throughout the world, many of them exhorted by local visits from Florida, adopted creative class attraction strategies to little or no avail (Peck 2005; MacGillis 2009). Urban amenities typically are insufficient enticements in comparison to fundamental problems, such as poor schools, safety concerns, inadequate public services, and limited job prospects. Even cities that witnessed substantial downtown redevelopment and revival frequently bore declines in other, more residential neighborhoods. Furthermore, too many creative class projects have been undifferentiated, fashioned hurriedly and with insufficient attention to local qualities and assets. Building on existing advantages (e.g., affordable housing, ample water supply, or legacy cultural amenities in the U.S. Midwest) could have produced strategies tailored for individual cities and more likely to achieve their objectives.[22]

Discussion questions

1 What sorts of economic advantages could a city offer to resident firms that are due to its population size?
2 How do the industries in your area tend to interact with their local suppliers and customers? Which kinds of interactions take place more often and which kinds less often? Considering these different kinds of supplier and customer interactions, which may help businesses to improve their practices?
3 What roles can the public sector play regarding different kinds of agglomeration economies? How might government intervention either enhance or hamper the mechanisms of agglomeration economies?
4 Is achieving greater industrial or economic diversity a worthwhile objective to aspire to in your region? How might you be able to advance that objective, given the existing mix of industries?
5 How might the pursuit of industrial diversity contradict efforts to enhance local comparative advantage? Conversely, how could the two approaches be complementary parts of a local economic development agenda?
6 Which industry clusters exist in your region? For each of these clusters, what types of linkages connect the constituent industries and businesses?
7 What kinds of agglomeration economies are important to local clusters? Do some local clusters depend more on some types and other clusters on different agglomeration economies?
8 Is it better to allocate limited economic development resources to supporting a large, locally entrenched industrial cluster experiencing decline or toward attempts to develop new or emerging clusters? What types of information and analysis would help you to determine the answer?
9 How do creative industries differ from creative occupations as part of the regional economy? How would economic development strategies centered on creative industries differ from those focused on creative individuals?
10 What issues may arise if strategies to attract the creative class based on urban amenities produce intraregional migration to the central portions of the city

from the city's residential neighborhoods and from surrounding suburban locations?

11 Should people belonging to the majority of the working population that is not considered part of the creative class be encouraged to apply creativity in their work? How can they be so encouraged?

12 What kinds of economic development strategies may achieve greater societal tolerance?

Notes

1 There are numerous explanations for the emergence of cities, such as to be able to store and distribute surplus agricultural production efficiently, to strengthen or simplify common defense, to stage the prosecution of conflicts, and to permit rulers to manage and control resources (Schoenberger 2008; Taylor 2012). Some cities have their origins in local natural resources or amenities (Glaeser and Gottlieb 2009). Although these and other possible reasons may be linked to distinct and often contested historical interpretations, they do not inherently contradict contemporary urban economics understandings of cities as providing market efficiencies.

2 Several further conceptual divisions and types of agglomeration economies have been suggested, such as agglomeration economies of scope (Parr 2004, based on Goldstein and Gronberg 1984) and activity-complex economies (Parr 2002b), but these have not garnered widespread recognition or application in empirical research.

3 Examples include information exchange, access to the variety of consumer goods and services supported by a larger population, personal and cultural interactions, public safety ("eyes on the street"), and the production of societal behavioral norms.

4 Rent- seeking is the practice of attempting to gain income or wealth from the activities of others without any reciprocal productive contribution or compensation.

5 High factor prices due to localized competition should be a short-run phenomenon, unless the particular inputs are difficult to produce or transport (for instance, a natural resource that is in short supply). Over time, aggregate demand encourages entry of specialized suppliers into the input market, creating the agglomeration economy identified by Marshall.

6 For many years, beginning in the 1940s, regularities in the city- size distribution of nation-states were observed and recognized. The "rank-size rule" refers to the clear, positive association between the size of an urban area and its ordinal rank with respect to the size of all other urban areas. More precisely, the relationship between the logarithm of city size and the rank-order of cities was found to be approximately linear. The rank-size rule is an example of Zipf's law, which is a statement of the commonality of inverse frequency-rank relationships in the distributions of many types of data examined across the physical and social sciences (Ijiri and Simon 1977).

Rank-order city-size distributions were later described as log-normal city-size distributions, to contrast with primate city-size distributions. More developed countries, such as the United States, had a log-normal distribution—representing cities along the entire size range, with an increasing number of places as city size decreased. On the other hand, many less-developed countries exhibited a primate distribution—one large capital or port city, virtually no intermediate-sized cities, and many small cities. These *ad hoc* observations led to empirical tests of the relationship between level of economic development and distribution of city size, but no clear relationship was revealed, perhaps because the research analyzed nation-states rather than true systems of cities (Vapnarsky 1969). For example, all Commonwealth countries and Great Britain together have a combined city-size distribution that is much closer to log-normal than is the distribution of any single one of the constituent countries.

7 "Diamond" refers to a four-vertex diagram Porter fashioned to illustrate the categories of advantage (1990, p. 258).
8 Although Porter (1990) originally delineated clusters and the four types of associated competitive advantages at the level of nations and international competition, his subsequent work (Porter 1998, 2000) readily adapted the concepts to the regional scale, where the gains from geographic concentration are key to competitiveness.
9 Thompson offers more rigorous approaches to industrial targeting than those derived from clusters (Chapter 10).
10 As might be expected, it is much more difficult and uncertain to identify emerging, and especially nascent, clusters than existing ones. See the Criticisms and Elaborations section of this chapter.
11 Other than being organized around the membership of an industrial cluster, this approach is very similar to the application of product cycle theory (Chapter 6).
12 Micro-foundations refer to economic theories based on the decisions and behaviors of individual economic agents, such as consumers or firms.
13 Krugman received the 2008 Nobel Memorial Prize in Economic Sciences for this work.
14 Behrens et al. (2014) consider selection to be an additional explanation for urban advantages beyond agglomeration. Selection may occur within the labor market, as individuals with superior skills or talent seek the greater returns available in larger cities, or for business location and survival, as the stouter competition of larger markets drives out less productive firms. They also note natural advantage as relevant to early urban development but not as a source of advantage for mature cities.
15 Jacobs achieved a lasting effect on both fields, despite possessing no formal credentials in either discipline, nor even a college degree.
16 Her earlier text, *The Death and Life of Great American Cities* (1961), was a treatise on the inherent productivity of city life that condemned modernist architecture and city planning practice in the 1950s.
17 See also discussion and references in note 1.
18 Jacobs was less optimistic than Schumpeter with respect to the developmental outcomes of "creative destruction." Unless government protected emerging industries and the entrepreneurs who owned them, existing elites would remain dominant, innovation would stall, and stagnation would result. She also took issue with Marx's view that class conflict eventually would undermine the capitalist system. Jacobs perceived labor and capital as likely allies with shared interests in protecting markets and jobs. The more probable conflict is between those who own and control the existing economic base and upstarts expanding into new areas of work.
19 The empirical evidence on this point is mixed, though much of the existing research relates specifically to the knowledge spillover source of agglomeration economies and utilizes performance measures that arguably reflect economic growth more than development.
20 To Jacobs, import replacement is quite different from import substitution. Import substitution occurs when a commodity that was previously imported is produced locally, with no necessary modification of the product or production process. Import substitution may reduce interregional trade as the city becomes more self-sufficient, whereas import replacement can increase exporting.
21 Tolerance as a factor supporting creativity does not originate with Florida. The idea that cities offer anonymity, which permits creative expression, stretches back to Emile Durkheim (1893 [1997]) and others.
22 Florida continues to offer useful suggestions to economic developers through the website CityLab (formerly The Atlantic Cities). For example, he identifies "6 rules" to improve economic development practice: say no to incentives, invest in local clusters and ecosystems, work closely with anchors, leverage talent, foster inclusive quality of place, and make equity and inclusion a priority (CityLab, February 26, 2019).

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10

FROM ECONOMIC DEVELOPMENT THEORIES TO STRATEGIES

This final chapter has four sections. We begin with Wilbur Thompson, whose life work was to understand and offer policies to improve urban and regional economies. Thompson formulated important insights about economic development over a period of five decades. Next, we present Enrico Moretti's analysis of regional inequality, one of the most pressing economic development problems in the United States. Third, we offer a general strategic framework for economic development that offers an alternative to economic growth strategies. We primarily draw on Thompson's and Moretti's synthetic treatments of theory. Finally, we briefly discuss economic development at the intraregional level where, instead of competition, we advocate cooperation based on each metropolitan subarea's economic niche.

Thompson's contributions

Thompson provides one of the best examples of theoretically informed strategic thinking. His book titled *A Preface to Urban Economics* (1965) is much more than an introduction to what was then a new field; it now stands as a seminal work in interregional and intraregional theory and policy. Two decades later with his son, Phillip, he extended these ideas to incorporate an "occupational-functional" dimension that offered another way to understand regional economies (Thompson and Thompson 1987). After publication of the 2000 U.S. census, Thompson (2008) conducted an extensive empirical analysis of decennial data from 1950 to reconsider his thinking. He examined all metropolitan areas, all nonmetropolitan counties, and the central cities within them organized by states.[1] Thompson continued to refine and revise his analysis until his death in 2008.

As previously noted, economic development practice in the United States is primarily concerned with achieving economic growth in specific localities. Applying

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Thompson's robust and eclectic insights offers enormous opportunities to expand and enrich local economic development practice in many useful ways.

Thompson (1965) brings together concepts of economic base, linkages, product cycle, entrepreneurship, and the importance of institutions (oligopolies and labor unions) in economic development. His model is primarily demand-driven and sensitive to the distribution of resources within the economy, but he recognizes key factors on the supply side, such as entrepreneurship. He argues that economic base theory (and the economic base model) provides a useful way to understand the local economy if we are concerned with near-term economic growth. The theory is consistent with Keynesian short-run analysis and is especially useful for estimating business cycle impacts. In the near term, the industry mix, particularly among exporting industries, determines the rate of growth. Exporters influence the entire local economy through linkages that transmit multiplier effects.

However, economic developers, city planners, and others concerned with long-term change must look elsewhere for appropriate theory. To understand the local development process, the competitiveness of the local economy must be examined over decades and compared to other areas.[2] In the long term, urban growth leads to larger markets and more interaction within industrial complexes and clusters, which include technology-linked companies with buyer-supplier relationships. Growth and linkages attract producers that can realize external economies. Furthermore, larger markets attract more sophisticated business and professional services and require additional public services. Echoing Blumenfeld's (1955) thesis about the importance of city-building activities (Chapter 3), Thompson explains that urban institutions facilitate adaption to external forces and support locally initiated change. Thus, as time moves on and the area grows, local activity comes to the fore as the prime mover and catalyst of further development.

Development supports the interactive process of invention, to innovation, and commercialization. It leads to higher levels of welfare in terms of (1) income level, (2) income stability, and (3) income distribution. Here Thompson defines economic development in welfare economics terms rather than as jobs, investment, or the expansion of the tax base—the pillars of current economic development practice. The income *level* is a function of the skill and power of local organizations. Skill refers to the ability of local producers to create and market new or income-elastic products successfully. Power refers to oligopolies that use size and collusion to garner market share and labor unions that bargain for a fair share of productivity gains. High wages in the oligopoly sector "roll out" to increase hourly earnings throughout the local labor market.

Income *stability* depends on several factors. Places that specialize in producer durables tend to be most unstable because large investment expenditures are at times not in sync with consumption expenditures. During downturns, places with older establishments are more susceptible to cutbacks and closings. City size is associated with stability, because as size increases, the economic base of the city tends to be more diverse and therefore more stable.

Large places are in the best position to enjoy stable growth over time, because their export base contains a mix of new and income-elastic products as well as mature and inelastic ones ("breadth"). Size also bestows the capability to support innovation, which is needed to change industry mix for long-term viability ("depth"). Anticipating new ideas in evolutionary geography ascendant in the 2000s (Boschma and Martin 2010), Thompson (1968, p. 53) offers an insightful and invaluable statement about why breadth and depth make a local economy competitive:

> The economic base of the larger metropolitan area is, then, the creativity of its universities and research parks, the sophistication of its engineering firms and financial institutions, the persuasiveness of its public relations and advertising agencies, the flexibility of its transportation networks and utility systems, and all the other dimensions of infrastructure that facilitate the quick and orderly transfer from old dying [economic] bases to new growing ones. A diversified set of current exports (breadth) softens the shock of exogenous change, while a rich infrastructure (depth) facilitates the adjustment to change by providing the socioeconomic institutions and physical facilities needed to initiate new enterprises, transfer capital from old to new forms, and retrain labor.[3]

As for income *distribution*, economic growth occurs in localities where the industries export new products or income-elastic products. Greater demand begets greater supply, which requires higher workforce participation rates and puts upward pressure on wages and other costs. As the wage roll-out effect continues to operate, demand growth reduces income inequality by employing marginal workers. Gradually, the area may attract low-income in-migrants seeking job opportunities, and the local level of unemployment may increase as a result.

With respect to the factors of production, Thompson argues that larger urban areas not only have advantages in labor force and immobile capital but in entrepreneurship as well. Often natural resource endowments give rise to a city at a particular location. These conditions are continually modified by the changing built environment that satisfies workers and, more importantly, attracts entrepreneurs. These compelling advantages led Thompson to hypothesize the "urban size ratchet" effect that results in sustained advantages for larger cities (1965, pp. 21–24). Cities are the locations where entrepreneurship and immobile capital combine to achieve growth.[4]

Using concepts from shift-share analysis and industry (not product) life cycles, Thompson presents the relative importance of industry mix and regional share in large versus small cities. Large metropolitan centers spin off industries to smaller peripheral areas. Large cities can grow above the national average by capturing new products while spinning off routine work. Smaller cities are more volatile, winning or losing routinized production. The former become high-wage, high-skill places

where labor unions are prominent; the latter are low-wage, low-skill, unorganized smaller cities. He articulates the filtering-down dynamic in the following way:

> The larger, more sophisticated urban economies can continue to earn high wage rates only by continually performing the more difficult work. Consequently, they must always be prepared to pick up new work in the early stages of the learning curve—inventing, innovating, rationalizing, and then spinning off the work when it becomes routine. In its early stages, an industry also generates high local incomes by establishing an early lead on competition. The quasi-rents of an early lead are in part lost to the local economy, as dividends to widely dispersed stockholders, but in part retained as high wage rates, especially if strong unions can exploit the temporarily high ability to pay. It would seem, then, that the larger industrial centers as well as the smaller areas must run to stand still (at the national average growth rate); but the larger areas do run for higher stakes.
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> In order to develop, it seems that the smaller, less favored urban area must attract each successive industry a little earlier in the industry's life cycle, while it still has substantial job-forming potential and, more important, while higher-skill work is required. Only by upgrading the labor force on the job and generating the higher incomes hence the fiscal capacity needed to finance better schools, can the area hope to break out of its underdevelopment trap. By moving up the learning curve to greater challenge and down the growth curve toward higher growth rates for a given industry, an area can encourage the tight and demanding type of local labor market that will keep the better young adults home, lure good new ones in, and upgrade the less able ones.
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> *(Thompson 1968, pp. 56–57)*

Thompson recognizes that the overall impacts of these processes are not easily determined much less achieved. Positive and negative feedback represent countervailing effects on local growth and change. Equilibrium and disequilibrium forces are reflected in the struggle between market power and overpriced labor. Positive versus negative outcomes are also the result of timing and history (path dependence). With the growing pool of potential locations around the world, the competition faced by smaller regions in the United States has continued to increase over time.

The occupational-functional dimension

Wilbur and Phillip Thompson (1987) argue that industrial targeting, the recruitment of large firms in attractive industries that are feasible given local resources, needs to examine another dimension. Specifically, the approach is one-sided unless coupled with an occupational-functional focus that defines an area's "appropriate work." The functional specialization that shapes the local industry mix reveals what

the place makes, for example, a textile city or financial center. The occupational-functional dimension identifies what the place does, that is, the type of work that is most prevalent. Thus, a factory town offers much different work than a college town or a state capital or a headquarter city. The Thompsons developed a matrix with industry groups as columns and occupational groups as rows that they used for in-depth analysis of local economies.

Five occupational specializations represent different types of work and suggest ways to achieve competitive advantage: routine production, precision production, research and development, headquarters administration, and entrepreneurship.[5] One locality may have strength in more than one area but rarely in more than two areas. The occupational-functional dimension can be used to indicate where among the cities in the urban system, new work (product innovation) is most likely to occur and where existing work can be done most efficiently.

Development occurs as localities change skill levels and occupation mix over time, which change functional specializations and, gradually, the basis of competitiveness. However, in the near term, the obvious strategy is to leverage existing occupational strengths, be they routine production, precision production, R&D, central administration, or entrepreneurship. At headquarter locations, dominant companies may promote innovation through internal investments in new products or through skillful acquisition of patents and young growing companies.[6]

With creative and efficient firms and individuals, the local economy can change specializations and continue to enjoy a viable export sector. Thompson argued that the local-basic dichotomy in economic base theory should be broadened to a trichotomy in order to understand more fully the role of the non-basic sector. Thompson distinguishes developmental services from routine distributive services in addition to basic industries. In the near term, the city's economic base is its export goods and demand-driven services sectors; in the long term, the city's economic base depends on the availability and quality of its supply-responsive developmental services. These services include sound educational systems, diverse health services, rich cultural activities, and the range of sophisticated business and professional services that can sustain the creation of new products and new business enterprises.[7]

Thompson's contributions offer an unusually sophisticated understanding of local economic development. Near-term changes in the urban area's industry mix provide the basis for understanding economic growth. Typically, growth leads to more employment and aggregate income, larger tax base, and higher property values. Gauging the structural change that occurs over the long term explains the more complex process of economic development. In addition to continued economic growth, localities sustaining economic development should be able to experience improvements in per capita income levels with less unemployment and instability. Although economic growth and economic development are related processes, development is more profound and fundamental. Economic development leads to and sustains competitiveness; competitiveness in turn results in economic growth.

Reflections on regional theory and policy

Through an extensive empirical analysis of regional census data from 1950 to 2000, Thompson (2008) reconsidered his thinking about urban and regional economic growth and development and related urban policy based on a data-driven approach. This unpublished manuscript with 1,494 single-spaced pages covers the broad scope of A Preface to Urban Economics. . . . The following commentary is highly selective, focusing only on topics relevant to the far narrower scope of this book.[8]

Economic growth can be measured year by year, but economic development should be examined over decades. It is an "intergenerational process." The local economy is "a growing, aging and renewing stock of capital." Thompson called this process "aging in space." Thus 50 years, in this instance 1950 to 2000, is an appropriate, perhaps minimum, time frame given amortization and replacement cycles of private capital and public infrastructure. Importantly, skill development leading to good jobs over the long term is far more important than "job creation" (any and all jobs) or "raw growth."

In his empirical analysis of metropolitan areas, Thompson assessed whether growth over time led to development. He compared population growth to median family income to make this assessment and found "only scattered evidence" of a significant relationship. He also compared population growth to both income growth and the poverty rate, finding no significant relationships. Thompson also correlated the level of and change in family income with the level of and change in poverty rate and found that strong inverse relationships became increasingly weaker over the decades. He thought greater structural unemployment and workers formerly in manufacturing dropping out of the labor force could partly explain this trend.

Next, Thompson examined one result of growth: increases in city size. Larger size is associated modestly with higher family income but more strongly with a richer occupation mix, better-educated employees, higher female labor force participation, and larger local markets. The diseconomies of size are underscored and analyzed fully in his intra-urban analysis in Book Two. Moreover, the largest metropolitan areas can develop further with only modest rates of growth because of absolute increases in population and employment. Furthermore, the highest-paying jobs reside there, and the large amount of job attrition provides opportunities for younger workers. Perhaps the most important local market is the large labor market. With greater size comes wider occupational choices, more competition among employers, and greater stability among other benefits (Chapter 9).

Thompson is well known for recognizing the benefits of oligopolies in manufacturing and the associated labor unions as vehicles to higher wages and stable employment. He notes another benefit—the resources to build prominent public universities in these areas (the original Big Ten). As manufacturing employment has declined over time, the educational requirements of manufacturing jobs have increased. Metropolitan areas retaining manufacturing have workforces that are

better educated, with more female participation. If homeownership rates are relatively high, these skilled workers are more likely to stay in place during downturns.

The last three chapters of Book One (Chapters 9–11) contain in-depth treatments of his favorite themes: the strength of developmental services that foster long-term economic development, the metrics and logic of more sophisticated industrial targeting, the occupational-functional approach to foster local economic development, and the five paths based on what places do (versus what they make). Thompson provides considerable detail about how to apply the occupational-function approach in Chapter 11. He then considers each occupation-based function separately in Chapter 12 and provides extensive guidance about how to treat the occupation-function in each case. These two chapters (175 pages) contain more new material than any other chapters in Book One.

Instead of competing for industries either on a targeted or an untargeted basis, Thompson argues for applying occupational-functional analysis because it leads to policies that build local comparative advantage. He sees this approach as positive sum rather than zero sum. Instead of industrial targeting, Thompson makes a cogent case for occupational adaptability as the basis for long-term development in noting that many professional and skilled occupations can find employment across many industries, both declining and growing. Building on existing occupational clusters may be more viable than building on industrial clusters. He adds the caveat that, to be successful, the place must embrace "both scholarship and entrepreneurship—a love of learning and a manageable fear of change."

In examining the five alternatives in Chapter 12, all but entrepreneurship build directly on industrial specializations and the existing economic base. Central administration, R&D, and precision production have substantial potential to evolve the economic base and improve local economic development. However, places dominated by routine production have a lower level of development. These places should prioritize employment opportunities and defer the objective of higher incomes.

Entrepreneurship is a special type of occupational strength because no metropolitan economy can claim entrepreneurial energy alone as its economic base. This strength is best thought of as complementary to one of the others. Entrepreneurship can be primarily gap-filling, fleshing out distributive services, or more innovative by augmenting developmental services. These entrepreneurial companies may become major service exporters. In a supportive institutional context, entrepreneurship can foster growth companies that renew or replace existing export sectors (Chapter 7).

For all five occupational functions, Thompson envisions "occupational ladders" as the vehicle for skill development and the path to higher income as workers move from lower- to higher-level jobs.[9] Ideally, workers could move, with appropriate continuing education and training, from low-skilled to semi-skilled jobs and from these jobs to professional work. Within most metropolitan areas, such occupational ladders are not complete. In Chapter 17, he argues for state-level policy to integrate occupational ladders across cities, suburbs, and rural areas.

Strategic applications and criticisms

Clearly, the goals articulated by Thompson are not mainstream in economic development practice. Most jurisdictions designate jobs and investment (tax base) as their primary development goals. Where can one find a jurisdiction primarily committed to increasing per capita income, reducing income inequality, and lessening income instability? Beyond job growth, localities seem willing to embrace the goal of greater economic diversity, presumably as a way to experience greater stability. Furthermore, growing income inequality has become so widespread in recent years that it is very hard to ignore it in economic development circles. Even narrowly focused developers recognize the negative impacts that grossly unequal distributions of income and wealth have on aggregate demand. Increasing labor's share of income or wealth to stimulate demand has become an economic growth strategy. We take up the spatial aspects of inequality in the next section.

Thompson believed that local economic developers informed by his ideas and framework would be able to address competently the major problems and opportunities facing their locality. Developers would examine both the evolution of the locality's industry mix and its occupational-functional mix over the past 50 years (or longer). From this analysis, they would gain a deeper understanding of the evolution of what their place currently makes (the dominant industries) and more importantly what it does (the primary occupations). Armed with this in-depth knowledge, developers may be able to craft long-term development strategies that identify alternative avenues for movement up the learning curve to higher levels of personal income and skill. The strategies could suggest ways to change what local firms do, for example, from routine production to precision production, and how to overcome impediments to further development, for example, by resolving education or infrastructure problems. Local economic developers would logically focus on developmental services. Increasing the quality and diversity of these services should promote more innovation in larger metropolitan areas and higher productivity in areas specialized the production of standardized goods and services.

Thompson's conceptualizations through 1990 are colored by his long tenure at Wayne State University in Detroit, his experience with Midwestern cities, and his deep knowledge of the U.S. economy in the 1950s and early 1960s. He did not foresee the dramatic decline of manufacturing in the United States. Nor did he anticipate the rapid pace of branch manufacturing migration from the "industrial hospices" in the South to countries where wages were far lower and environmental standards less restrictive. The loss of manufacturing production and employment and the rise of service industries have not followed the logic of sector theory (Chapter 3). Most economic developers would like to help fashion an economic base that includes viable traded sectors (exporters) that are also high value-added sectors. They would value developmental services that promoted innovation. Fewer metropolitan areas that have knowledge-driven, talent-centered economies should remain competitive accounting for a growing share of future GDP. Many smaller metropolitan areas currently engaged in routine production are more likely

to fulfill back office or local service functions that have few positive spillovers. The service-oriented economy is generally low-wage; service industries are unlikely to boost tax revenues significantly. Tighter labor markets may encourage labor-replacing technology rather than higher wages or the upgrading of workforce skills. Outmigration may be more likely than sustained growth.

Thompson's more optimistic scenario depends heavily on effective targeting and on the ability of labor unions to achieve increases in labor's share of productivity gains. The growing divide between increasing labor productivity and stagnant real wages since the late 1970s underscores the reduction in the power of labor versus capital. Indeed, the direct connection between marginal productivity and wages conveniently assumed in neoclassical economic theory ignores the well-demonstrated historical fact that wage increases depend on the ability of labor to exercise power. In general, Thompson's approach may be better suited to metropolitan economies located in countries like Canada that are more socially oriented than pro-big business and more democratic than plutocratic.

Wilbur Thompson was a part of the Greatest Generation. He grew up during the Great Depression and died at the outset of the Great Recession. Throughout his long productive career, he formulated original creative ideas that could make the market economy work better for all Americans, notwithstanding the powerful local growth machine's obsession with "raw growth."

Moretti's Great Divergence

How can regional development theories help us better understand the contemporary problems that economic development practitioners and policymakers struggle with today? We choose to focus on one important issue: the growing regional divide between the have and have-not metropolitan areas in the United States. Economist Enrico Moretti refers to this phenomenon as the "Great Divergence." In his 2013 book, *The New Geography of Jobs*, Moretti argues that the shrinking U.S. middle class and the growing rift between rich and poor *households* are also very much the story of the widening gulf between rich and poor *regions*. Counted among the rich are the nation's leading innovation centers, including Silicon Valley and San Francisco, Boston, Seattle, and smaller areas like Austin and Raleigh-Durham. In three decades from 1980 to 2010, the relatively small number of leading "brain hubs" have amassed more and more of the nation's income and wealth, while former industrial giants and many second-tier cities continue to sink farther behind. This interregional income and wealth divide is linked to stark differences in quality of life: divergent rates of educational attainment, divorce, and mortality, not to mention growing ideological polarization and the associated rise of populism on both the right and the left.

Moretti presents no original theory of regional development to explain the Great Divergence. Instead he offers a concise and non-technical synthesis of concepts that underscores the importance of innovation and focuses on differences among regional labor markets in the United States.

The decline of U.S. manufacturing

Moretti considers the decline of domestic manufacturing as one of the key factors behind the Great Divergence. For most of the 20th century, productivity growth in manufacturing fueled rising incomes and the ascension of the American middle class. The initial location of an industry was often due to access to raw materials and low-cost transportation over major waterways. Once the industry gained a foothold in an area, powerful agglomeration forces set in, creating a self-reinforcing process of path dependence. The dominant external scale advantages associated with the industrial era were generally confined to industries mainly bound together through buyer-supplier transactions. Relatively specialized industrial complexes came to dominate the economies of particular regions. Well-known examples include the motor vehicles complex of the Greater Detroit region; photography in Rochester, New York; and armaments in Springfield, Massachusetts. As these products matured through the life cycle, standardization, automation, and cost considerations began dominating location decisions. Since labor and other key inputs are typically cheaper in less developed regions, the free movement of capital helped spread development to other areas, such as the Southeast United States. This spatial diffusion of regional development helped fuel interregional convergence, as predicted by neoclassical growth theory (Chapter 5).

By the late 1970s the U.S. economy began a structural shift away from material production, coinciding with the initial decline in the rate of interregional income convergence. The same cost pressures that first brought factories to less developed U.S. regions eventually led them offshore. In order to survive, the remaining stateside operations either had to automate intensively or pivot to high value-added niche product lines. New communications technologies, liberalized trade policies, and lower shipping costs accelerated this process by enabling firms to physically separate their operations by function: headquarters decoupled from back office operations, from R&D, and from production. The most knowledge- and interaction-intensive functions (corporate headquarters and R&D) concentrated in larger cities that became innovation hubs, while production and other support activities diffused across the globe, most notably to China, India, and Mexico.

The rise of the brain hubs

The other, and perhaps more dominant, force behind the Great Divergence is the ascension of the "New Economy," whereby innovation supplants manufacturing as the driving source of national productivity growth and wealth generation. It is also heavily polarizing, as the most knowledge-intensive industries and occupations have become heavily concentrated in a handful of urban centers, as noted earlier. Silicon Valley/San Jose is the best-known brain hub.

Moretti incorporates theories of external economies and agglomeration (Chapter 9) to explain the evolving uneven regional geography of innovation, invoking both demand-side (cumulative causation) and supply-side (endogenous) theories.

He also weaves in contemporary topics, such as innovation clusters, creative economies, and entrepreneurial ecosystems. He explains that innovation is particularly sensitive to spatial variations in human capital because nearly all value-added (and thus wealth) in this sector comes from ideas. Very little comes from low input costs or production efficiencies. Ideas spawn where smart and creative individuals interact, inspire, and learn from one another. Thus, innovation thrives on increasing returns stemming mainly from knowledge spillovers and labor-pooling externalities.[10] The need to recruit and retain creative talent is so critical that firms are willing to suffer the very high rents and pay well over prevailing industry wage standards to be where the action is.

Moretti draws heavily on economic base theory and its dynamic extensions (Chapter 3) to describe how growth in the innovation sector spreads to benefit other sectors. Applying economic base theory, Moretti divides the region's economy into traded (export-oriented or basic) and non-traded (local-oriented or non-basic) sectors. Productivity growth in the traded sectors is the primary source of wealth creation and income generation. However, most jobs reside in the non-tradable industries, which are more labor-intensive and less prone to productivity improvements.

Productivity growth in the tradable sector fuels job growth in the local non-tradable sector through multiplier effects. Moretti points out that innovation activities have far higher *local* multiplier effects than nearly all other sectors, including manufacturing. Despite being low-skilled, many jobs in non-tradable industries, like that of carpenters and waiters, are resistant to offshoring because they have to be performed close to where the service is provided (Manning 2004). Nor can they be easily automated, because they involve non-routine tasks, such as navigating crowded restaurant isles or building custom cabinets for oddly shaped closets (Autor et al. 2003; Goos and Manning 2007). Spread effects from the innovation sector drive local demand in non-tradable industries and local growth, whereas backwash effects increase the interregional divergence of wealth and job creation. Moretti points out that high-school degree holders in leading regions routinely make more than college-educated workers in lagging regions.

Place luck and policy options

Growth and agglomeration theory may help us understand the growing divergence of have and have-not regions in the New Economy, but they do not explain how the brain hubs of today got established in the first place.

Moretti's view is that it is largely place luck that determines the initial foundation for an innovation cluster.[11] As such, he offers little concrete advice for lagging regions hoping to reinvent themselves in the new economy. In fact, he is rather dismissive of most deliberate policy efforts to establish a brain hub. Consider research universities as one possible catalyst. Clearly, many of today's rising innovation hubs are in areas with leading research institutions. Yet, Moretti sees this as neither a necessary nor sufficient condition for establishing a brain hub, pointing to

the many counterexamples of places, such as St. Louis, Missouri, that have leading universities but no viable hub. Instead, the spark more likely comes from the entrepreneurial actions of academic mega-stars who just happen to have worked for that particular institution at the time of their big breakthrough (Zucker et al. 1998). Universities play a secondary role as a talent magnet and provider of ecosystem services, but innovation is essentially a game of numbers and luck, with emphasis on the latter. While the prospect of spawning a cluster may seemingly validate university efforts at luring academic stars through promises of high pay, superior facilities, and deep-pocketed research endowments, Moretti sees this strategy as difficult to sustain. Even if it were successful at generating innovations, the benefits would not likely "spill-over" without a fertile ecosystem outside of the university, which he sees as critical for transforming university inventions to regional gains.

> Universities are most effective at shaping a local economy when they are part of a larger ecosystem of innovative activity, one that includes a thick market for specialized labor and specialized intermediate services. Once a cluster is established, colleges and universities play an important role in fostering its growth, often becoming a key part of the ecosystem that supports it and makes it successful.
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> *(p. 197)*

Moretti is likewise critical of conventional place-making approaches to luring human capital, such as the creative economies and creative cities approaches commonly associated with Richard Florida (Florida 2002, 2005).[12] This perspective views developing the arts, culture, entertainment, and other forms of lifestyle amenities as the key to attracting innovative people. These innovators will, in turn, create businesses and attract firms seeking talented human capital. Moretti certainly recognizes the magnetic lure of talent but argues that creative-cities approaches ultimately have confused effect with cause; artisans and other creative workers flock to the wealth created by successful innovators, not the other way around. It would be difficult to create an innovation cluster purely by first attracting artisans or boasting of an area's superior quality of life. Moretti points out that there are lots of beautiful places with attractive amenities, but few have evolved into brain hubs.[13]

Moretti also argues against the use of locational incentives to lure businesses. He contends that while "big push" development strategies may indeed help a place out of the poverty trap, the United States lacks the political will to support areas to the point where they can sustain themselves. Government also has a poor track record in picking the right sectors. However, Moretti is more amenable to place-based incentive programs, such as the Clinton-era Empowerment Zones program, that target incentives while supporting workforce development initiatives and neighborhood revitalization efforts that can generate positive social externalities.

It is somewhat ironic for a book focused on exposing the ills from the inequitable spatial concentration of wealth that Moretti favors approaches that would encourage *even more* out-migration from impoverished areas. He recognizes that

migration is highly selective and therefore heavily stacked against less developed areas due to the growing need to satisfy the professional ambitions of dual-career households and the specific preferences of the highly educated (Costa and Kahn 2000). Nevertheless, a policy targeted to increasing mobility among the poor and the unemployed would ultimately benefit underdeveloped areas by easing pressures caused by concentrations of poverty.[14]

In conclusion, Moretti draws from many theories presented in previous chapters: economic base (traded and non-traded sectors and multiplier effects), comparative advantage (pp. 33–34), modern growth theory (human capital focused), cumulative concentration and diffusion of development, product life cycles, creative destruction (pp. 148–149), and agglomeration theory. He relies most heavily on his background as a labor economist and concepts related to innovation theories (Chapter 8), including entrepreneurial ecosystems and creative economies.

Strategic economic development framework

Throughout this book, we have drawn distinctions between economic growth, getting bigger in the near term, and economic development, getting better in the long term. To promote economic development, Thompson treated as his tripartite objective higher levels, more stability, and fairer distribution of household income. Rather than households, we focus, like Moretti, on the structure of the metropolitan economy. Our objective is to provide a strategic framework that will help economic developers facilitate local economic development built upon their assessment of the regional economy.

To capture the competitive differences among labor market areas, the strategic framework offers four meta-level goals, which are attributes that reflect the area's capacity for long-term economic development. These attributes are the product of past decisions and events which in turn represent fundamental differences in the capabilities of individuals and firms to compete in the global economy. The existing industrial structure, occupational strengths, private capital stock, public infrastructure, political culture, and many other features of the local economy are given. When local economic developers choose preferred development strategies, they should recognize that their choices are conditioned by this economic reality.

We present three of these meta-level goals in pairs, where each pair represents two ends of one continuum. Pursing either end could promote local economic development, but trying to pursue both simultaneously is less likely to succeed.

The most basic questions relate to comparative and competitive advantage (Chapter 4). What role(s) does a region play in the larger economic system? How have its industrial sectors evolved over the past 30–50 years? Because regional competitiveness depends on the viability of industrial specializations in the evolving economic base (Chapter 3), we identify *functional specialization* as the first meta goal. At one extreme of the continuum are regions with multiple specializations (breath). At the other extreme are regions with one or very few well-resourced specializations (depth). Regional economies with multiple specializations may be

more flexible and stable. Narrowly specialized regions may be more competitive, especially in the near term, due to focused attention buttressed by agglomeration economies. Either extreme may sustain highly productive firms or spawn innovative firms.

The second meta goal builds on Thompson's concern with the occupational strengths of the region (what its workforce does versus what its industries make). The region's current occupational strengths have evolved over many decades and cannot be radically changed in the near term. This meta goal is not one continuum. Instead, it identifies four different strengths that build on the skills, talents, and tacit knowledge of the workforce: (1) administrative centers, (2) production centers, (3) consumption centers, and (4) R&D centers. Administrative centers tend to combine command and control functions with expertise in finance. Production centers are extremely varied: some generate standard products, whereas others offer cutting-edge products or services. Consumption centers may serve only the local population aging in place or offer hospitality facilities and entertainment that attract tourists and retirees. R&D centers are often associated with research universities or major health facilities. These include Moretti's "innovation hubs" or "brain hubs," with Silicon Valley as his prototypical example. He might argue that innovation hubs will outperform the other types of centers since they are service sector-oriented, research-driven, and knowledge-based. We argue that it is more important to leverage whichever occupational strength exists in the region, since regions within each category will vary in their ability to attract and benefit from investment.[15]

The third meta goal relates to the economic power of companies in the region. Companies wielding a dominant position within the region tend to detract from performance and long-term development. But local companies that exert monopoly or oligopoly power in national or global markets may benefit the home region. Growing entrepreneurial firms may eventually gain power and offer the same local advantages. In such regions, economic developers may want to find ways to help companies with market power remain dominant. They may also want to assist local entrepreneurial firms whose aim is to displace established companies located elsewhere. In other regions, existing companies, both large and small, may face external competition that presses them to remain lean and innovative. Local economic developers should find ways to customize the local business climate to support these companies. They should enhance the entrepreneurial ecosystem to assist nimble, disruptive upstarts.

A fourth meta goal pertains to how firms in the region respond to adversity or opportunity. Here we contrast resistance to resilience. Resistant firms can withstand externally generated stress ("take a punch") and do so for relatively long periods of time. Resilient firms can react to external stress effectively and can seize opportunities quickly. In the context of recessions, places with resistant firms tend to maintain employment levels longer and sustain less economic damage than regions with less resistant firms. On the other hand, places with resilient firms recover more quickly, regaining or exceeding former levels of employment, than

do regions with less resilient firms. Firms in most regions tend to be either more resistant or more resilient. Local economic developers should try to help resistant firms maintain existing strengths or help resilient firms pursue new opportunities.

When considering these four meta goals, the size of the region matters. Larger metropolitan areas are likely to have more functional specializations with high location quotients (more export sectors). However, they are also more likely to have larger shares of the national total for any sector. The sector's relative importance within the region and its absolute size are both important. For large regions, the meta goal for functional specialization could be broadened to support existing export sectors and gain a larger share of the national total for prominent industries. Larger places are also more likely to have nationally dominant companies and resistant firms. Larger labor market areas may also have the "thickness" to support growing entrepreneurial companies and more resilient firms.[16] They should have the resources needed to enhance agglomeration economies while mitigating diseconomies.

In conclusion, developers should find the four meta goals useful in framing relevant economic development strategies. They should think broadly about regional economic structure by considering important and emerging local companies as well as more aggregate industrial sectors. Local economic developers can fashion strategies to influence and hopefully improve regional outcomes.

Intraregional practice

Most economic development organizations embrace many strategies. Economic developers are asked to recruit industry, create small-enterprise networks, build incubator facilities, capitalize venture funds, promote tourism, attend to existing industries, cultivate entrepreneurial ecosystems, and encourage international exports—to mention some of the more popular ones. This shotgun approach to strategies is contrary to the message of this book. For local economic developers, the fundamental challenge is to arrive at strategies that are *uniquely* suited to their regional economy and the local jurisdictions within it.[17]

Considerable competition exists among local economic developers hired by different jurisdictions that are part of the same labor market area. Unfortunately, this competition frequently drives development professionals to pursue similar strategies and to target the same existing industries or prospects, which often reduces everyone's effectiveness. Just as the theories presented in this book are intended to reduce *inter*regional competition among economic developers by helping them understand the unique features of their labor market area, they can also help to reduce *intra*regional competition. When job creation is the central concern, region-wide cooperation should be attractive, since employment opportunities within one labor market area become available to all. On the other hand, the goal of tax base expansion may foster competition among local jurisdictions. The advantages of regional tax base sharing are obvious in this regard, but the practice is politically difficult.

How can more cooperation be accomplished? First, economic developers from the same labor market area can meet and, together, arrive at a common understanding of their region. Second, these developers can analyze the variations in the economic landscape across local jurisdictions, with an eye toward understanding the interrelationships and interdependencies among them. This, in turn, will allow local developers to particularize strategies to their jurisdictions that remain sensible at the labor market level. For example, the largest jurisdiction or a strategically located smaller jurisdiction may offer the amenities attractive to specialized service firms, while other jurisdictions may be able to provide the affordable industrial space sought by cost-conscious manufacturing, distribution, or service firms. Still other areas may offer residential development to accommodate the growing workforce. Local economic activity that serves household demand would be prominent in these jurisdictions.

Conclusions

This book presents insights about economic growth and economic development deduced from regional theories. Most economic developers will be able to construct an eclectic understanding of economic development by drawing on these theories selectively. A carefully formulated synthesis of theories can serve an important purpose, but the developer can also realize useful insights from applying each theory separately. By exploring each theoretical perspective carefully and fully, while at the same time being mindful of the specific theoretical questions and empirical problems the perspective is attempting to address, the developer is more likely to discover insights that clarify the process and possibilities of local economic development. If different theories support the same development strategies, the priority of these strategies may be elevated as a result.

As argued in Part I, without theory, the economic developer pursues politically expedient strategies with professionally accepted techniques but has no way to build a defensible basis for independent action. With theory, the developer can first understand the threats and opportunities facing the regional economy and then fashion unique strategies that address its strengths and weaknesses. Instead of politics dictating potentially inferior development efforts, economically significant strategies may be adapted to meet political realities. In this sense, a good understanding of theory will enhance the economic developer's creativity and ability to design effective solutions to local economic problems.

With a real understanding of the local economic development process, economic developers may be able to promote their region's competitiveness by facilitating better work and new work (long-term development), not just more work (near-term growth), and build the region's necessary physical, business, labor, and political infrastructure in the process. They can work to improve the overall milieu of the area as well as target efforts to specific firms, workers, industries, or subareas. The key to success depends on how and from where the economic developer derives specific strategies and programs. In places where strategies rationalize

existing programs, techniques, and political expediencies, success will depend more on luck than on skill or effort. In cities and regions where strategies flow from deep insights into the structure and function of the local economy, economic development efforts stand a far greater chance of success.

With our focus on labor market areas and metropolitan regions, we have made limited reference to primary sectors, like agriculture or mining, or more generally to natural resources. Clearly, the economic base of the global economy continues to rest heavily on the unsustainable consumption of natural resources, and especially the extraction and utilization of fossil fuels, primarily coal, petroleum, and natural gas. Climate science demonstrates clearly that this foundation is not sustainable. An economy built on renewable sources of energy that uses natural resources sustainably is the only viable pathway for the global economy (Masson-Delmotte et al. 2019).

Although abandoning the carbon-based economy may appear daunting, we should remember that combining collective and private action has led to extraordinary innovations and technologies over the years, which has led to major shifts in industrial organization, political and social norms and practices, and the distribution of wealth among people and places (Mazzucato 2013). The internet, which offers open access to almost limitless business and consumer markets at virtually no cost, is one example of public-private action.

Certainly, concerted and bold actions are needed to find tangible and impactful mitigation solutions to the environmental challenge, but they are within reach in terms of technical, social, and economic feasibility (Hoegh-Guildberg et al. 2019). Bozeman (2007), Mazzucato (2018), (Coenen et al. 2015), and other emerging work that critically examines the concept of *value* challenges all economic development participants to think not just about which strategies in terms of *what* and *how* but also in terms of three more basic concepts. The first is *direction*—the future we want as a society. The second is *legitimacy*—the reasons we want that future and who decides. The third is *responsibility*—the parties who must participate to get us there (Uyarra et al. 2019, p. 2362). We are optimistic that local economic development practitioners, informed by positive and normative theory and implementing well-designed strategies customized to the needs and potential of the regions they serve, will make their own significant contributions to shaping a global economy that is environmentally sustainable and more just in its distributions of income and wealth.[18]

Notes

1 In a letter to Malizia dated September 24, 2004, Thompson parenthetically describes this work as "an act of sheer madness." He wrote almost 636,000 words, which translates into a published book of over 2,000 pages.
2 Thompson considers all aspects of development in comparative terms. Indicators of development are always comparative either across regions or over time in one place.
3 The concepts of breadth and depth appear to be consistent with Shapero's (1981) argument about the capacity for local economies to create new work in response to external change. Breadth is a short-hand term for the diversity of the economic base, which is

the presence of multiple specializations. Depth appears to support the economy's ability to change, or, in Shapero's terms, to demonstrate resilience.

The only deficiency in the statement is the assumption that city size appears to function as a causal factor. More likely, size is correlated with or is the outcome of more basic growth and development factors such as functional specializations or resistance/resilience. See the discussion of city size in Chapter 9.

4 Thompson seems to exaggerate the advantages of city size *per se* and to underestimate the importance of large corporate organizations that tend to be headquartered in the largest cities. Other theorists recognize the major influence of large multi-locational firms, for example, Pred (1976), Markusen (1985), and Malecki (1997).

5 Rosabeth Moss Kanter (1995) presents a compatible but less structured argument about attaining competitiveness in the global economy. Cities, she describes, as "thinkers," are essentially R&D-oriented places. "Makers" are places that focus on precision production in either manufacturing or service industries. Other cities are "traders" that focus on international finance and communication. For trade-oriented cities, Kantor has combined the historical competitive advantage of port cities—as physical and commercial breaks in transportation—with their current role in the urban hierarchy as headquarter cities. Although advantaged by trade-oriented infrastructure, these places currently function as administrative/command and control centers.

6 Corporate centers are dense with headquarters, money-center financial institutions, advanced business services, and professional workers. They tend to have hub airports, good air travel connections, and advanced telecommunications, which enhances corporate control.

7 Thompson does not identify developmental services precisely. The following NAICS codes are examples of industries engaged in largely developmental service activities in contrast to routine or consumer-oriented service. The NAICS codes are 4541, Electronic shopping and mail-order houses; 481, Air transportation; 485, Transit and ground passenger transportation; 51, Information—the entire sector, which includes electronic and non-electronic publishing and broadcasting, motion pictures and telecommunication; 52, Finance and insurance, which includes mortgage bankers, security brokers, surety insurance, and miscellaneous investing; 54, Professional, scientific and technical services; 55, Management of companies and enterprises; 6113, Colleges, universities, and professional schools; 6114, Business schools and computer and management training; 6115, Technical and trade schools; 6221, General medical and surgical hospitals; 711, Performing arts and spectator sports; 712, Museums and historical sites; 713, Amusement, gambling, and recreational industries; 722, Food services and drinking places; and 7211, Traveler accommodations. Alternatively, one can examine major occupation groups to find groups of workers delivering developmental services, for example, 15, Computer and mathematical; 17, Architecture and engineering; and 19, Life, physical and social science.

8 Book One discusses urban and regional analysis and policy. Book Two focuses on intra-urban analysis and policy. Each book is subdivided into three major parts. Book One has eleven chapters. Book Two adds ten more.

9 Similar ideas are fleshed out in Nelson and Wolf-Powers (2010) and Lowe and Wolf-Powers (2017). See also Markusen (2004).

10 Moretti does mention proximity to intermediate goods and services as well as access to venture capital (which he equates to supportive entrepreneurial ecosystems) as further benefits of agglomeration, but clearly Moretti sees human capital as the major factor driving location decisions in the innovation sector.

11 See Reese and Ye (2011) for a discussion of the debate about place luck versus policy.

12 Florida's work is more thoroughly discussed in Chapter 9.

13 Moretti does not address the intraregional scale, such as whether it would make sense to concentrate innovative activities in one city neighborhood or "innovation district." While this would not create a new regional hub immediately, it might be an effective

means of concentrating existing innovators that eventually foments a self-sustaining cluster.

14 Moretti does not consider all possible downsides, such as those stemming from severing social and communal ties, the high opportunity costs of providing infrastructure in declining places, exacerbated cost pressures and displacement in growing areas, as well as the option value of having a variety of healthy and vibrant communities (Bolton 1992, 2007).

15 On the other hand, Atkinson et al. (2019) call for significant public investment in eight to ten existing metropolitan areas to make them "growth centers" (see Chapter 6) in order to counter the growing concentration of high-tech employment in the existing brain hubs.

16 In an empirical analysis of employment in U.S. metropolitan areas before, during, and after the Great Recession, we found that larger metropolitan areas were more likely to be both more resistant and more resilient.

17 They can fine-tune their strategies by talking with economic developers in comparable labor market areas, that is, in areas that have a similar economic location in the global economy.

18 More fundamental changes in the guiding principles and measurement of value in U.S. capitalism are necessary. What if value for all stakeholders (employees, customers, suppliers, the public, as well as the natural environment) trumped shareholder value? What if the focus on economic efficiency was subordinated to the objective of economic resilience? What if the public good value of locality, place, and community was taken seriously in national policy and public investment decisions? Unorthodox economic scholars like Mazzucato (2018) and more mainstream economists such as Banerjee and Duflo 2019) and Rajan (2019) are contributing to thinking along these lines that is long overdue.

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APPENDIX

Economic thought

It is useful to present economic thought in its historical context for three primary reasons. First, here we find the written products of scholars arguing about the realities of economic life. The arguments began in earnest in the 18th century and continue today. These give-and-take arguments cannot be learned by studying economics from textbooks. Second, thought and practice continually interact. By understanding economic thought historically, the reader can correlate concepts and arguments to the major historical events of the period. Ideas are formulated to explain changes in economic life, and, to some extent, economic life is shaped by the accepted economic doctrines of the time. Third and most importantly, old economic ideas are still used to explain economic development currently. See Heilbroner (1972, 1988) and Galbraith (1987).

The outline of economic thought shown in Figure A.1 presents the general flow of ideas over the past 300 years. We begin with mercantile and physiocratic thought because these ideas form the basis of certain long-standing arguments about economic development in the United States and Canada, although modern economists no longer use them. Adam Smith, David Ricardo, and J.S. Mills, writing in that order and building on earlier work, present the first complete treatment of classical economics (political economy). The critics of classicism include both supporters of capitalism, like the Marginalists and Leon Walras, and dissenters in Karl Marx and the Socialists. Next, Alfred Marshall consolidates classical thought with the theory of supply and demand. Over the next several decades, many others, including J.M. Keynes, broaden and deepen economic theory. These ideas are synthesized in modern micro- and macroeconomics, which continue to grow with the support of mathematics and econometrics.

Neoclassical critics have generally objected to the formalism and level of abstraction in modern economics. Critiques of the institutionalist and Austrians have waned, while critiques of post-Keynesian and Radical economics have continued. New ideas have arisen, such as supply-side economics during the 1970s, when "stagflation" challenged Keynesian policies.[1]

Unlike neoclassical theory's concern for equilibrium or steady-state growth, the major objective of classical thought is to understand the evolution of the economic system over the long term.[2] Classical thought is particularly relevant to development economics, a subfield that emerged after World War II (Arndt 1981). Development economics tries to grasp the evolution of the economy in terms of economic growth and structural change and draws theories from the body of economic thought portrayed in Figure A.1.

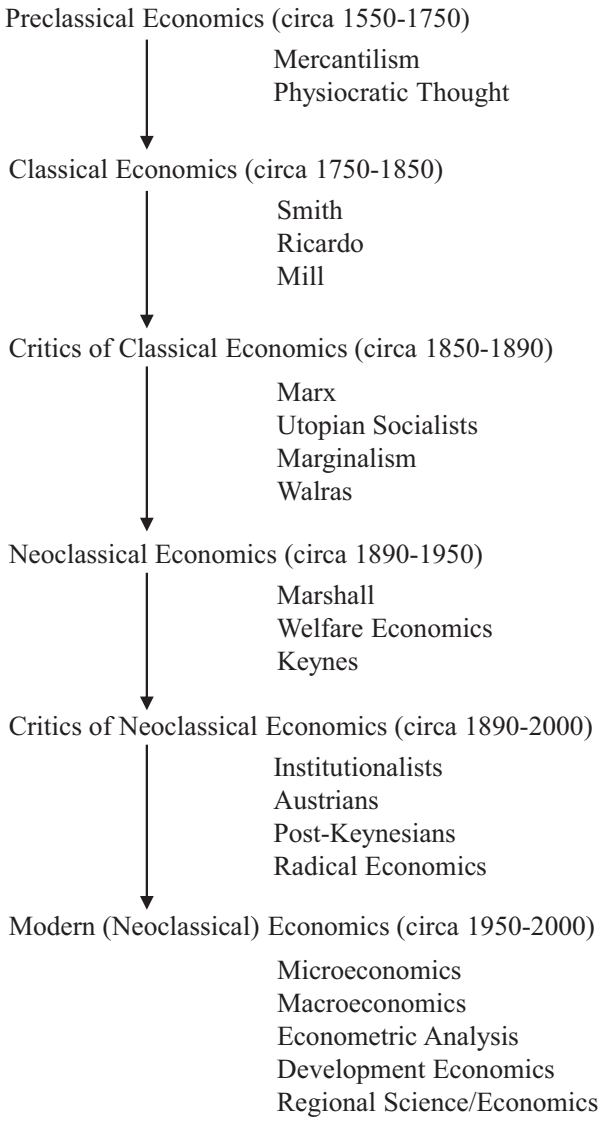

FIGURE A.1 Historical overview of economic thought

Until recently, economic thought has largely neglected the spatial dimension of structural change. It was economists on the European Continent who examined geography taking up issues of space, regions, and urbanization. The theory of location was almost entirely developed by German and central European economists from about 1820 through 1940. Isard (1956) synthesized this work, which subsequently spawned the subfields of regional science and regional economics.

The theories in Part II draw from different schools of thought. Economic base theory (Chapter 3) is compatible with Keynesian theory. Staple theory (Chapter 3) is a regional application in the spirit of institutional economics that emphasizes legacy and path dependence. Neoclassical trade and growth theories (Chapters 4–5) flow most directly from mainstream neoclassical economics as applied in development economics. Perroux, Myrdal, and Hirschman (Chapter 6) were early critics of mainstream development economics and had their ideas incorporated into formulations of regional economics. Product cycle theory (Chapter 6) is an interesting combination of neoclassical theory and location theory. Schumpeter's theory of entrepreneurship and regional innovation theories (Chapters 7–8) draw from the Austrian and Neoclassical schools. Agglomeration theories (Chapter 9) build on Marshall's ideas about external economies. Radical and Marxist theories provide the inspiration for many modern critiques of traditional development.

The remainder of this Appendix is devoted to explanations and applications of economic thought that should help clarify the way many people *think* about local economic development. This thought is presented in approximate historical order.[3]

Mercantile thought

Mercantilism is not a theory of economic development but rather a diverse set of ideas about the economic development process and government's role in that process. Mercantile thought was prominent in Western Europe for several hundred years until the middle of the 18th century. Although many ideas were poorly defined and inconsistently applied, mercantilism has continued to appeal. Perhaps its appeal stems from the fact that mercantilists were men of business and practical affairs. Though insightful, they were certainly not theoretically inclined.

Mercantile thought made the pursuit of wealth respectable, a radical departure from the Catholic Church's view of commerce. Mercantilism helped elevate the secular power of the state at the expense of religious influence. Mercantile thought was most prominent in England, which became the dominant European power during the 17th and 18th centuries.

Mercantilists believed that nation-states should achieve and retain a favorable balance of trade. When merchandise exports were greater than merchandise imports, foreigners would pay their trade-related debts in the form of gold or other precious metals, which accumulated in the national treasury and enabled state spending. Thus, rulers of the nation-state and the merchant class were natural allies. The merchant class helped provide the funds needed by the nation-state to increase its power to consolidate the national territory, colonize peripheral areas,

or wage war. The international trading companies, in turn, received state protection and favorable government policies, and the merchants got rich in the process.

Mercantilists argued that, with effective state intervention, growth in the foreign trade and export manufacturing sectors would result in the accumulation of public and private wealth. They ignored domestic demand and the difficulties of structural change, instead focusing on the exchange of goods for money. Mercantilists proposed and debated far-reaching interventions to support foreign trade: navigation laws, tariffs on imports, direct export promotion, state-protected trading monopolies, product monopolies (patents), transportation, and other infrastructure investment, to name a few.

Mercantilists believed in the strategic importance of commerce and industry, preferably controlled by relatively large companies. Aggregate production could be increased by expanding the labor force through immigration and natural increase, as well as by using better machinery and higher skilled labor. Sufficient money supply would keep interest rates low and encourage domestic industrial growth by stimulating the demand for labor and other inputs. The growth process would increase the surplus available for foreign trade when (1) resources were used productively, (2) agriculture provided cheap wage goods, and (3) wages remained low at subsistence levels. National power would increase with the growth of output and population as well as with the accumulation of money wealth.

Applications of mercantilism

Mercantile ideas continue to have broad appeal because they appear sensible and connected to economic reality. Indeed, people who believe that politics dominates economics are especially attracted to mercantile thinking. Regional economists have extensively studied the influence of federal and state policies on regional development. Markusen (1986) traced the regional influences of defense spending. Others have looked at the political economy of U.S. trade (Noponen, Graham, and Markusen 1993). Certainly, economic developers need to be aware of the local impacts of state and federal policies and expenditures.

State and local public officials and economic developers often embrace an ideology or a strategic orientation consistent with mercantilism. Many developers support the process of economic growth, which leads to more aggregate output, jobs, and tax base. Like the mercantilists, many developers believe that interventions should be pro-business and intended to support and facilitate business plans. Importantly, they consider large oligopolistic companies in the export base sector as the most important because they bring revenues into the region. However, economic history teaches that oligopolies are frequently undermined and that when competition rules across sectors of the economy, higher levels of consumer well-being often result.

The mercantile idea that a favorable balance of trade is essential for economic prosperity has misled economic developers more than any other. This misconception leads many developers to concentrate on making money rather than on

increasing productivity. Although a favorable balance of trade can help sustain local growth, so can internally focused exchange. Yet many developers are keen on increasing the locality's trade surplus. Most believe in export promotion, primarily by attracting export industries to the locality, and import substitution to reduce income leakages, which may be the most popular development strategies in the United States.

This mercantile misconception can be corrected, as follows: regions and nations need to sell products in international markets in order to buy products in these markets without incurring ever-increasing debt. But accumulated funds from trade do not *per se* indicate wealth or prosperity. Rather, prosperity and wealth come from the productive deployment of local resources. A favorable balance of trade can indicate economic strength, but it simply means that the value of exports exceeds the value of imports. This favorable balance will continue as long as local companies are able to compete successfully in external markets. The presence of strong (efficient, adaptive, and innovative) companies is what *causes* economic growth; net exports is simply an *indicator* of growth.

Physiocratic thought

The Physiocrats represented the first true school of economic thought. Writing in the 18th century, they proposed a reasonably coherent and consistent body of ideas about the political economy of France. Decidedly anti-mercantilist and ardently laissez faire in spirit, the Physiocrats tried to show objectively how different parts of the economy interrelate and how value is created and circulated. Although Adam Smith and the classical economists rejected many of their tenets, they set a high standard for economic thinking that continued to challenge the classical economists.

France's largely agricultural economy was suffering, and landowners and peasants were burdened by heavy taxes and harmful government policies. With an enlightened French monarchy, the Physiocrats wanted to preserve and reform the French agricultural system, save the landed aristocracy that owned it, and reduce the excesses of the court. They opposed the imposition of mercantile policies on the French economy and the growing influence of merchants and the manufacturing sector. Their appeals for economic reform proved to be inadequate; the French Revolution ultimately swept away the privileged classes and led to the restructuring of the French economy.

Physiocrats believed that all wealth came from nature, embodied in land and natural resources. Agriculture and other resource-based activities, therefore, created wealth; all other forms of economic activity merely circulated wealth. The productive classes included landowners and agricultural managers. They considered merchants, professionals, artisans, manufacturers, and bureaucrats to be unproductive classes. The labor class was dependent on these other classes for employment and was either productive or unproductive, depending on their type of employment.

Physiocrats, inspired by rationalism and natural law, supported property rights and free trade. Except for national defense, any intervention on the part of the state was suspect. Government intervention to further mercantile interests was ardently opposed. Government revenues, needed for a limited number of activities, were to be raised by direct, single taxes on the agricultural surplus, which was the income of the productive classes. By simplifying the tax system, the size of government could be reduced more easily.

The Physiocrats devised an ingenious accounting framework to underscore their position on productivity. This framework is often viewed as the forerunner to input-output economics. The *tableau economique* (attributed to Francois Quesnay) attempted to measure "net product" or surplus. The table was used to show how the net product circulated through the economy. After compensation of the productive classes who worked the land, the net product belonged to the aristocracy.

The physiocratic conception of value directly opposed the mercantile definition of wealth and focus on trade. Physiocrats argued that trade added no value but merely circulated commodities. Nor did manufacturing add value, since industrial labor simply worked on materials originally from the land. Economic progress could be achieved only by increasing agricultural production and the agricultural surplus. Thus, agriculture, not manufacturing, was the strategically important sector.[4] Income per capita could grow by allocating sufficient capital to agriculture, by allowing competition and free trade, especially of agricultural products, and by serving the growing domestic market. In contrast to mercantilism, exports and balance of payments, colonies, and expansionary population policies were not important.

Applications of physiocratic thought

One enduring, useful idea from the Physiocrats is their focus on connections. Not only are different regional economic activities interdependent but regional economies themselves are interconnected. Input-output analysis is a framework for tracking important linkages through commodity flows. The concept of linkage is important for economic developers. The analysis of linkage helps explain how the regional economy connects to the larger system and how local sectors support that connection.

Although economic developers do not accept the physiocratic conception of value, many believe in the distinction between productive and unproductive economic activity. Basic economic activities, namely, manufacturing, extraction (mining, forestry, fisheries), and agriculture, are wealth creators. Other forms of economic activities merely circulate wealth. This idea is wrong; any economic activity that satisfies consumer wants and needs creates value.

More generally, economic developers should not favor any sector or set of firms on *a priori* grounds. For example, one should not choose basic activity over local activity, manufacturing over services, large firms over small firms (or the reverse). None is inherently superior. The theories presented in Part II identify firms with

strategic importance. These firms have high multipliers; provide good jobs; offer developmental services; export income-elastic products; and consist of efficient, adaptive, or innovative firms.

Physiocratic thought is strongly identified with the economic interests of local property owners just as mercantilists favor merchants and industrialists. They often support less government regulation of business and defend economic freedom and property rights. Many believe that taxes on businesses income and wealth should be minimal. Whether consciously or not, many economic developers support the economic interests of groups that directly benefit from aggregate economic growth.

Classical economics

The famous Scottish moral philosopher Adam Smith presented the first complete treatise on "political economy," what became known as classical economic thought in *The Wealth of Nations* (1776 [1937]). This book built upon an ethical system developed in his earlier work, *The Theory of Moral Sentiments* (1759 [1976]). As a moral philosopher concerned with human happiness and well-being, Smith presented the moral sentiments that would restrain narcissistic human tendencies. The sentiments of sympathy and need for social approval, he argued, would balance self-love and provide the moral basis for economic affairs. With this moral and ethical framework in place, his "simple system of natural liberty" would harmonize individuals' self-interest with the public interest and keep competition humane.

Smith defends the competitive capitalistic system as an efficient way to achieve secular progress. The "invisible hand" of the market leads to natural prices and just compensation of labor, land, and capital. The cooperative efforts of labor produce useful goods whether employed on farms or in factories. It is natural for people to specialize in what they can do well and trade for what they need. This division of labor increases productivity. Specialization, which the size of the market ultimately limits, increases the size of the pie, and competition insures that consumers can purchase at a reasonable price the commodities for which they are willing to pay. He argues that the nation prospers under this system of natural liberty as long as proper moral sentiments are embedded in the culture.

Smith's factors of production also represent social classes—land (property owners), labor (workers), and capital (business owners). He was especially concerned about the well-being of workers who had lost their economic security that was tied to the land in the transition from feudalism to capitalism.

Smith poses new definitions of value and wealth, where value is created neither from accumulated money nor from agricultural surplus but from productivity, that is, the ability to combine labor, land, capital, and other inputs efficiently to produce greater output. The continual division of labor increases wealth, which leads to more specialization and trade. Free trade not only assures the best allocative outcomes but also increases the size of the market, which stimulates further specialization and division of labor.

Although known for his support of laissez-faire competition and free trade, Smith articulated important roles for government, much larger than the Physiocrats would have accepted. In addition to enforcing the legal framework for contracts and private property, the government should regulate, tax, and spend in the public interest. Regulation is justified when the social costs of private activity exceed the private costs (negative externalities). Public production is necessary when the social benefits exceed private benefits such that no rational private producer would provide the good or service.

Smith devotes considerable attention to criticizing mercantilism. He considered mercantile thought to be fraud that businessmen perpetrated on the public. He demonstrates why the accumulation of money is not the wealth of the nation. He rails against the monopolistic trading practices of the Mercantilists. His thinking ultimately contradicted the mercantile view of trade, which was conventional wisdom in his day.

Smith was more favorably disposed to the Physiocrats. He shared their views about productive and unproductive classes and the existence of natural order. Yet there were sharp and important differences: natural liberty resided in the people, not some enlightened despot, and value came from human effort more than from the gifts of nature.

Smith presented a creative and readable work that influenced economists over the next century. He distinguished his basic tenets from mercantile and physiocratic thought and considered competitive capitalism to be the best path to long-term development. Smith's concern for economic development in England remained the major focus of subsequent classical economists.

The most important classical thinkers after Smith were David Ricardo, Thomas Malthus, J.-B. Say, and J.S. Mill, who tried to develop a series of laws describing the natural order of capitalist development. Ricardo focused on income distribution and foreign trade. He formulated two important contributions: comparative advantage and diminishing returns. His concept of comparative advantage was developed to explain specialization and commodity trade between countries. (Chapter 4 covers trade theory.) Ricardo was the first to see that specialization could lead to diminishing returns. In his pessimistic scenario, which contrasts to Smith's optimistic growth model, the economy eventually stagnates as landowners become the dominant class. His scenario underestimates the ways in which technological progress and substitution can overcome diminishing returns. Figure A.2, adapted from Dome (1994), neatly portrays the contrasting classical views of economic growth formulated by Smith (expansion of market, increase in profits) and Ricardo (decrease in profits).

Malthus is best known for his work on the influence of population increase, where he presented the most cogent classical statement on the limits of economic growth. He argued that the rate of national economic growth depends on the relationship between population growth and the growth of capital stock. Current debates about economic growth, population increase, natural resource constraints, environmental deterioration, and climate change began with Malthus.

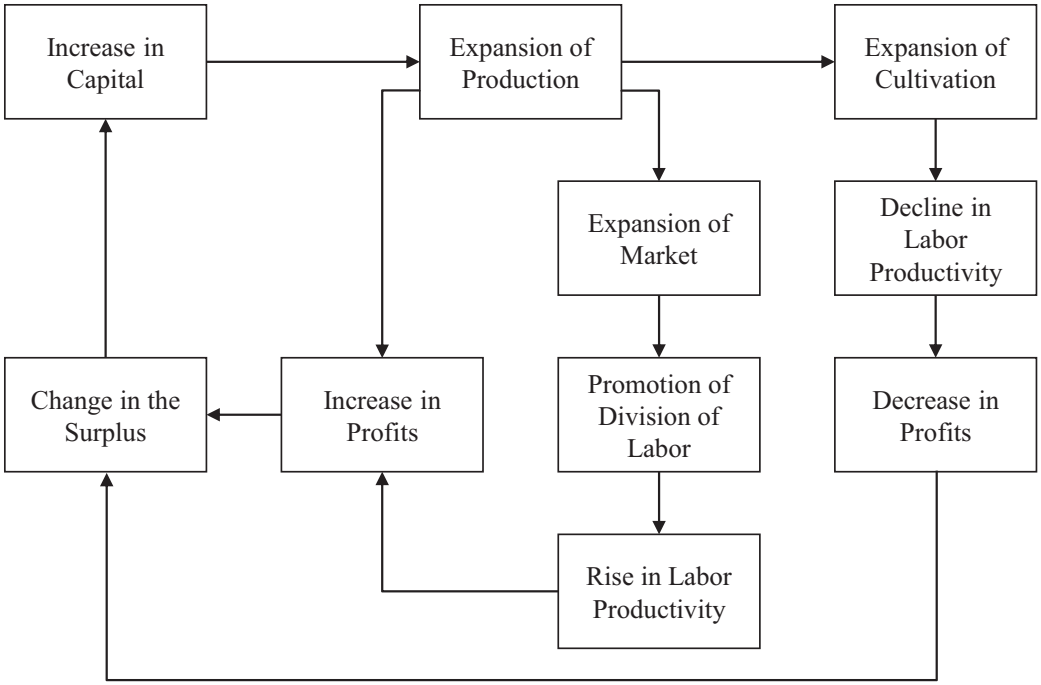

FIGURE A.2 Classical economic growth process

Say, who transformed Smith's ideas to textbook format for French language readers, made several contributions in the process. He is best known for Say's Law, which argues that markets should neither have excess supply nor have excess demand because the compensation of factors producing supply provides the demand for that output.

J.S. Mill wrote the leading English language treatise on economics in the latter part of the 19th century. He synthesized and contributed to classical thought and incorporated social justice issues raised by socialist critics of capitalist development. Mill became an advocate of population policy (encouraging emigration), land for the poor, public education, and even women's rights. He correctly thought that these measures would reduce population growth and elevate the living standards of workers above the subsistence level (Dorfman 1991).[5] Mill's ideas seem especially relevant currently with the unprecedented concentration of income and wealth, socially and geographically.

Applications of classical thought

Classical economists developed economic concepts that contemporary developers can use, especially to counter mercantile and physiocratic thought that many still accept. Perhaps they believe economic thinkers, long dead and largely discredited, because these ideas serve their narrow economic interests.

Although modern economics has developed beyond Smith and other classical economists, certain classical tenets remain quite relevant for clear thinking about

economic development. Smith, for example, would want developers to focus on competitive firms, want government to support competition, strongly advocate for greater specialization to serve viable local and external markets, and encourage regions to build on their specializations to sustain productivity growth. He would also advocate trade to satisfy local demand, with more exporting and importing, rather than less.

Classical economists would not be supportive of economic developers and politicians who narrowly focused on local growth and job creation, which would tend to support narrow business and property interests. Classical economists were primarily interested in near-term efficiency, long-term productivity gains, consumer satisfaction, and the wealth creation process. Economic developers who embrace these ideas would promote broader community interests.

Smith's attention to the moral basis of capitalism is especially relevant. In our increasingly mobile, information rich, and technologically sophisticated society, it is difficult to find and sustain meaningful community life. Yet without meaningful communities of people who respect one another, their social experiences are not likely to support the sentiments of sympathy and approbation. Although people may behave with regard for others who live in their neighborhood, the most positive sentiment many seem to be able to muster for others is tolerance. In the absence of Smith's moral sentiments, economic activities and political affairs have become less ethical and, all too frequently, illegal. The rise of shareholder value as the singular corporate value defends these unethical activities as necessary to maximize near-term profits.

Marx

Classical economists were primarily concerned with understanding the evolution and dynamics of capitalist development. In this sense, Karl Marx was a classical economist. He drew directly on Ricardo, both in substance (value theory) and in method. Yet Marx was a broad social thinker more than a political economist. He attempted to synthesize and build upon Hegel's historical method, physiocratic thought, and socialist ideas.

Marx presented his version of "scientific socialism" to demonstrate how and why capitalist development would ultimately fail. Although his theory was inconsistent and incomplete, he had powerful insights about long-term development. He argued that (1) capitalist development is inherently unstable, (2) internal contradictions would cause the collapse of capitalism, and the subsequent rise of socialism, and (3) technological progress would delay this collapse.

Marxist political economy consists of historical, holistic, and synoptic thinking intended to understand how conflict leads to change and flux. In other words, one must study the larger economic system in order to understand development in one place and examine the political and social sphere in addition to the economic sphere in order to understand the economy. This holistic perspective encourages the search for connections between social institutions and production. Its historical

perspective forces us to address the question: how did things get the way they are? One must study real people and events over the relevant time period to understand the region's economic history.

Marxist theory is built on dialectical laws.[6] In Marxist theory, human nature is unfolding or continually changing; human beings are becoming and, therefore, human nature is dynamic. Instead of serving as the point of departure for a mediated theory of human action, Marx's theory has been interpreted as a closed system of thought driven by technological determinism which has led to its misuse and abuse.

Marx's major work, *Capital* (1867 [1967]), is a study of *alienation* under the capitalist mode of production. Alienation is an unnatural separation or division that exists in all areas of economic life under capitalism because producers are separated from the means of production. Unequal power relations make things (objects or concepts) more important than people which results in and is sustained by class society.

At the root of this analysis is Marx's definition of social classes. Marx uses economic functions to determine class position in keeping with the classical approach (land, labor, and capital refer to three distinct social groups). The upper class owns the means of production; the working class comprises employees who own little beyond housing and personal property. The managerial class runs private and public organizations in the interest of the upper class. The proprietor class represents small business. The managerial and proprietor classes own some productive assets but much less than the upper class. Finally, the unemployed own very little and probably have negative net worth (Bottomore 1966).

Through technological progress, capitalism can create more wealth and productive capacity than any previous mode of production in human history. Greater efficiency and labor-saving technologies, however, generate overproduction and unemployment, leading to increasingly severe economic crises.[7] These realization and liquidation crises eventually doom the system.[8]

In summary, Marxist theory treats the relations of production as basic units of analysis. The definition of economic development is broadly conceived as the reduction (and eventual elimination) of alienation. At its core, Marxist thinking is based on the 18th-century assumption that human beings can improve as a species, and therefore its view of secular progress and human nature is quite optimistic. If, on the other hand, we are terminally uncivilized brutes, always requiring authority to keep the peace, then the Marxist believes that we will perpetually suffer alienation from our products, our tools, our natural environment, and one another.[9]

Applications of Marxist thought

Economic developers are expected to be savvy about the politics of their community in order to facilitate positive changes in the economy. They can use Marxist thought to identify the individuals occupying leadership roles in the largest organizations headquartered in the region. They should recognize the channels and

extent to which these individuals exercise political leadership. The objective here is not to discover some "ruling class" that uses democratic structures to impose its singular will on the populace. Rather, the analysis should help developers determine the strength of business influence in local governance and the relative difficulty involved in implementing any economic development strategy.

The presence of a coherent influential class varies from region to region. In some communities, the political system is quite open, and the process is very pluralistic and democratic. Elsewhere, political discourse and processes are tightly controlled. Economic developers need to learn quickly the kind of environment in which they are working. Neither extreme insures favorable outcomes, however. In more pluralistic places, it is easy to raise issues, discuss alternatives, and mobilize enthusiasm for various development strategies. Yet it may be impossible to reach agreement on an overall strategy or mobilize enough resources to implement that strategy. In less pluralistic places, power is sufficiently concentrated to take effective action and mobilize resources. But it may be impossible to convince the leadership of the need for change, or it may take too long to get their attention.[10]

Economic developers working in the United States will find few, if any, local actors who think about development from a Marxist perspective. Instead, the main application of Marxist thought is in linking what people say about development to what they do in terms of their class position. Marxist thinking can help developers be aware of the competing and conflicting economic interests in the locality and the groups that are influential in the political arena because of their control of capital. They should recognize that the strategies they support favor certain economic interests more than others, often those of business owners and managers.

In summary, economic developers can use early economic thought to understand the local thinking about economic development. The ideas of mercantilists and physiocrats are at the root of popular misperceptions about economic development. Classical thought can help correct these misperceptions while describing economic development in ways more likely to serve the public interest. Marxist thought should help developers see the connections between local views of economic development and the economic interests served by these views.

Neoclassical economic thought

The origins of neoclassical economics may be traced to the development of the concepts of marginal utility and marginal product and the subsequent focus on price determination in competitive markets (Blaug 1968). More generally, the reformulation of classical economic thought during the 19th century brought utilitarian ethics and mathematics to the treatment of economic relations. With the introduction of marginal analysis as a means of explaining the allocation of given quantities among competing uses, the emphasis thus turned from long-term growth to near-term equilibrium. Mathematical formalism was taken up most seriously by the Lausanne school, especially Walras, who formulated general economic equilibrium as a system of simultaneous equations. (The so-called Walrasian

auctioneer as a mechanism to achieve equilibrium in all product and factor markets is discussed in Chapter 7.)

Carl Menger and the Austrians contributed to marginal analysis with their subjective approach to utility and value, providing one counterpoint to the socialist thinking of the late 19th and early 20th centuries. Friedrich Hayek (1944) authored an influential treatise against central control and planning. The most lasting Austrian influence on regional development is through entrepreneurship theories, most notably Joseph Schumpeter's.

It was Alfred Marshall and his followers (Arthur Pigou, Edward Chamberlin, and John Hicks, for example) who reformulated classical economics most thoroughly and developed the topics now covered in standard microeconomics texts. Of critical importance was the development of comparative statics to analyze short-run and long-run equilibria. The theory of consumer demand, the theory of the firm, welfare economics, imperfect competition, and the influence of external economies were essential features of this developing neoclassical thought. Given a well-defined set of postulates and assumptions regarding economic behavior, early neoclassical economists aimed to show how the unimpeded operation of the market led to the maximization of aggregate social welfare. This would be achieved through the market determination of a set of prices that would yield complete market clearing throughout the economy (termed "general equilibrium"). The concept of space, or regional economies within a national economic system remains largely absent from mainstream neoclassical models (Blaug 1997), but this situation has been changing with recent analyses of imperfect competition, increasing returns, and growth and trade (Krugman 1997).

J.M. Keynes provided the major challenge to the neoclassical perspective. Keynesian thought based on economic aggregates (e.g., income, savings) eventually became macroeconomics (which now includes both Keynesisan and non-Keynesian models). His theory discredited the long-standing acceptance of Say's Law and provided a rationale for government intervention to influence aggregate demand and the money supply. Keynes' primary focus was on near-term business fluctuations and not long-term economic growth.

As with any intellectual paradigm, the neoclassical approach embodies certain values and assumed truths regarding economic behavior and the economic system. Hunt (1989) presents three that are often challenged by other approaches to the study of development. First, the neoclassical approach implies that economic inequality is a major source of incentive, although adherents to the neoclassical perspective have become concerned with finding ways to narrow inequality. Second, the neoclassical perspective attaches a very high value to individual freedom. Government regulation that reduces personal freedom is resisted. Third, neoclassical economists believe that the market is a much more efficient allocator of resources than the public sector, even though this commitment to the notion of *laissez faire* has not been vindicated by objective research (Toye 1987).

Economists working within the neoclassical tradition continue to make significant contributions to the analysis of underdeveloped economies, much of it

concerned with short-run questions of allocative efficiency. Many of these contributions include the notion of trade based on comparative advantage (Chapter 4), policy analysis, and cost-benefit analysis. The traditional neoclassical analysis of long-run economic growth has been extremely influential in the United States as a model of subnational development. Indeed, writing in 1973, regional economist Harry Richardson (1973, p. 22) asserted that "neoclassical models have dominated regional growth theory much as they have dominated growth theory in general." Although neoclassical growth theory ceased to dominate regional growth analysis in the 1980s and 1990s (particularly as the development of the theory stagnated within mainstream economics itself), it still contributed insights as well as generated useful research. With the advent of endogenous growth models, growth theory in the neoclassical tradition became one of the most important and promising areas of research and study in regional development (see Stough 1998, Bal and Nijkamp 1998, Krugman 1997).

Applications of neoclassical thought

The important applications of neoclassical thought are interregional trade theory (Chapter 4) and regional growth theory (Chapter 5). The former takes the microeconomic perspective whereas the latter takes the macroeconomic perspective.

Notes

1 This theory was embraced to justify federal tax cuts posed as the silver bullet that would solve all problems. Ample evidence exists that documents its failure to work in practice. See Atkinson (2006).

2 Meier (1984) distinguishes three types of thought used in development economics: analytical, radical, and historical. Analytical thought is most prominent and involves applications of neoclassical growth and trade theories. Radical theories, such as dependency theory, have been formulated with the realities of less developed countries in mind and are used to view development from the less developed country perspective. Historical theories, which include the work of Marx and Schumpeter, focus on long-term growth and change. In an earlier work, Meier's development theories are classical, Marxian, neoclassical, Schumpeterian, and post-Keynesian; see Gerald M. Meier and Robert E. Baldwin (1957). Herrick and Kindleberger (1983) devote two chapters to theories. In Chapter 2, they review growth theories from the classical, neoclassical, and post-Keynesian traditions. In Chapter 3, they present theories of economic development: neoclassical (Bauer and H.J. Johnson), structural disequilibrium (Chenery), and radical (Amin, Baran, Gunder Frank). See also Ranis and Schultz (1988) and Stern (1989).

3 The main sources used in this review are Rima (1991) and Spiegel (1983). Additional references include Bronfenbrenner (1979), Chong-Yah (1991), Dome (1994), Dorfman (1991), Heilbroner (1972, 1988), Hoselitz (1960), Friedmann and Weaver (1979), Galbraith (1987), Herrick and Kindleberger (1983), Landreth and Colandeer (1989), and Russell (1945). See also Dinc (2015).

4 Strategies to increase economic development often favor industrialization, specifically the growth of manufacturing. Manufacturing growth was limited by available inputs, most importantly, labor since the large majority of the population was engaged in agricultural production, often at the subsistence level. An increase in agricultural productivity was

needed to generate surplus wage-goods and surplus labor. This reasoning is consistent with sector theory presented in Chapter 3.

5 Rima (1991) presents a concise list of the laws developed by the classical economists, as follows: (1) the law of diminishing returns, (2) the law of population growth, (3) the law of wages, (4) the law of capital accumulation, (5) the law of rent, (6) the law of comparative advantage, (7) the law of value, (8) the quantity theory of money, and (9) the law of markets (1991, p. 189). Note that none of these laws account for technological change that Marx emphasized (Dorfman 1991).

6 Rather than try to describe these laws, it is more useful to illustrate one of them—the unity of opposites—as a way to explain Marxist theory more fully. Distinctions commonly made in traditional theory are unified by using the social relation as the unit of analysis. In traditional theory, facts are supposed to reflect what is given and values are said to represent what is desired. Yet these apparent opposites are actually not fundamentally different. Rather, as noted in Appendix 2.1, facts are made as the result of human action. Historical facts (data) are given; future facts (values) are produced as human intentions are realized.

The two-sided, reciprocal approach not only requires explanation of why things are different but why they are part of the same process. The dualist distinctions between employment and unemployment, affluence and poverty, or development and underdevelopment tell only half the story and the less important half at that. The more pressing question is: how do these aspects relate as part of the same process? Analysis of essential relations leads to the conclusion that some become employed or affluent, while others become unemployed or remain impoverished, or that some places become more developed as others become increasingly underdeveloped.

7 Realization crises and liquidation crises are described in Bronfenbrenner (1979), Chapter 5. In a closed system, the process of transforming money into commodities and commodities into money breaks down in the following ways. The amount of capital involved in production continues to rise as labor-saving technology is introduced. The rate of profit consequently falls. Eventually, a minimum rate of profit is reached that is too low to induce further investment. Capitalists hoard money, which results in underinvestment and a "liquidation" crisis, where money fails to be transformed into commodities.

Alternatively, capitalists can sustain an acceptable rate of profit by garnering more surplus from production. But the cost is the generation of greater unemployment. More unemployment reduces aggregate demand and leads to a "realization" crisis, where commodities fail to be transformed into money. Marx expected liquidation and realization crises to alternate as capitalists try to postpone the system's collapse. Capitalism suffers these crises, which become ever more serious, until revolution occurs.

8 The historical perspective can also be usefully applied to labor market relations in different regions of the world. This view is contrary to neoclassical theory, which assumes that all labor is paid its marginal product. Wages are *historically* determined and exogenous to labor markets, where supply and demand interact. At any point in time, the average laborer is compensated to the extent necessary to achieve generally expected and acceptable levels of living. These expectations are formed by workers' previous experience, comparisons to peer workers, and what is known about the experience of previous generations of workers. Far from being separate activities, workers' wage expectations are based on a direct connection between consumption and production. Workers seek employment in order to earn acceptable levels of living, and the levels of living experienced reinforce the need to work. Development occurs as levels of living gradually improve; expectations rise, compensation demands increase, demands are met with higher wages, and living levels improve. The different cultural experiences among workers in different parts of the world account for the existence of vastly different compensation for essentially the same work. Workers tend to get what they find acceptable regardless of their average or marginal productivity. Within the United States, more modest differences in expectation exist. Still, workers in small towns or rural areas

tend, especially in the South, to expect less than urban workers. Immigrants are usually willing to take jobs domestic workers shun. Neoclassical theorists have tried to explain away these differences by controlling differences in cost of living, educational levels, etc. between people or places. What is ignored and what is much more important are the differences in consumption. Workers with simple tastes and lifestyles cost employers less than sophisticated ones.

Social media now virtually connects people throughout the world. It is influencing attitudes and tastes, particularly among younger people. Over time, higher expectations will translate into demands for higher wages, which could change competitive advantage and influence international investment decisions dramatically.

9 For further discussion, see Ollman (1971).

10 Often, Tupelo, Mississippi, is cited as a place where the political leadership has mobilized for effective action in the interest of local economic development. It would be worthwhile to explain the proximate causes of success. See Holladay (1992) and Martin (1994).

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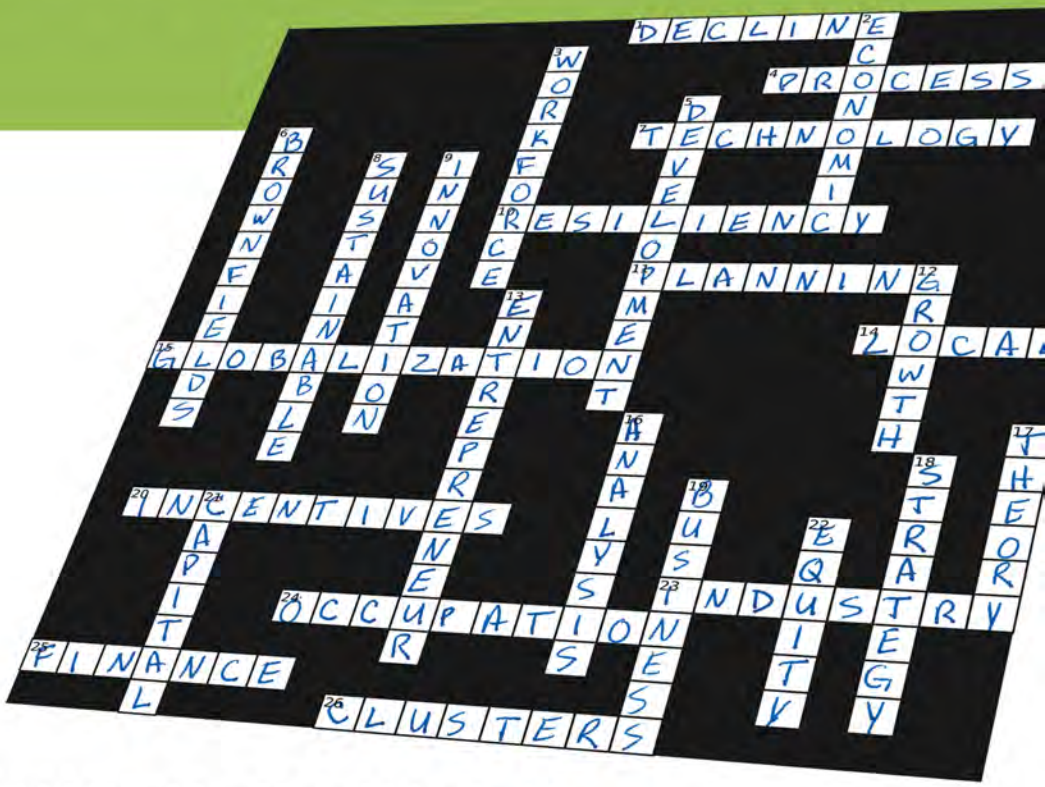

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Preface

The sixth edition of *Planning Local Economic Development* continues to respond to the needs and feedback of planners and academics. Each edition of the book evolves due to this feedback, as well as in response to what the authors have learned from their research and practice. Each edition of the book also strives to reflect how the context for economic development planning and practice is changing.

As we noted in the 2013 fifth edition's Preface, due to the weakness of the overall recovery from the Great Recession of 2008, many localities hadn't begun to recover, and those that had were still struggling to return to their pre-recession state. Eight years later, the postrecession period has been given the moniker of the "Great Stagnation," and the conditions that gave rise to this moniker significantly change the context for local economic development planners. These conditions include rates of earnings, job, and economic growth that haven't matched the period before the recession. This has been accompanied by a growing American angst over widening income inequality that is shared across many nations. Not unrelated, at least in the United States, are concerns about how young adults' lost decade (from approximately 2000 to 2011) in terms of employment and earnings gains affects the future of the middle class.

The definition of economic development that this book presents has always included the principle that processes and outcomes reduce inequality. To do so, local economic development planning and practice must explicitly consider the distributional consequences of anticipated growth and change outcomes. The reader will find that distributional consequences of economic development are explicit or implicit themes throughout the book.

Many individuals generously granted us permission to use material that enriches our understanding of local economic development planning. We are most grateful for the outstanding research assistance and contributions to this book of Ashley Bozarth, current Georgia Tech City and Regional

Planning master's degree student. Other Georgia Tech students (current and past) have contributed valuable research assistance: Dana King Brewster, Nathanael Hoelzel, Heon Hyeong Lee, Jeong-Il Park, and Patrick Terranova.

We are also grateful to Laura Davis Chandler and Geri Campos Lopez for their cooperation in the preparation of their organization's case studies, and to Stuart Andreason, Dan Immergluck, Brian Stone, and Kenneth Thomas for their research insights.

We remain indebted to our many planning colleagues whose own research and writings have helped us articulate our view of planning local economic development, especially Ted Bradshaw, Edward Bergman, Peter Hall, Ann Markusen, and Michael Teitz.

Nancey Green Leigh
Edward J. Blakely

Overview

Planning Local Economic Development strives to place the basic tenets of local economic development planning in one volume. It explicitly broadens the view of local economic development from one that emphasizes real estate development and industrial recruitment to one that encompasses workforce development and community-determined processes. It explicitly incorporates the notions of equity and sustainability. The work distinguishes itself from all other texts on economic development planning by explicitly asserting that authentic economic development incorporates the basic principles of sustainability.

This book is aimed primarily at students studying to become professional planners or practitioners of local economic development at the regional, agency, city or county government, or neighborhood levels. We hope that this updated edition that reflects the evolving field will continue to be a reference for economic development professionals as they carry out their responsibilities. Economic development specialists and planners should find the resource materials included in the text useful for their work.

This book continues to provide guidance for community-based organizations and their client groups engaged in the struggle to find viable means to develop the economic base of their communities. It is also designed to serve as primary material or as an adjunct to other materials used in teaching economic development. Both the reference materials and case examples are arranged in a manner suitable for teaching.

Policymakers at either the local government or the community level may find the book useful in exploring the roles that private enterprise, unions, community groups, and other institutions can play in local economic and workforce development activities. In addition, the book can aid private citizens interested in local economic development and employment issues in determining ways they might assist government bodies or community groups in meeting their economic development objectives. Community groups may

find the illustrations and case examples discussed in the text valuable for networking with those in similar circumstances throughout the country.

Local economic development and workforce initiatives are continually evolving. There are no hard and fast rules or long-proven experiences upon which to draw. We ground this book in the needs, issues, and options available at the local level and encourage readers to contribute ideas for future editions. A brief summary of the book's chapters follows:

Chapter 1 discusses key national and global socioeconomic trends that shape the context for local economic development planning.

Chapter 2 covers the evolution of national and state policies for promoting economic growth that impact local economic development planning.

Chapter 3 reviews theories of economic growth and development and discusses definitions of economic development that inform traditional economic development practices and sustainable economic development planning.

Chapter 4 is focused on the profession of economic developers (practitioners and planners).

Chapter 5 provides an overview of the complete process of economic development planning.

Chapter 6 is an introduction to the analytical methods used in the first phase of the economic development planning process.

Chapter 7 focuses on the second phase of the planning process, selecting a local economic development strategy.

Chapter 8 focuses on issues and steps that need to be addressed to make ready the locality for which economic development is being planned.

Chapter 9 covers a range of tools essential to foster businesses in the local economy.

Human resources, the focus of **Chapter 10**, are also essential to successful local economic development, and, of course, a primary rationale for local economic development is to improve the lives of community residents.

Chapter 11 focuses on community economic development planning, typically conducted at the neighborhood level to meet the needs of poor and working class residents.

Chapter 12 addresses building the implementation plan for local economic development and the essential public-private partnerships this often entails.

Chapter 13 discusses the role of institutions in managing the local economic development process.

Concluding the book, **Chapter 14** discusses technology and innovation strategies for responding to the global economy, resiliency strategies to cope with extreme weather events, and strategies to foster structural change in local economic development and planning.

This book surveys the full range of activities that constitute the planning of local economic development. If all localities were to systematically undertake this full range of activities, they would be competitively positioned to weather economic crises created by forces beyond their control, or to thrive in more benign economic conditions.

1

The Enduring Argument for Local Economic Development Planning

Cities, towns, counties, and all local entities in a global economy have the challenge and opportunity of crafting their own economic destinies. This is true for the poorest as well as the wealthiest localities. In reality, the forces of nature, demography, technology, and industry are such that no local economy can ever count on an achieved position of stability and security. This has always been true, but the contemporary context for local economic development planning is severely challenged by the two trends of rising inequality and global warming. It is also challenged by the increasingly transitory nature of any given local economy in the face of overwhelming forces of globalization. These forces flatten the world in such a way that few, if any, local economies are exempt from globalizing forces that can bring growth and development or decline and increased poverty (Friedman, 2005).

Local Economic Development Planning in the Face of Globalization

The globalizing economy—until the recession that began at the end of 2007—was truly a case of the whole being greater than the sum of its parts. The integration of national and local economies into one global economy accelerated growth in the gross world product. The International Monetary Fund (IMF; 2007, 2015) data indicate the world economy grew at a rate of

3.2% from 1988 to 1997, 4.4% from 1998 through 2007, and again at only 3.2% from 2008 to 2015. This was accompanied by continued growth in the share of world income that went to individuals (gross domestic product per capita), with persons in the newly industrializing and emerging market countries gaining at a higher rate.

In an increasingly integrated global economy, the previously stated growth trends illustrate that economic downturn in one major nation can spread across the globe, as happened from the second half of 2008. The global economy experienced the worst recession since the Great Depression of the 1930s. And while the recession was officially declared to have ended in the United States in mid 2009, the United States and the rest of the global economy are still not fully recovered. We provide a brief explanation of the Great Recession next.

The U.S. financial crisis had at its core the subprime housing market. Home loans were made to unqualified buyers in violation of prudent lending practices and regulations. The banks making the loans did not hold on to them. Instead, they sold them to secondary mortgage consolidators, who then packaged them into derivative financial instruments. These, in turn, were sold to investors across the globe, who suffered severe losses when the loans went into default. There followed a major credit crisis as many banks and investing houses failed.

Some 70% of the U.S. economy is consumer based. Without access to credit, because of bank failures and decreased lender ability, as well as willingness to provide credit even to financially sound businesses and individuals, consumer spending severely declined. Consequently, all the businesses that sold to them suffered. At first, the businesses selling big-ticket items such as autos were especially hard hit. But as the effects of the Great Recession lingered, many small businesses were unable to hold on. The small business failure rate increased 40% between 2007 and 2010, with retailers and manufacturers experiencing the highest rates of failure (Dun and Bradstreet, 2011). Normally, half of all small businesses fail within their first five years of operation, while two thirds fail by the end of the tenth year.

The U.S. auto industry is one of the most globalized in terms of its production systems, sourcing parts from around the globe. Further, a large proportion of the goods sold in stores within the United States are imported. Thus, countries around the globe experienced the backlash of the U.S. economic crisis with associated declines in foreign trade, number of firms, and employment.

What does increased global integration mean for the local economies that we focus on in this book? We answer this question within the context of three phases of globalization that Friedman (2005) described more than a

decade ago. Long before the Great Recession, the United States' globalizing and sending of goods abroad, or what Friedman called Globalization 1.0, brought significant prosperity to many local economies making manufactured goods, growing crops, and producing services and entertainment. As U.S. companies globalized in the 2.0 phase, accessing overseas markets and employing labor in other nations, U.S. local economies experienced plant closings on an accelerating scale. Local economies overly dependent on the industry sectors that found it most profitable to move their operations overseas experienced the greatest devastation. Many of the companies in these industry sectors simply were unable to compete with cheaper imports and thus moved overseas to take advantage of lower labor and other production costs. At the same time, companies from other nations located in local economies across the United States to gain access to our consumer market—and in the case of certain industry sectors, to less expensive labor and other costs of production. On balance, however, there was legitimate concern that the process of globalization could leave behind many local economies, and demographic groups within those economies, if they continued to pursue "business as usual."

More recently, Globalization 3.0 shifted the drivers of globalization away from U.S. and European companies to individuals and non-Western nations. Further, even before the Great Recession, Globalization 3.0 created major new challenges for local economic development planning and practice in the United States. The solutions, as Friedman (2005) astutely observed, called for an orientation away from traditional business development and recruitment toward ensuring all participants in a local economy have adequate preparation to make maximum contributions. Recovering from the Great Recession and creating a new path for prosperity requires a shift from "business as usual." It also requires an economy focused on reinventing itself through new technologies, innovations, and renewed commitments to ethical leadership. The challenges to local economic development are the greatest they have been since the establishment of the formal field. More than ever, local economic development planners and policymakers will need to have a sophisticated and comprehensive set of tools and strategies to remake their economies.

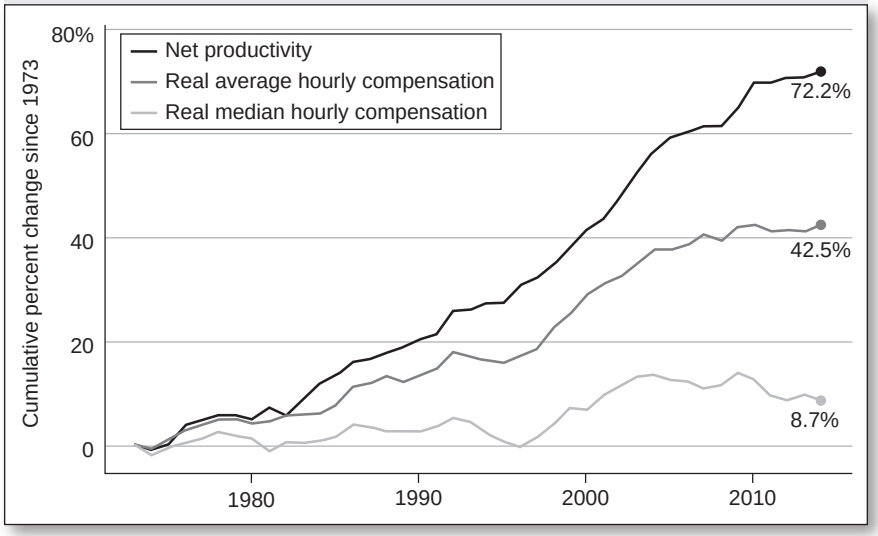
Prior to the Great Recession, new immigrants' increasing labor force contributions and the problem of longtime residents with weak attachment to the labor market was of growing importance because of the aging population of the United States and the rest of the "rich world." Most of Europe, as well as Japan, will experience sharp drops in population over the next three to four decades due to declining birth rates. The resulting aging of the population signals increased expenditures for health care and

other government-provided services and places real strain on the future prosperity of these important global European partners of the United States. It is possible, however, that an aging labor force will now no longer be able to retire at the normal age due to the impact that the stock and housing market declines have had on retirement investment portfolios.

Historically, the United States has been in an enviable demographic position compared with its advanced nation allies. As a result, international capital flowed to the United States at a record pace. The United States also has had one of the most liberal and desirable immigration programs in the world. Thus, we should have an adequate *number* of workers to meet demand when the national economy is not in recession. However, the local economic development challenge is to ensure that this labor force is fully prepared to meet the demands of employers facing heightened global competition. One of the most encouraging economic development trends in the aftermath of the Great Recession has been that of inshoring, or bringing back production to the United States. However, many employers (especially in manufacturing) are complaining that they cannot find the skilled workers they need.

It will be critical for the United States to retain its high rate of economic productivity. In most industries, the combination of American workers and technology has created higher productivity than anywhere else in the world. However, the average U.S. worker has not benefited from productivity increases, as once was the case (see Figure 1.1). In fact, one of the most important explanations for rising inequality and threats to the American (read middle-class) standard of living is that earnings from work have grown much more unequal since the early 1970s (Bivens and Mishel, 2015; Blinder, 2007). In 2007, Blinder cited evidence from IRS data that the average taxpayer in the top one tenth of 1% of all wage and salary earners had earnings amounting to that of 44 average taxpayers in the bottom half in the year 1979, but by 2001, this earnings disparity had increased almost fourfold, equating to that of 160 earners. The gap between the average American worker and the executive class is increasingly polarizing the nation. Bivens and Mishel (2015) provided evidence that the decline in national income going to workers in the form of wages and benefits and its increase to owners of capital does not stem from workers being less productive. Instead, they fault key policy shifts such as abandoning a commitment to full employment, failure to increase the minimum wage to keep up with inflation, and lack of adjustment measures to prevent workers from being damaged by economic globalization.

Figure 1.1 Growth of Productivity, Real Average Compensation, and Real Median Income, 1973–2014



Source: Bivens and Mishel (2015).

Note: Data are for all workers. Net productivity is the growth of output of goods and services minus depreciation, per hour worked.

The Influence of Outsourcing and Insourcing

Workers and communities across the United States have been losing control over their destinies as the nation has increasingly become tied to global rather than national and local forces. Globalization is altering the locus of firms and work for all nations, rich and poor. The growing dominance of multinational firms within and outside of the United States is one of the most important trends accompanying globalization. There were approximately 40,000 multinational companies in the United States prior to the Great Recession, up from 7,000 in 1975 (Atkinson and Correa, 2007). Sassen (2006) suggested that the multinational firm has evolved to supersede much of national authority, elevating the significance of global cities and the connections between them in the globalization process.

The negative impacts on manufacturing employment from globalization have been felt for more than two decades. More recently, significant concern has been voiced over the offshoring of service jobs. A review of the evidence, however, suggests fewer than 1 million service jobs had been lost to offshoring

prior to the Great Recession, which is less than one month's normal turnover in the labor force (Blinder, 2007).

However, this may be just the tip of the iceberg, according to Blinder (2007), who suggested "the key labor-market divide in the Information Age will not be between high-skilled and low-skilled workers, as it has been in the recent past, but rather between services that can be delivered electronically with little loss of quality and those that cannot be" (p. 3). This can just as easily impact high-skill jobs such as software engineers and financial analysts as it does low-skill jobs such as assembly workers. As information technology (IT) continues its global diffusion, Blinder (2007) estimated that 22% to 29% of American jobs today could be offshored, though he expects this will actually occur to only a fraction of them. Nevertheless, job displacement will be a growing problem across a wide range of the labor market, and local economic development planning will be greatly needed:

> We must take steps to ensure that our labor force and our businesses supply and demand the types of skills and jobs that are going to remain in America rather than move offshore. Among other things, that may require substantial changes in our educational system—all the way from kindergarten through college. And it will certainly entail a variety of steps to ensure that the U.S. remains the home of innovation and invention, for we will never compete on the basis of cheap labor. Nor do we want to. (Blinder, 2007, p. 4)

It is important to appreciate that globalization also brought employment to the United States. Many law, advertising, and other firms in the United States have provided value-added services and products to the developed and developing world alike. Further, the United States gained new jobs as foreign corporations invested here. It has been estimated that 21.1 million jobs in the United States come from foreign direct investment (FDI), with the largest number occurring in manufacturing (12.2 million). FDI also contributes 2.3 million jobs to the wholesale and retail sector; .5 million to the finance, insurance, and real estate sector; 1 million to the information sector; and 800,000 jobs to professional, scientific and technical services (Price Waterhouse Cooper, 2012).

Networks

The competitive advantage of firms in the New Economy has been greater specialization. However, this results in more interdependency with other firms, organizations, and suppliers. Business is no longer conducted by

companies working alone. When leading-edge firms need specialized skills, they outsource to another organization in a related field or even in the same field. Many companies hire partner companies and form virtual corporations that combine for one product and then recombine with entirely different sets of collaborators for another product.

The concept of "blue ocean," coined by Kim and Mauborgne (2004), is based on the notion that innovation comes from reinvention as well as new invention. They cite Cirque du Soleil as a prime illustration of reinventing within the template of an existing industrial category to generate a new product for new buyers. Some people and places seem to generate more of this sort of intellectual ware for reasons that Florida (2002), along with Kim and Mauborgne, cited as conducive to collaborative activities or launchpads for new ideas. Bradshaw and Blakely (1999) provided a spatial dimension to this argument in their work on third-wave economic development approaches.

Thus, it is no longer feasible for a firm located in one place to be unconcerned with the network of institutions and suppliers that can provide its materials and talent. Firms with well-developed networks are flexible as well as able to identify and select strong suppliers and penetrate new markets. The implication for workforce development is clear. In a networked economy, the skills of suppliers are as important as the skills within the firms.

The enduring challenge for local economic development planning is that the loss and gain of firms and jobs is never a one-for-one match, for either the community or the worker. When an auto job is lost in Detroit, its replacement in the American economy is more likely to be in financial services and located elsewhere. Even when another auto job from a foreign-owned firm appears in the U.S. economy, it does not do so in Detroit. Instead, it is located in the new Auto Alley running through the southeastern states. A classic explanation for this is found in Schumpeter's (1947) notion of "creative destruction"—that is, capitalism and market economies only survive and grow through a process that destroys old ways and creates new ways of doing business. Cities, regions, and nations are affected by this process because they are the hosts to economic activities that experience birth and decline. Some of the new and key characteristics associated with evolving capitalism's manifestation in the economy are discussed next.

The Geography of the New Economy

What came to be called the New Economy has been with us since 1990. Atkinson and Correa (2007) described the transformation to the New Economy as "equivalent in scope and depth to the emergence of the factory economy in the 1890s and the mass production, corporate economy

in the 1940s and 1950s" (p. 3). They identified five major areas by which the transformation can be defined and measured: knowledge dependent, global, entrepreneurial, rooted in IT, and innovation (see Economic Developments 1.1 for a more detailed description). Using 26 indicators to capture transformation in the five areas, Atkinson and Correa (2007) examined recent economic activity in the United States and concluded that transformation to the New Economy has been uneven: It is most strongly in evidence within the Northeast, mid-Atlantic, Mountain West, and Pacific regions. The lagging regions are the Midwest, Great Plains, and South. When viewing the transformation through a metropolitan lens, Atkinson and Gottlieb (2001) observed a shift from the largest metro areas to midsized metro areas (between 250,000 and 1 million people). Within metro areas, the shift to the New Economy is associated with decentralization of activity away from the central city. Unfortunately for rural counties not adjacent to metro areas, Atkinson and Correa (2007) observed that they have been left out of the New Economy and have lost job share.

Jobs have been far more mobile than people. Over the past three decades, the Northeast and Midwest "Snow/Rust Belts" have shed manufacturing and related jobs. In the 1990s, these areas regained some of this type of employment but added a significant segment to the service employment base, particularly in new technology areas and in transportation and goods movement sectors. Old factories have been restored as logistic centers, moving freight by air and rail. Expansions in international trade have created new jobs for heartland workers importing and exporting goods to Latin America and Canada. The South and West have added new technology and trade jobs, as well as construction and food production employment. Although the North lost manufacturing jobs during the 1980s and 1990s, the Southeast added some manufacturing jobs in the auto sector as European automakers came to the South seeking cheap skilled labor during the same period.

Atkinson and Gottlieb (2001) argued that the most appropriate way to view the New Economy is through the lens of metropolitan areas, observing that America is "neither an urban nor a rural nation, but rather a metropolitan nation where the majority of the population lives and works in large metropolitan areas that include both historic central cities and dispersed suburban development" (p. 3). Contrary to common perception, the movement of jobs has not been confined to North–South or East–West shifts. Some northern metropolitan regions that lost population and employment during the 1980s and 1990s are now rebounding with new technologies and reinventing themselves as part of the New Economy by acting as springboards of industries like publishing and printing as well as other

ECONOMIC DEVELOPMENTS 1.1
The New Economy

So what exactly is the *New Economy?* The term refers to a set of qualitative and quantitative changes that in the last 15 years have transformed the structure, functioning and rules of the economy . . . . The New Economy is a global, entrepreneurial and knowledge-based economy in which the keys to success lie in the extent to which knowledge, technology, and innovation are embedded in products and services.

Today's economy is *knowledge dependent*. Of course, managers and "knowledge workers" have always been part of the economy, but by the 1990s, they had become the largest occupational category. Managerial and professional jobs increased as a share of total employment from 22 percent in 1979 to 28.4 percent in 1995 and to 34.8 percent in 2003. In contrast, about one in seven workers is employed as a production worker in manufacturing, and even there, knowledge and continual skills enhancement is becoming more important.

Today's economy is *global*. While it is true that some firms have long had global links, today's globalization is pervasive, as more nations join the global marketplace, as more goods and services are traded, and as more of the production process is interconnected in a global supply web. Since 1980, global trade has grown 2.5 times faster than global gross domestic product (GDP). World exports are now at $12.5 trillion, nearly 20 percent of world GDP.

Today's economy is *entrepreneurial*. While it is true that entrepreneurial growth, market dynamism, economic "churning" and competition have been features of the American economy since the colonial days, the center of gravity seemed to shift to entrepreneurial activity after the 1990s. At the same time, the underlying operation of the economy accelerated to a new speed and became more customized and innovative. For example, in the 60 years after 1917, it took an average of 30 years to replace half of the 100 largest public companies. Between 1977 and 1998, it took an average of 12 years. Moreover, from 1980 to 2001, all of the net U.S. job growth was from firms less than five years old, while older firms actually lost jobs.

Today's economy is *rooted in information technology*. While it is also true that information technology has played a role in the economy since the invention of the telegraph, something happened in the 1990s when semiconductors, computers, software, and telecommunications became cheap enough, fast enough, and networked enough to become so ubiquitous as to power a surge in productivity growth. Indeed, information technology is now the key technology driving the economy, not just in the IT industry itself—which continues to see high-wage job growth—but also in the use of IT in virtually all sectors to boost productivity, quality and innovation.

Today's economy is driven by *innovation*—the development and adoption of new products, processes, and business models. Nations, states, regions, firms, and even individuals compete on their ability to accumulate, aggregate, and apply their assets to create value in new ways for increasingly diverse customers all over the world.

Source: Reprinted with permission from Atkinson and Correa (2007).

communications firms. For example, many academic presses are now in New England in old picturesque mill towns that can compete with New York City because they have digital printing capacities and can be reached on the Internet.

Beyond major metropolitan areas, the United States has continued to become more urbanized—or, more accurately, suburbanized, as we will discuss later. The population and employment picture for rural or nonmetropolitan areas has not been as steady as that in urban areas (Kusmin, 2003; Pigg, 1991). Many have suffered from the continued losses of manufacturing and farm employment. However, between 2005 and 2006, the 2 years before the Great Recession, rural counties actually experienced net domestic migration (where the number of in-migrants exceeded the number of out-migrants). This trend was greatest in western locations that combined scenic attributes with tourism, recreation, second-home development, and retirement migration. Parts of the rural South (Texas Hill Country, southern Appalachia, the Florida coast, and northern Virginia) experienced rapid growth due to the amenities they provided in conjunction with their proximity to metro employment (Kusmin, 2003).

Correspondingly, in some locations, the skill level of rural dwellers has increased to a degree that is competitive with urban and suburban areas. Extending the work on the creative class begun by Richard Florida (e.g., 2002), McGranahan and Wojan (2007) found that particularly high-amenity rural areas are competitive with urban areas in attracting the creative class. Their research provides an important contribution to understanding current economic development trends. The creative class is composed of people in highly creative occupations such as artists, architects, engineers, design, entertainment, and science. Florida argues that economic growth is driven by the creation of knowledge and ideas that primarily come from those in occupations that involve high levels of creativity. This creative class seeks a high quality of life as well as rewarding work. McGranahan and Wojan (2007) observed the following: "While developed with major metropolitan areas in mind, the creative-class thesis seems particularly relevant to rural areas, which lose much of their young talent as high school graduates leave, usually for highly urban environments" (p. 18). McGranahan and Wojan found that, between 1990 and 2004, rural counties with high proportions of creative-class workers experienced a 44% growth in jobs, while metro counties experienced a 39% job growth. Whether in rural or urban areas, the activities associated with the creative class bring new jobs and growth, and the message for all localities is to carefully preserve their natural amenities as well as to nurture their cultural resources.

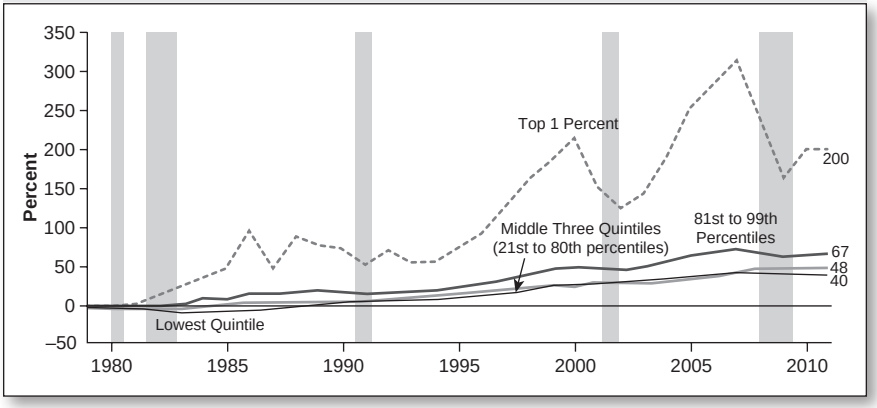
People and Places Left Out of the New Economy

Growing Income and Earnings Inequality

One way of understanding the changing economy is to see how growth is shared between its component parts—labor and capital. While labor productivity has been increasing, this has not translated into increasing wages (Bivens and Mishel, 2015; DeNavas-Walt, Proctor, and Lee, 2006). The share of national income going to wages and salaries is the lowest ever recorded and fell below 50% for the first time in 2010, while the 14.15 share going to corporate profits was the highest ever recorded (Norris, 2011). Therefore, the common perception that all boats rise and fall as the overall economy cannot be assumed. Instead, more of the real gains are transferred to capital that may reside outside of the United States and to small segments of wealth-capturing groups with strong stock and other capital asset portfolios.

Not only has labor generally not shared in the increasing national prosperity, but there has also been a shift in the distribution of earnings within labor segments. The top of the economic pyramid has fared far better in the distribution of income than the bottom portion. The real improvements have been for those who receive income from capital flows rather than labor (Willis and Wroblewski, 2007). Between 1979 and 2007, the U.S. Congressional Budget Office (2014) found that after-tax income for the highest-income households grew more than it did for any other group (see Figure 1.2). Specifically, income increased 200% for the top 1% of households, 67% for

Figure 1.2 Cumulative Growth in Average Inflation Adjusted After-Tax Income, by Before-Tax Income Group, 2011



Source: U.S. Congressional Budget Office (2014).

the next 81st to 99th percentiles, 48% for the next 21st to 80th percentiles, and only 40% for the bottom 20%. As these trends have continued, they have finally become a major national focus and even the overriding and bipartisan issue of the 2016 presidential election contest.

Gaps in opportunity have also increased across all spectra of the economy. High tech and finance executives, as well as athletic superstars, who represent a very small segment of the nation have gained immensely relative to others. Decline in unions and manufacturing employment has pushed many less-educated and computer-illiterate workers into lower-wage jobs where they compete with international labor pools. The high level of unemployment due to the Great Recession eroded household savings and decreased wages as higher numbers of job seekers competed for few openings.

Debate over whether the middle class was shrinking or merely moving into the growing upper middle class has been an ongoing accompaniment to the shift to the New Economy (see Economic Developments 1.2). But the Great Recession and its lingering effects shifted the debate's focus to the overall decline in the middle class, the top 1%, and to those whose education should have prepared them for a place in the middle class. A 2012 analysis estimated half of new college graduates were unemployed or underemployed (Yen, 2012). Boushy and Hersh (2012) made the case that a strong middle class is essential to a strong economy for four reasons. It promotes the development of human capital and a well-educated population; creates a stable source of demand for goods and services; incubates the next generation of entrepreneurs; and "supports inclusive political and economic institutions, which underpin economic growth" (p. 3).

The loss in middle-income families has had a corresponding impact on working middle-class neighborhoods. Middle-income neighborhoods have declined by 58% since 1970, according to a Brookings Institution study (Booza, Cutsinger, and Galster, 2006). This dramatic decline far outpaced the corresponding drop in the proportion of metropolitan families earning middle incomes, from 28% in 1970 to 22% in 2000. Of the nation's 12 largest metropolitan areas, only 23% of their central city neighborhoods were middle class in 2000 (Booza et al., 2006). The Great Recession worsened these trends, as the study of rising metro segregation by income has found (Fry and Taylor, 2012).

Growing Racial Inequality

Income growth has been largely stagnant, with growing inequality between races. The median household income for all races was $51,939 in 2013, an increase of around 8% since 2006 (DeNavas-Walt et al., 2006;

ECONOMIC DEVELOPMENTS 1.2
What Is Happening to the Middle Class?

The "plight of the middle class," as it is subjected to forces transforming the U.S. economy has become a major topic of interest among economists, political analysts, policymakers and politicians. Economic development planners should understand the debate as the middle class is the backbone of the U.S. economy and American society. The middle class standard of living is a benchmark by which economic development progress is measured. Historically, the mass market has been oriented towards satisfying the middle class consumer. A position in the middle class is generally considered the development goal of the lower classes and of many of those who aspired to assist the lower classes.

The debate over what is happening to the middle class is intertwined with two other major economic debates: that of the U.S.'s industrial transformation, and that of the effects of changing demographics (aging baby boomers, immigration …). How the middle class is defined can make a significant difference in the trends observed and conclusions drawn. Various trend analyses have focused on earned income or total income, as well as household income or individual earnings. They have used different definitions of the middle (a range around the median level, or dividing the earnings or income distribution into quintiles and focusing on the three middle segments). Using household or family income enables one to look more at the total income picture. If the main concern is with impacts on standard of living, then household or family income may be the most appropriate variable for analysis. If the primary concern is what effect the declining middle has on employment and earning opportunities, then individual earnings is the appropriate variable. Both are important from an economic development perspective. Today, the two-earner household increasingly makes up the family income unit while there are also growing numbers of single earner/occupant households. How has the possibility for attaining a middle class standard of living changed in concert? Does it now take more than one earner in most households to achieve a middle standard of living? If so, does this represent economic development advancement if it takes two or more earners to maintain a middle standard where one could do so previously?

Source: Leigh, Nancey Green. (1994). *Stemming Middle-Class Decline.* New Brunswick, NJ: Center for Urban Policy Research, © 1994 by Rutgers, The State University of New Jersey.

DeNavas-Walt, Proctor, and Smith, 2013). The median White household income was 112% of that for all households, while it was 129% for Asians, 79% for Hispanics, and only 67% for Blacks. This persistent racial inequality is reinforced by the fact that the Black poverty rate was the highest of all racial groups. At 27.2%, it was almost 3 times that of Whites and Asians and 3.7% higher than for Hispanics (see Table 1.1).

Table 1.1 Household Income Poverty by Race, 2006–2013

Race Category	Household Income		% Change	Median Household Income as Percentage of Total Median Household Income		Poverty Rate	
	2006	2013		2006	2013	2006	2013
All Races	$48,201	$51,939	7.76	100%	100%	12.3%	14.5%
White	$52,423	$58,270	11.15	109%	112%	8.2%	9.6%
Black	$31,969	$34,598	8.22	66%	67%	24.3%	27.2%
Asian	$64,238	$67,065	4.40	133%	129%	10.3%	10.5%
Hispanic	$37,781	$40,963	8.42	78%	79%	20.6%	23.5%

Sources: DeNavas-Walt et al. (2006, Tables 1, 3); DeNavas-Walt et al. (2013, Tables 1, 3).

Note: This edition uses "White, non-Hispanic" data from 2006 and 2013 tables.

In part, these discrepancies are attributable to racial differences in educational attainment and in single-earner versus dual-earner households. Additionally, foreign-born workers can remain trapped in various forms of domestic service work in which they have low wages and no bargaining power without better language skills. From an economic development perspective, the link between high rates of poverty and low educational attainment is clear. Consequently, the success of the local education system is a necessary foundation for local economic development.

Welfare reform introduced by President Clinton in 1994 was aimed at moving welfare recipients—particularly Black single-headed households—from poverty to work. It is clear that welfare rolls have declined substantially as a result of this law. While states now spend less on welfare per se, they spend a good deal more on job training, education, and programs designed to lower teenage pregnancy and other factors that cause intergenerational poverty (Haskins, Sawhill, and Weaver, 2001).

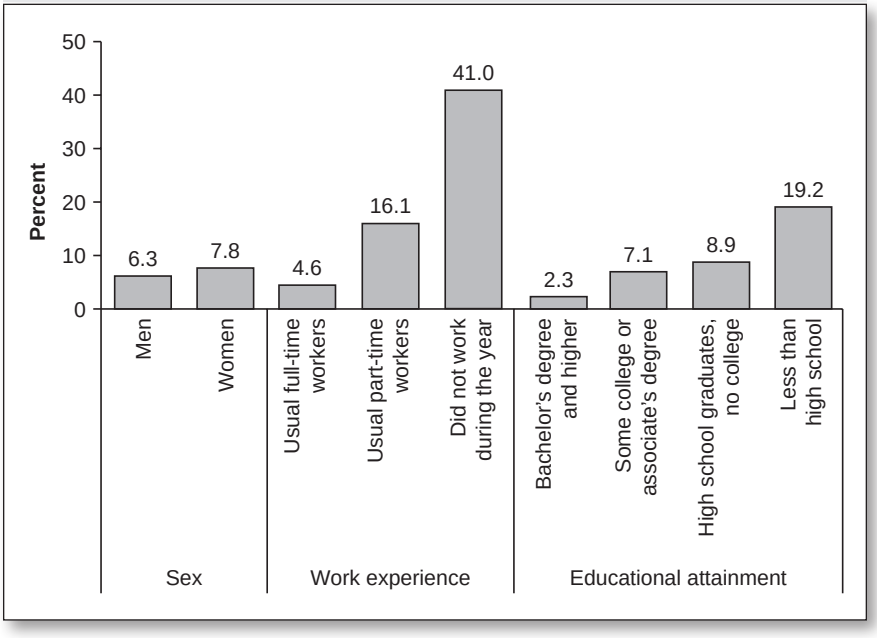
However, there is mounting evidence that the work welfare recipients find is low wage and often only part-time. Thus, those formerly dependent on welfare are increasingly working for wages at or below the poverty line, thereby requiring other forms of support, such as food stamps, to make ends meet.

The Working Poor

Former welfare recipients may be part of a larger group known as the working poor: persons who are in the labor force (at least 27 weeks) but still do not earn enough to have an income above the poverty level.

For the overall American labor force, the working poor grew from 6.5% to 7.0% between 2007 and 2013. Black (13.3%) and Hispanic (12.8%) rates of working poor were significantly higher than those for Whites (6.1%) and Asians (4.5%). Further, 27.5% of those who worked part-time involuntarily (because they wanted full-time work but could not obtain it) were also working poor. Being a member of the working poor is correlated with one's occupation and educational level. Figure 1.3 shows that 19.2% of those without a high school education were working poor, compared to 2.3% of college graduates. Those who work in services, natural resources, construction, and maintenance jobs also had a much higher likelihood of being among the working poor (U.S. Department of Labor, 2015).

Figure 1.3 Working-Poor Rate, by Sex, Work Experience, and Educational Attainment, 2013



Source: U.S. Department of Labor (2015).

For families, those with children under 18 years were about 3 times more likely to be working poor, and those with female heads were more likely to be in poverty (U.S. Department of Labor, 2015).

As can be seen in Table 1.2, while about a quarter of the workforce is low wage (average hourly wage of $10.10 in 2011), two thirds of this low-wage workforce is female.

Table 1.2 The Low-Wage Workforce

Characteristic	Low-Wage Workforce	Total Workforce
Percentage of workforce	26%	100%
Average hourly wage (2011)	$10.10	$22.27
Gender		
Female	66%	47%
Male	34%	53%
Race		
White, non-Hispanic	50%	66%
Hispanic	25%	16%
Black	17%	11%
Asian/other	8%	7%
Education		
Less than high school	23%	9%
High school grad	36%	27%
Some college/Associate's Degree	32%	29%
College grad+	8%	35%
Age		
16–24	31%	12%
25–49	45%	54%
50–75	22%	33%

Source: National Women's Law Center (2014).

Part-time low-wage work is no longer a short-lived interlude until a better full-time job is found. Few of the skills developed in low-wage work are transferable to higher-order jobs. In fact, many part-time jobs are deskilling. For example, the worker becomes more of a watcher than a technical aid for the work performed. Store clerks no longer need to add and subtract, or indeed do any high-order functions, since the computer calculates and analyzes. Few part-time jobs offer any training or require much skill, so they are not ladders to anything better.

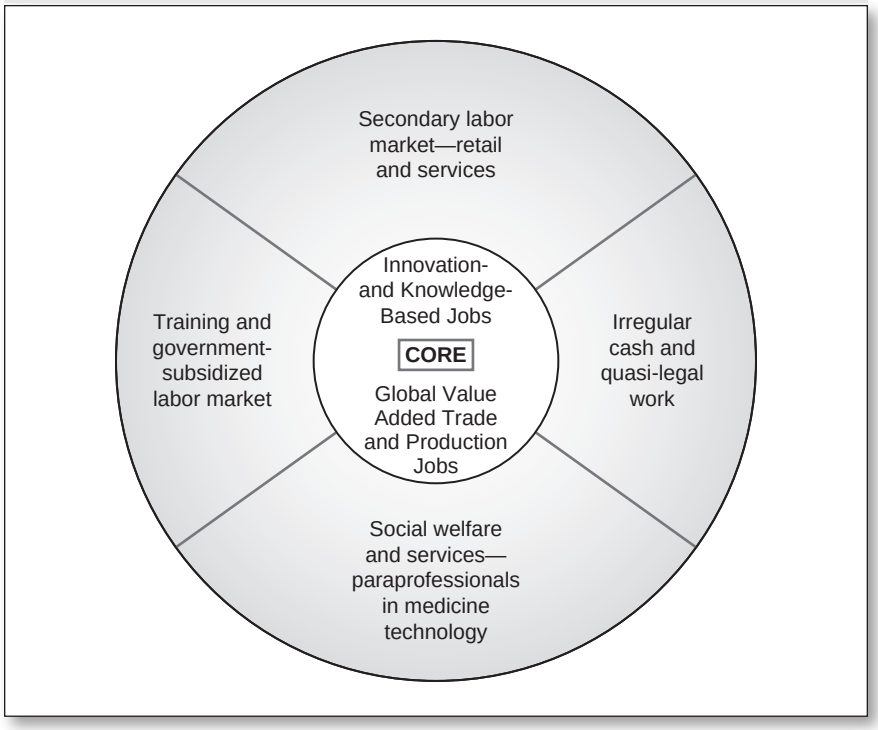
While globalization has increased the competition for lower-skilled workers in many countries, the fact is most of the United States' lowest-paid part-time work cannot go overseas to sell hamburgers or make beds. This form of work is infiltrating sectors that once provided job ladders like custodial services and that served for many new immigrants as the way into government and other work. These civil-service job-ladder opportunities have been closing, as the work is now increasingly privatized and given to contractors. Low-skilled minorities, especially women, are caught in a vicious cycle of low-wage employment that is time consuming but not skill enhancing, and too often they lack the resources or support systems to further their educations so they can move to higher-wage occupations.

The Decline in Good Jobs

The picture of a deeply dividing labor force that Bennett Harrison (1978) painted more than three decades ago is still with us today. The picture of this labor force presented in Figure 1.4 is only slightly modified from what Harrison originally conceived. At the core of the current labor market are the primary (or good) jobs. Primary employment consists of career professional and technical positions with good wages and benefits, career mobility, and additional training opportunities. These jobs have historically been unionized or had some degree of employment security based on the ability of the workers holding these jobs to bargain, since they possessed skills and technical knowledge needed in the productive economy. In addition, jobs in the primary sector are generally more rewarding than other positions because they tend to be "knowledge intensive"—that is, individuals' intellectual skills are more likely to be used in the work.

Surrounding the core primary jobs are more marginal employment activities, which have increasingly come to be seen as bad jobs. The principal real employment in this segment lies in what has been called the secondary labor market: low-wage, unstable employment in personal consumer services areas or in firms that are footloose. The secondary labor market includes

Figure 1.4 The Structure of Urban Labor Markets



Source: Adapted from Harrison (1978).

many occupational categories, ranging from manufacturing to clerical. Individuals in this market seldom have any job security and enjoy few benefits from their employers. As a consequence of the low wages paid in the jobs, individuals and families in most urban areas are forced to send more members of the family to work, including working-age children. At the top of the figure are the increasingly part-time retail jobs. To the left of the core are public sector job training programs for welfare-to-work transitions and displaced and hard-to-employ legal workers. To the right of the core is the segment of workers who are legal and illegal. The illegal portion is made up of individuals and some small firms that do all their business in cash and pay few or no taxes. A portion of this sector is engaged in illicit activities.

Government was a larger employer when Harrison (1978) first depicted the labor market. The jobs it shed have been replaced by those in the social welfare sector and by paraprofessional jobs in medicine, social services, and other arenas filled by contract employees. The latter work without benefits, so they are dependent on a new form of government handout from grants

and contracts. This is a growing sector that has less power than the government agencies it replaces. Even the education sector is moving in this direction, with more and more schools privatizing as charter schools. While the charter schools give more local control over teachers and curriculum, they also provide less job security than the public system.

Good jobs are those that provide, at a minimum, a living wage so that if a person works year-round, full-time, his or her earnings will take him or her above the poverty level. These jobs also have employer-provided benefits such as health care, retirement plans, and opportunities for job training and career advancement. As more work becomes part-time and small employers replace larger ones, job quality is suffering. In particular, health care benefits are nearly as important as wages, for without health insurance, even a small medical emergency can push a household into bankruptcy. Further, when the only resource for an uninsured worker is the emergency room of a local government-supported hospital, the community suffers from excessive and unreimbursed use of the most expensive form of health care.

Employer-provided health insurance is more associated with larger employers who can realize cost savings from buying large group policies. However, large employers see the aging and unhealthy workforce as a future liability, particularly given the increasing incidence of type 2 diabetes, asthma, and other largely preventable diseases. This, in combination with soaring health care costs, caused major employers to cut back on health care coverage beginning in the 1980s (Economic Policy Institute, 2009). In turn, it led to growing calls for a national approach to providing health insurance. However, it wasn't until 2010 that a national approach, in the form of the Affordable Care Act (ACA), materialized. Details on this approach are discussed in Chapter 2.

Inconsistent access to health care, corporate downsizing, offshoring of jobs, the decline of unionized jobs, and the rising use of temporary help agencies to meet firm employment needs are just some of the factors that have contributed to an eroding good jobs base. Some states and communities have tried to preserve and grow their good jobs base by tying job quality to the provision of economic development incentives.

Overall, the U.S. labor market faces substantial challenges in continuing to be the vehicle through which the majority of Americans, newcomers and old-timers, achieve the American way of life. Beyond corporate restructuring and offshoring, two trends represent particular challenges for marrying local economic development efforts with workforce development efforts. The first is incorporation of the foreign-born population, and the second is the rehabilitation of a growing and largely Black male prison population.

The Rise of the Foreign-Born Population

Foreign immigration increased from 4.7% in 1970 to 13.1% in 2013, and during this time, the regions from which immigrants came changed from predominantly Europe to Latin America, South Asia, or East Asia (Pew Research Center, 2015). Unlike previous generations, new immigrants from all regions of the world are able to keep many of their linguistic and other traditions, since international communications such as satellite television, radio, and the Internet make it easier to maintain contact with their homelands. As the new immigrants settle, they also become important assets to communities in a variety of ways, from providing needed labor to purchasing local goods and services.

On the other hand, new immigrants are seen as competing for jobs at the low end of the scale, thereby depriving local workers of these jobs. Immigrants are also producing increasing numbers of children due to higher fertility rates than the locally born or domestic population. Immigrants work and do pay taxes, but in areas with high concentrations of low-skilled, low-paid immigrants, they impose net costs on U.S.–born workers. The reason for the so-called immigrant burden is that illegal immigrants receive services like education and health care for which they may not pay directly, since they seldom pay property and income taxes. Furthermore, the vast majority of legal immigrants are in the lowest income groups and thus have higher welfare or other public supports. Yet, as we will discuss later in this book, immigrants have the potential to be strong forces for local economic development.

Prison Populations

Prisons became the de facto "employers" for many of the nation's minority males as a consequence of their first work experience: drug dealing. They are disproportionately home to young Black males, generating incarceration role models that have become celebrated in pop music. In 2014, 6% of the Black population aged 30 to 39 was in prison, compared to just 2% of Hispanics and 1% of Whites in that age group. This translates to 2,724 Black inmates per 100,000 Black male residents serving sentences of at least 1 year, compared with 1,090 Hispanic inmates per 100,000 Hispanic male residents, and only 465 White inmates per 100,000 White male residents. Further, younger Black males ages 18 to 19 were 10 times more likely to be in state or federal prisons than White males (U.S. Department of Justice, 2015).

The tragically higher rate of Black males in prison is a symptom of household and community dysfunction that has generated deep despair among policymakers of all colors who are unable to find successful corrective courses of action. Table 1.3 shows that low attachment rates to the educational system significantly increase the likelihood that Blacks, Hispanics, and

Table 1.3 Educational Attainment and College Course Enrollment of Males, Ages 18–24, by Race/Hispanic Origin, for Prison and General Populations, 2009

	White		Black		Hispanic	
Educational Attainment	General Population	Prison Population	General Population	Prison Population	General Population	Prison Population
Less Than High School	14.3%	40.8%	24.8%	58.4%	33.3%	62.7%
High School Diploma	28.7%	19.4%	31.2%	16.5%	30.9%	14.1%
GED	4.7%	23.0%	4.7%	15.3%	3.2%	12.3%
Some College +	52.3%	16.8%	39.3%	9.9%	32.6%	10.8%
College Course Enrollment	47.4%	11.2%	42.2%	13.5%	34.3%	14.2%

Source: Ewert and Wildhagen (2011).

Whites will become incarcerated and diminish their chances for fully participating in the legal economy. Post-release from prison, few can find living-wage work. Moreover, state lawmakers eager to show toughness on crime extended sentences, thereby reducing the possibility of successful rehabilitation to community life.

There are two significant recent policy efforts aimed at increasing the possibilities for the formerly incarcerated to successfully gain employment and reenter society. The first is the Ban the Box movement focused on ensuring employers provide a fair chance to job applicants by removing the question on history of conviction from application forms. This question typically results in the applicant being excluded from any further consideration. By removing the box, inquiries into an applicant's record come later in the hiring process and give applicants a chance to show their qualifications (and rehabilitation). Twenty-one states and more than 100 cities and counties have adopted some form of Ban the Box policy as of 2016 (Rodriguez and Avery, 2016).

The second policy effort explicitly recognizes the correlation between levels of low education and high incarceration. At the federal and state level, there is a push to provide greater levels of general, vocational, and college-level education to prisoners. Some cities are also taking the initiative to address this critical problem, as can be seen in Economic Developments 1.3. Recent studies have shown

ECONOMIC DEVELOPMENTS 1.3
Five Keys Charter School Provides Education Access to Prisoners in California*

The United States has not only the largest prison population in the world but also relatively high recidivism for parolees. These high rates indicate that incarceration should not be the sole solution to support criminals' reintegration into society. Since there is considerable evidence that crime and imprisonment are associated with lack of education, increasing comprehensive (core subject and socioemotional) educational opportunities for prisoners could reduce recidivism and alleviate the ever-increasing social and fiscal costs of incarceration.

In San Francisco, the sheriff's department Five Keys Charter School (FKCS), a nonprofit corporation, offers educational access to adults in county jails or to those on probation or parole in treatment facilities or workforce development programs. The network of schools is public, and courses are based on requirements through the California Department of Education and completely funded by the San Francisco United School District. Since the jails' budgets cover costs of rent, food, transportation, and facilities, Five Keys can utilize school district funds primarily for investments in technology and intensive programs involving English as a second language (ESL), mental health, and special and remedial education.

The original school, FKCS, was founded in 2003 and offers classroom-based full-day school to men in county jails. The Five Keys Adult School (FKAS) was later established to provide full-day classes for men *and* women. In addition to traditional core courses for the GED/high school diploma, both programs emphasize wraparound support classes on restorative justice, parenting, violence prevention, substance abuse, and career preparation. At FKAS, unlike FKCS, classes go year-round and are held within the inmate housing units, ensuring broader access by incarcerated adults (Visiting Committee Report, 2015).

Five Keys also expanded its programs outside of jail through Five Keys Independence High (FKIH), providing independent study options to men and women in jail or out on parole who cannot attend classes on-site, and to those working and/or enrolled in job training or residential treatment programs. Students complete independent study courses, meet with teachers at least once a week, and have the option of attending daily classes. These various options of school type within the FKCS system provide students a fluid system to start and/or continue their education once released (Visiting Committee Report, 2015).

FKCS serves most county jails in San Francisco and expanded to Los Angeles County jails in 2012. The charter now offers kindergarten through 12th grade courses to address the needs of students on all levels. To address low retention rates after release, there are future plans to offer online courses and mobile classroom sites on refurbished city buses for parolees in remote and/or rural areas (Visiting Committee Report, 2015).

In the 2013–2014 school year, Five Keys served 9,528 students, 37% of which were Black, 27% Hispanic, and 14% White. Of all students, 82% were male, and 61% were incarcerated. Of all the students who took the California High School Exit Examination in 2013, 79% passed the English section and 70% the math section. In addition, 70% of students enrolled for at least two months had access to vocational training and thus better chances of finding employment (Visiting Committee Report, 2015). Based on a recent report, Five Keys has a recidivism rate of 28% compared to the California state average of 68% (Barba, 2015; California Department of Corrections and Rehabilitation, 2014).

The San Francisco Sheriff's Department recently won the 2015 Innovation in American Government Award from Harvard University for its increasing impact on students and their local communities (Barba, 2015). Adequate funding, continuity of education between the charter organization's on-site and independent studies programs, as well as a comprehensive curriculum including socioemotional courses allow students at Five Keys a flexible and supportive path toward workforce entry. This program in California offers just one example of a burgeoning movement to recapture a group of men and women who often lack access to adult education and career development opportunities.

*Research assistance provided by Ashley Bozarth.

that inmates who receive education are much less likely to be incarcerated after release. Further, the costs of providing education to prisoners are estimated to be less than one fifth of the costs of reincarceration (Davis et al., 2013).

Growing Spatial Inequality

Two primary ways to examine trends in spatial or regional inequality in the United States are through the categories of major regions (Northeast, Midwest, South, and West) and the metro and nonmetro regions (treated as synonymous with *urban* and *rural*). From Table 1.4, we see that there are significant differences in income levels, incidences of poverty, and lack of health insurance coverage between the four major regions and within metro regions as well as between metro and nonmetro regions. Despite the high population and employment growth rates the South has experienced for many decades, its income levels continue to lag behind the other regions of the United States, while the proportion of persons in poverty and lacking health insurance is highest. Even though the West had the highest income in 2012, the proportion of westerners lacking health insurance was almost as high as the South's. The Northeast and Midwest rank second and third,

Table 1.4 Spatial Inequality in Income, Poverty, and Health Insurance

Area	Income			Percentage Below Poverty			Percentage With No Health Insurance		
Region	2006	2012	% Change	2006	2012	% Change	2006	2012	% Change
Northeast	$52,057	$54,627	4.94	11.50%	13.60%	18.26	12.30%	10.80%	−12.20
Midwest	$47,836	$50,479	5.53	11.20%	13.30%	18.75	11.40%	11.90%	4.39
South	$43,884	$48,033	9.45	13.80%	16.50%	19.57	19.00%	18.60%	−2.11
West	$52,249	$55,157	5.57	11.60%	15.10%	30.17	17.90%	17.00%	−5.03
Metro Status									
Inside Metro	$50,616	$52,988	4.69	11.80%	14.50%	22.88	15.80%	15.50%	−1.90
Inside Central City	$42,627	$45,902	7.68	16.10%	19.70%	22.36	19.00%	18.60%	−2.11
Outside Central City	$55,775	$58,780	5.39	9.10%	11.20%	23.08	13.80%	13.50%	−2.17
Outside Metro	$38,293	$41,198	7.59	15.20%	17.70%	16.45	16.00%	15.20%	−5.00

Sources: DeNavas-Walt et al. (2006); DeNavas-Walt et al. (2013).

respectively, for the three standard-of-living indicators: income, percentage below poverty, and percentage without health insurance. Although both regions have suffered significant losses in good jobs over the last several decades due to manufacturing decline in the industrial heartland, the stronger labor agreements that are the legacy of unionization have helped to stabilize their standards of living. However, the Midwest was the only region to see increases in population without health insurance coverage.

Within each of the four regions, there is significant diversion in standards of living and economic development at the state and substate levels. As discussed previously, much of this diversion is attributable to whether a location within a region has natural amenities such as mountains and coastlines that make logical resort choices or whether it is part of a metropolitan area. Indeed, it is not regions or states but metropolitan areas that are the true drivers of U.S. development. Around four fifths of the U.S. population lives in metropolitan areas, and half of the U.S. population lives in their suburbs. Even more significant is that U.S. population and economic activity are concentrated in only one third of all our metro areas:

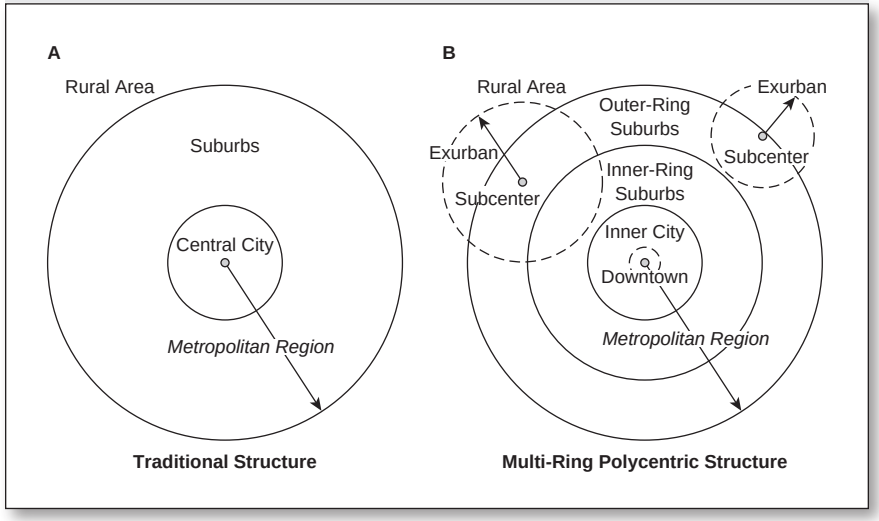
> The 100 largest U.S. metropolitan areas contain 65 percent of the nation's population and 68 percent of its jobs, but gather even larger shares of innovative activity (78 percent of U.S. patent activity), educated workers (75 percent of graduate degree holders), and critical infrastructure (79 percent of U.S. air cargo). As such, they generate three-quarters of U.S. gross domestic product. (Berube, 2007, p. 7)

Dabson (2007) detailed the key connections between the nation's metro and rural economies, noting that the major metro economies "draw strength from, and provide benefits to, smaller places throughout the nation." Indeed, more than half of the population living in rural areas, defined as low-density areas and towns, are in counties within metropolitan areas (Dabson, 2007). Dabson (2007) noted that firms in major metropolitan areas depend on the lower cost labor in these rural areas, which are either part of their commuter sheds or may be hundreds of miles away and provide business process services made possible by IT advances.

Increasing Metropolitan Inequality

Despite metropolitan America—particularly its top 100 cities—being the geographic focal point of U.S. economic growth, there are a number of concerns raised by recent patterns. First, there is a twin set of increasing bifurcation occurring within metro areas. This is associated with the

Figure 1.5 The Emergence of Suburban Rings and Subcenters in the Metropolitan Areas



Source: Lee and Leigh (2004).

significant suburbanization within U.S. metropolitan areas that has transformed metropolitan spatial structure from the dichotomous form of central city–suburbs to one of a multiring polycentric structure with suburban rings and subcenters (see Figure 1.5). The resulting metropolitan region is an interactive system of downtown, inner city, inner-ring suburbs, outer-ring suburbs, subcenters, and exurbs. Within this system, downtowns are experiencing gentrification and revitalization in reaction to the long commutes associated with metropolitan sprawl, while the minority-populated inner-city portion of the central city continues to suffer from high crime rates, disinvestment, poor schools, and poverty concentration. At the same time, the suburbs are becoming increasingly differentiated, and the inner-ring suburbs have been experiencing declining household incomes. Their aging housing stock is being occupied by new immigrants and the traditional poverty population that is being displaced by "back to the downtown" movements (Lee and Leigh, 2007).

The signs of suburban decline are clear, including homeless people in shopping malls in many close-in suburbs and even some affluent areas. Affordable housing, which was a code word in the 1980s for low-income housing, is now a concern of suburban police officers and schoolteachers as well as the poor. The suburbs have also witnessed a rise in crime and in the number of new social problems in their midst, with many families

experiencing stress and rising levels of child abuse and family dysfunction. Suburban schools, once thought to be sanctuaries, have experienced violence of unimaginable scale and horror across the nation. In April 2007, Blacksburg, Virginia—a small picturesque college town with no history of violence—rocked the nation with 32 unprovoked killings by a psychotic student. Less than a decade earlier, Columbine High School in Colorado Springs experienced a similar incident. Although some have blamed television for these horrific acts, many sociologists blame the suburban living arrangements that isolate youth from a larger network of social settings, which fosters good communal life. At the same time, participation has been declining in community institutions that formed the backbone of civic life for 50 years, such as PTAs, 4-H clubs, and Lions Clubs; even attendance in traditional churches has been in long-term decline (Putnam, 2000).

Increasing Rural Inequality

The bifurcation in economic fortunes within rural areas and small towns is just as significant as that which has occurred within our metro areas. Those who prosper, as previously discussed, have significant natural amenities and/or are close to a thriving metropolitan area. Those with an employment base in farming continue to experience net job and population loss.

Farmland speculation, global competition, and overproduction have severely taxed many rural communities. As farms collapse, mines close, and other natural resource operations diminish, the dwindling employment base in agriculture and extractive areas declines even more swiftly. The loss in farm, timber, and mining income has a disastrous ripple effect through an entire community. In fact, many single-crop and single-firm nonmetropolitan communities have been extremely vulnerable due to their narrow economies. Further, manufacturing branch plant closings have had a more marked impact on rural than urban communities. As branch plant economies, these communities exercise little control over the corporate decision-making process. When international commodity prices fluctuate, the actions of other suppliers of raw materials influence the base economy. In a sense, some rural communities have been trapped by their own success in attracting firms and expanding foreign trade. They need to reformulate their economic development strategies to achieve more resilient economies. However, their most recent major growth opportunity—shale oil production—presents profound challenges for becoming a sustainable and resilient economic development strategy.

Shaping Global Warming: The U.S. Economic Engine

Only a small minority of scientists and policy advocates refuse to recognize the significance of climate change for the U.S. and global economy. With less than 5% of the world's population, the United States produces more than 15% of the CO2 gases that threaten the global atmosphere. Our American lifestyle is not without cost to the rest of the world. Americans consume more than a quarter of the world's natural resources to maintain an increasingly fragile form of consumption-oriented living. Americans transport, consume, and produce debris in greater quantities than almost all of the rest of the world combined. We are running out of landfills for our waste and reducing our own fresh water supply by our wasteful practices.

The International Panel on Climate Change report indicates global temperatures may rise as much as 6 degrees Celsius (11 degrees Fahrenheit) by the turn of the next century. Accompanying sea level rise could inundate more than 70% of the world's largest metropolitan areas located on coasts. Cities like New York, Sydney, and Mumbai are equally threatened by sea level rises of as much as 3 to 6 feet. While the sea is rising, we are also witnessing other regions threatened by spreading drought and deserts.

The economic consequences of global warming are far from trivial, yet the actions needed to deal with climate change may still be within our grasp. But how proactively nations will confront this impending disaster is not certain. Despite the fact that, until recently, the United States was leading greenhouse gas (GHG) emitter in the world, many see reductions in the production of GHGs to be hostile to economies. Meanwhile, China, now the world's top emitter of GHGs, and other rapidly growing nations like India are adopting U.S.-style living patterns as their growing middle classes urbanize and adopt automobile-based economic and cultural systems. As their combined population is several billion compared with 320 million for the United States, adoption of U.S. consumption and auto-dependent lifestyles by these nations has begun to greatly accelerate global warming.

The only real recourse is for a new economy to emerge that is less dependent on fossil fuels and more oriented toward the production of low-energy and low-waste lifestyles. Some policymakers and scientists see this new economy as one that uses substitutes for fossil fuels and for materials that alter the form but not the content of the current lifestyles—that is, substituting wind or corn for fossil fuels might be a way around the current energy-production system. Others view climate change as the call to drastically change our way of life—to produce communities that are less dependent on fuels for survival and that produce more of their own food to be consumed locally rather than transported nationally or globally. This latter approach

takes people out of their cars and does not just substitute for the automobile. Switching to a non-auto-based and low-energy American way of life is a major challenge that some see as insurmountable for the United States and the rest of the world. So new techniques for lowering fuel consumption and better using existing resources are the preferred alternatives. This means a vastly different economic engine will have to be produced in very short order to prevent massive dislocations of people and the starvation of many.

While the national governments of the largest CO2 producers are slow to acknowledge and respond to the challenge of global warming, there is a growing local level response that was initiated when Seattle's mayor Greg Nickels became the first to adopt the Kyoto Protocol in May 2005. Established in 1997, the international climate change treaty aimed for an average 5% reduction in GHG emissions in developed nations by 2012. While the United States never actually ratified the treaty, 2 years after Nickels's adoption, the U.S. Conference of Mayors (2014) endorsed his Climate Protection Agreement, and more than 1,060 U.S. mayors from all 50 states, Washington, DC, and Puerto Rico signed on to it. This agreement required mayors to (1) strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from antisprawl land-use policies to urban forest restoration projects to public information campaigns; (2) urge their state governments and the federal government to enact policies and programs to meet or beat the GHG emission reduction target suggested for the United States in the Kyoto Protocol—7% reduction from 1990 levels by 2012; and (3) urge the U.S. Congress to pass the bipartisan GHG reduction legislation, which would establish a national emission trading system. In 2014, the Climate Protection Agreement was renewed and included local strategies such as incentives for carpooling and public transit, increased use of renewable energies, maintenance of urban forests, and investments in green infrastructure to increase city resiliency (U.S. Conference of Mayors, 2014).

Additionally, nonprofit organizations such as KyotoUSA and the ICLEI–Local Governments for Sustainability are providing assistance to community groups as well as local governments seeking to protect our climate (see www.kyotoUSA.org and www.ICLEI.org). Over 600 U.S. cities had measured their GHG emissions and adopted reduction plans with ICLEI assistance by 2012. In 2014, ICLEI partnered with the World Resources Institute (WRI) and C40 Cities Climate Leadership Group to launch the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) through which participating cities measure, report, and compare emissions based on comprehensive standards. The initiative will strengthen the Compact of Mayors, the largest international effort among cities to

reduce GHG emissions (www.ghgprotocol.org). These coordinated, city-wide efforts are all the more crucial, as projections show that 66% of the world's population will live in urban areas by 2050 (United Nations Department of Economic and Social Affairs, 2014).

The Future of Local Economic Development Planning

The United States is enmeshed in the global market system as leader, follower, and participant. No American firm of any size remains solely within the domestic market system and, consequently, neither does any American community. American firms and labor once shielded from international competition are now subject to the vagaries of international finance. The traditional system of economic development planning and practice has not only been ineffective in responding to a market system that itself has undergone globalizing structural shifts, but it is also actually contributing to structural shifts in environmental and social systems that are significant cause for concern. Growing recognition of evidence of these shifts in the form of widening inequality and global warming increasingly appears to be a tipping point from which we may be able to look back one day and see a transformation of the traditional system of economic development planning and practice. In addition to the mayors who have signed on to the Climate Protection Agreement and the cities that have already measured their GHG emissions, other key actors are taking major steps. For example, the International City/County Management Association (ICMA) adopted a formal resolution on sustainability in October 2007 that requires recognition of the interdependence between environmental stewardship, economic development, social equity, and financial viability. The Brookings Institution has formulated a Blueprint for American Prosperity that calls for "productive, inclusive, and sustainable growth that helps the United States maintain its economic leadership, fosters a strong and diverse middle class, and advances U.S. efforts to address climate change and achieve energy independence" (Berube, 2007, p. 22). Lastly, the economic stimulus package of the Obama administration aimed at bringing the United States out of recession incorporated major provisions for creating sustainable jobs and economic activities.

American communities can no longer depend—if they ever could—on an industry base that pledges long-term loyalty to a community or its workers. Silicon Valley is only slightly better positioned to handle the New Economy than Peoria, Illinois. And any such advantage is temporary. Therefore, communities must obtain more control over their economic

directions and destinies. The task may be difficult, but it is not impossible. Local economic and political decision makers need not surrender their communities' fates to chance, the marketplace, or unsupportive federal policies. Policymakers in local economic development must confront many crucial questions. Can anything meaningful be done to incorporate the unemployed and underemployed into the employment system? Are there enough jobs? Are there enough good jobs? Are there sufficient energy and natural resources to support the local economy? Can a single community tackle the problems of joblessness, homelessness, or climate change by itself? Can a politically and economically divided nation meet its goals of providing for all?

There are, of course, no clear answers to these questions. But it is clear that communities must have a better perspective on the problems affecting the global economy and their consequences for citizens in general and for specific groups. Local economic development and employment creation can be designed more effectively to deal with these problems. Adopting strategies that promote the green economy, foster entrepreneurship and local cultural assets, and substitute locally produced goods and services for those imported into the community as well as for export to the global economy are a few of the possibilities. The central thesis of this book is that locally based economic development and employment generation are more likely to be successful if initiated at the community and local level than elsewhere. Each of the factors influencing the economy has unique manifestations and slightly different causes in each local area. Solutions to community problems will not succeed if they are not targeted to specific groups and linked to the total regional economic system. Although this book is written for a U.S. audience, we are mindful of the growing international audience adopting the same strategies. Previous book editions have been translated into Korean, Arabic, Spanish, Dutch, German, and Russian in whole or in part, with a special edition for India.

Local economies the world over can translate these circumstances into their own settings. We hope that everyone who reads this book, whether in urban or rural areas, and whether in the United States or elsewhere, develops a new concept of how to solve local dilemmas for now and for many years to come.

Community leaders can assess their community's situation and place it in a larger context. Similarly, they can assess affected groups to determine how these will respond to different courses of action. In this way, local solutions can be found for national problems. The next chapter explores the dimensions of national policy that currently serve as a basis for local economic development.

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2

The Influence of National and State Policies on Local Economic Development

The use of national industrial and social policies to stimulate and sustain the economy has a long history in the United States. The Louisiana Purchase in 1803, the later development of the railroads, the creation of the land grant college system after the Civil War, and the Depression-era New Deal were all national policies. They were pursued with vigor, and they used whatever national resources were necessary to obtain the desired economic results. Many of these programs, like the New Deal, were controversial when they were introduced. Nevertheless, stimulating the national economy by using federal government tax, financial, regulatory, and monetary policy is "as American as apple pie."

Though many American economists do not like government intervention to affect the course of national or local economies, the United States has a crazy quilt of de facto or ad hoc industrial policies. The substance of these national policies ranges from farm supports to tax advantages for certain investments. States and cities in the United States have added their own taxes, land subsidies, and similar incentives to national efforts. The net effect is bewildering and sometimes counterproductive. Nevertheless, this collection of perspectives makes up the current national economic policy—or nonpolicy.

Three Approaches to National Economic Policy

Since 1990, three general approaches have dominated the economic development debate. The first approach invokes past traditions with regard to economic planning and advocates nationwide reindustrialization. It seeks to rebuild the nation's industrial stock through a new set of targeted tax incentives and national financing of infrastructure development. This approach also supports deregulation of labor to limit the power of unions to shape industrial actions, especially regarding international trade and firm outsourcing to overseas lower-wage areas. It refocuses economic development programs on rebuilding the nation's economy in the sectors where the nation must remain internationally competitive (Cohen and Zysman, 1987). As part of this approach, the transformation from old to new industrial and commercial activities should be accelerated through federal intervention that would identify "sunrise" industries—those producing new jobs that compete in a global market—as soon as possible and encourage them with appropriate investments and tax incentives (e.g., see Reich, 1991). This approach took on new life as part of the Obama administration's post–Great Recession efforts to strengthen the national economy and its global competitiveness. The administration established the Advanced Manufacturing Partnership of industry, government, and universities to invent and deploy new manufacturing technology, processes, and products. It also set a goal of doubling U.S. exports overall and created the Renewable Energy and Energy Efficiency Export Initiative for increasing U.S. capacity in clean energy manufacturing, exports of renewable energy and energy efficient manufactured goods and services, and reducing waste.

The second approach takes a dim view of incentives and dedicated taxes. It favors less rather than more government involvement in economic development and industry. Those advocating less government claim that the more interventionist groups have essentially made the nation a victim of regulations, special support systems, and inconsistent, often contradictory industrial and commercial policies that restrict trade and make the nation less competitive. Instead, they support a move to a fundamentally free market. In the American market economy, the best can and will survive, and the nation will be better served. It's important to understand, however, that if all regulations, support systems, and restrictive industrial and commercial policies were removed, firms could operate without consideration for the health and welfare of workers, their communities, or the environment.

Some free market economists would like to see the labor market further deregulated and the minimum wage either abolished or floated like the currency to absorb unemployed groups in the nation. These economists claim

that if wages found their natural level, many more jobs would be available for those genuinely willing and able to work. The George W. Bush administration favored this policy approach in sharp contrast to the Clinton policies, which were more interventionist.

Additionally, the George W. Bush administration favored major tax cuts as a means to stimulate the economy. Many advocates suggest these cuts stimulated spending and investment. Dissenters countered that tax cuts have distorted the gap between the rich and poor and placed a greater burden on the middle class to pay larger shares of the tax burden. Meanwhile, the nation's deficit soared, creating a new burden for future generations. In fact, the third richest man in the world, the American billionaire Warren Buffett, publicly stated his concerns about the inequity of the U.S. tax system in an interview with broadcaster Tom Brokaw:

> The degree to which . . . the taxation system has tilted toward the rich and away from the middle class in the last ten years is . . . dramatic . . . and should be addressed. (Crippen, 2007)

Buffett used his own firm as an example, noting that while he had no tax planning and just paid what the U.S. Congress specified, the total taxes he paid were only 17.7% of his income, while the average for 15 of his office staff was 32.9%. Buffet noted that even his office receptionist paid a higher rate of tax than he did (Crippen, 2007).

Concern over the decline of the middle class has become a major focus of national dialogue. Growing inequality between the top 1% and the other 99% of income distribution has spawned national protests, in particular the Occupy Wall Street movement of 2011 to 2015. The Obama administration's efforts to address the beleaguered middle- and lower-income classes were first confounded by the need to recover from the global financial crisis and second by a gridlocked Congress that has been incapable of working with the executive branch.

A third group of planners and economists suggests that both free market and regulated industrial policy perspectives aiming at firms alone are misconceived. This is because they are based on the long-held but increasingly false premise that what is good for business is good for communities and workers. As Sloan Foundation president Ralph Gomory (2007) observed, the origins of this premise come from Senate testimony by the chair of General Motors in 1953 that what was good for General Motors was good for the country and vice versa. While the premise explains much about why national policies have engendered the growing power of multinational corporations (MNCs), it has become increasingly false with the advent and growth of globalization.

Firms like General Motors found that what was good for them was not to be "good" to a community or even a nation of origin but rather to move their facilities to where production costs were perceived to be lower.

This job-exporting trend of U.S. businesses shows small signs of reversing for three reasons:

1. As a patriotic response to the Great Recession's lingering impacts and concerns over the eroding standing of the United States in the global economy
2. Because labor and material costs have been rising substantially in international competitor economies (e.g., China)
3. Because in advanced manufacturing as well as other key U.S. industry sectors, labor compensation has been stagnant while productivity levels have significantly increased

One of the enduring postwar trends of U.S. capitalism has been increasing industry concentration (see Brock, 2016). Consequently, the firms in these concentrated or oligopolistically organized industry sectors have become so large that if they were to fail, there would be severe impacts on the overall economy. The global recession brought about by failures in the large firms of the U.S. financial sector that, in turn, threatened the auto industry and beyond led to unprecedented moves on the part of the government to stabilize or bail out firms considered too large to fail. This has led to renewed debate over what is the proper role for government intervention in the private sector.

Going forward, while there may be circumstances under which assisting firm expansion is warranted, our fundamental view is that national economic and industrial policy must have a local dimension. Thus, we need national policies that (1) increase community control over corporate investment policies, (2) allow communities a greater role in determining their economic stability and quality of life, and (3) give workers increased control and certainty over their livelihoods.

Because of the increasing impacts of globalization, the means to reach these ends must come from the national, state, and local levels. They include national policies that restrict tax write-offs for nonproductive investments; provide government assistance in local economic development planning, including loans to achieve both ownership and development of industrial space at the community level; and provide worker retraining credits and/or educational incentives as well as more portable retirement and benefits. In essence, each worker could have an employer-supported transportable retirement account outside of social security, to which any employer could contribute and to which the worker could also make contributions. Effective national support for local development should target resources and efforts to create a

more level playing field across state and local jurisdictions so that all participants in the economy have an opportunity to realize their full potential.

States and localities are severely challenged by reductions in revenue and government personnel due to the prolonged effects of the Great Recession. At this time, reassertion of "a real role for the federal government at the community level, ending decades of retreat and delegation of social and economic problems to the states and cities" (O'Connor, 1999) may be welcomed. States and localities need help in maintaining and strengthening all levels of education to maximize their economic development potential. They need help in correcting the long-deferred maintenance of infrastructure (mass transit, highways, railways and bridges, power grids, water and sewer systems) that is critical for economic development.

The Organisation for Economic Co-operation and Development (OECD; 1986) has long advocated that national economic policy must incorporate regional and local economic development in order to both moderate the impact of rapid economic change on firms, localities, and individuals and revitalize local economies and facilitate their adjustment to the transformation of the national economy.

Specific objectives of regional and local economic development should include the following:

- Strengthening the competitive position of regions and localities within regions by developing otherwise underutilized human and natural resource potential
- Realizing opportunities for indigenous economic growth by recognizing the opportunities available for locally produced products and services
- Improving employment levels and long-term career options for local residents
- Increasing the participation of disadvantaged and minority groups in the local economy
- Improving the physical environment as a necessary component of improving the climate for business development and of enhancing the quality of life of residents

Policies to accomplish these aims include sustained investment, medium- and long-term job creation, and the building of local institutions capable of sustaining an area's economic vitality.

Monetary and Tax Policy

In the 1970s, the Federal Reserve Board began promoting a set of economic management approaches based on controlling interest rates. These policies

have led to a relatively high cost of borrowing for the nation's business. They are designed to combat inflation and deal with a high-consumption/low-production economy, which has succeeded for some and failed for others. For new small businesses, these policies have meant that money has been tight. For others, however, the reduction in the inflation rate and the economic stability have increased business confidence and stabilized both wages and prices. Overall, federal policies have achieved the basic mission of controlling rapid economic growth. For several decades, the United States was in good shape compared with its leading international competitors. The nation's economic strength up through 2007 led to strong job growth and created a wave of industrial production. But it did not arrest plant closings or inner-city neighborhood disinvestments. In large measure, the nation's basic industries and weak industrial base could not be restored by fiscal policy alone. Indeed, economist Robert Kuttner (2007) presciently argued that there had been a failed 30-year unnatural experiment in financial deregulation. The goal of the experiment had been the "deliberate dismantling of the mixed economy" (p. 1). Kuttner (2007) observed the following:

> Globalization of capital and commerce makes the project of managed capitalism far more difficult, institutionally and politically. It was the nation state that balanced pure capitalism with regulation and social investment. There is no global government, and financial interests have far more influence than ordinary citizens in transnational rule-setting bodies such as the World Trade Organization and the International Monetary Fund. "Free trade" versus "protectionism" is not a helpful distinction. The real issue is *laissez faire* versus a mixed, balanced economy. (p. 1)

The continuing weakness in the global economy post–Great Recession has recently eroded the demand for U.S. goods and services abroad ($2.2 trillion in 2015), while the U.S. demand for foreign goods and services continues to exceed exports ($2.7 trillion). Thus, the United States has one of the world's largest trade deficits: approximately $540 billion in 2015 (U.S. Bureau of Economic Analysis, 2016). The reason for this is simply that many foreign goods remain relatively cheap and superior in quality compared with domestic counterparts. Monetary policy alone will not address this situation. The global recession has made it even more imperative that management in the United States become sensitive to customers' demands both here and abroad in order to compete successfully.

Tax policy has always been a major component of economic development policy. Federal taxes are sophisticated instruments designed to steer private

investment capital. Tax write-offs and loopholes are the primary motivators for short-term investments. Numerous targeted tax credits in the new technologies have been implemented in recent years and have stimulated some good and many poor investments. A prime example of the benefits of this strategy has been strong support by Congress for the development of the Internet without tax interference or government controls or regulations.

More recently, a bevy of tax incentives were put in place for the Gulf Coast areas devastated in 2005 and 2006 by hurricanes Katrina and Rita. These GO Zone tax incentives, as they are known, along with other incentives, provided more than 50% tax credits through rapid depreciation allowances in areas devastated by the hurricanes. But even these measures did not fully bring back customers, and the Gulf region economy appears to be permanently smaller.

Foreign investments have long been a source of pretax dollars. The United States has embarked on a set of new policies designed to find better ways to tax foreigners so that they pay their fair share. These tax policies, combined with a slow market, may positively influence capital flows to the United States.

Whatever the direction in which capital moves, communities must help businesses by planning carefully and aggressively to assist new firms, to rebuild old ones, and to meet the needs of firms seeking new markets or developing new products. In other words, capital has to be captured—it will not necessarily seek investment.

Trade Policy

As noted previously, the United States continues to experience one of the worst balances of payments (incoming goods versus outgoing goods) in the history of the nation. At one time, the demand for U.S. products was so great that we could scarcely keep pace with it. At that time, we were champions of free trade. The general belief was that the best producers could and would maintain their markets and that tariff protection served only to protect weak industries and underpinned weak economies. The North American Free Trade Agreement (NAFTA; enacted in 1994) provided a new platform for the United States in international trade competition. NAFTA supporters argued that increased free trade would eventually bring more jobs to both the United States and Mexico, although in the short term there would be dramatic alterations in the location of employment centers and wage rates in both of these countries.

However, with rising global competition, U.S. goods have not penetrated foreign markets to the degree expected. Further, the trade policies of the European Common Market, Japan, and other major trading partners are not as open as those of the U.S. market. Until 2007, the U.S. dollar, as the world

currency, was maintained at such artificially high levels that it was difficult for U.S. manufacturers to compete in overseas marketplaces. However, the significant fall in the dollar that occurred in 2007—and that has caused concern among nations that peg their currency to the U.S. dollar—has resulted in greater exports for the United States. Further, while it would be expected that imports become more expensive, the degree to which they have done so appears to have been held down by foreign countries trying to maintain U.S. markets (Andrews, 2007b). At the same time, U.S. labor unions, farmers, and even some businesses call for the protection of American firms from unfair international competition. Sometimes this is a retaliatory move against the other country's own import quotas and duties on U.S. goods, as in the case of Japan or China. In other instances, the desire for higher tariffs is a response from an inferior competitive position. Unions and some communities view high tariffs and import quotas as the only mechanism for saving jobs. While some see a protectionist approach as shortsighted, others see it as an important current remedy for workers and firms, as well as for the members of Congress who represent the communities that are being adversely affected in the global economy. A companion policy to the creation of shelters for domestic industry is the creation of export subsidies for agriculture. The rationale for this is that U.S. agriculture is in global competition with more heavily subsidized farmers in Europe, Australia, and Asia. The General Agreement on Tariffs and Trade (GATT) accord on agriculture was almost killed by very highly subsidized French farmers. Whether or not the subsidy arguments have an economic rationale, they are politically volatile. Congress has yielded to protectionist sentiments by creating large export subsidies for agriculture.

A substantial body of recent research indicates that the most heavily protected manufacturing firms have been the least competitive internationally. Clearly, the use of tariff protection and subsidies will mean some short-term improvement in various communities. As Ohlsson (1984) noted, however, "It is well established in economic literature that tariffs or quotas are not the best policies to achieve goals related to national or sectoral production and employment . . . [and] are even less preferable for achieving regional employment goals" (p. 14).

For these reasons, some economists contend that protection-oriented trade policies cannot discriminate sufficiently to protect a nation's competitive enterprises from less productive firms still in existence due to tariffs. Furthermore, tariff protection as a leading economic policy merely locks dying, uncompetitive firms and industries into certain regions, which only undermines long-term economic viability by discouraging community-initiated diversification into more competitive sectors of the national and international economy. Enhanced domestic policies at the national and local

level to foster innovation, thereby creating new industries and jobs, are one of the strongest defenses against increased global competition.

Welfare to Workfare Policy

The literature on social welfare has generally been critical of both the goal and the result of this program. Some opponents of welfare have suggested that welfare itself created the underclass. Certainly, poverty has not decreased under the welfare policies of the past several decades—indeed, it has increased. In 1961, more than 65% of African Americans below the poverty line were engaged in some form of work. Moreover, most were in intact family situations despite their poverty. By 1971, only 31% of African Americans below the poverty line were engaged in any form of legitimate employment. Most of the African Americans below the poverty line were in irregular family situations and rapidly drifting toward underclass status. By 1985, the total central city population living in poverty reached 20.9 million—almost double the 1970 poverty population (Goldsmith and Blakely, 1992).

National welfare policy was always intended to be temporary. Its evolution into a permanent feature of American life surprised and confounded policymakers and social workers. Welfare recipients increasingly did not move into employment. Many of the nation's welfare recipients grew up in welfare-supported homes (Gottschalk, 2001).

The general public, including many poor people, came to view welfare in contempt and recipients as principally lazy and licentious persons (Gottschalk, 2001). This loss of public sympathy combined with a shrinking employment structure has led national and state policymakers to experiment with welfare, combined with education and work, as a path to employment. A number of schemes were put into effect with the aim of introducing welfare recipients into the work world, some focusing on the prevention or correction of bad work habits that contributed to "unemployability."

Workfare, as this approach is called, aims at requiring welfare recipients to increase their employable skills in exchange for public assistance. This can involve nonprofit agencies employing welfare-eligible people to work in community-serving enterprises. The agency receives the welfare payment plus a premium to provide social services and in turn places the welfare-eligible person on the payroll of a regular but highly subsidized job. It can also involve profit-making firms' hiring welfare-eligible workers at subsidized rates while they develop their skills and work habits.

The results of these approaches have been mixed. Nevertheless, they constitute an alternative to being locked into the underclass. As economic

development policy tools, they offer the potential to increase human capital in the urban population, thereby making it more possible for urban areas to attract or retain an economic base.

Health Care Policy

For some time, fewer and fewer of the new jobs being created have provided any health benefits. The percentage of the population under 65 years of age with no health insurance coverage was more than 18% in 2010 (DeNavas-Walt, Proctor, and Smith, 2011). More than 85% of this group was in the prime working age group of 18 to 44 years.

One health crisis has become enough to send many families into economic shock. Employee health coverage diminished both because of the costs and because health policies and practices like managed care decreased the number and quality of health care providers. Health maintenance organizations (HMOs), originally thought to be the salvation of the American worker, turned out not to be as capable of meeting the diverse health needs of the nation as presumed. Many HMOs have been consolidated, and others have gone out of business. While the health status of the poor has long made them unacceptable risks for many insurers, even middle-class families and self-employed individuals are now finding themselves blacklisted from reasonably priced private insurance just for taking cholesterol-lowering medicine (Consumer Reports, 2007). Thus, a strong attachment to the labor force was no guarantee of access to quality health insurance and care. This was the backdrop of the Patient Protection and Affordable Care Act, or Affordable Care Act (ACA), enacted under the Obama administration. It was a controversial act that many states have challenged because of objections to its mandates.

Passage of President Obama's 2010 ACA expanded public and private insurance coverage in the United States by requiring insurance companies to cover all applicants with minimum standards and provide the same rates irrespective of preexisting conditions. The health care overhaul requires individuals without employer-sponsored insurance, Medicare, or Medicaid to purchase a policy or face penalties. These individuals can purchase policies through a competitive marketplace exchange. Low-income people and families between 100% and 400% of the poverty level receive proportionately scaled federal subsidies for policies acquired through the exchange. While the original ACA also expanded Medicaid eligibility to ensure coverage for those below 100% of the poverty level, the Supreme Court ruled the expansion optional for states, and at the end of 2015, there were 19 states

that had not expanded Medicaid eligibility. This left millions of the nation's poorest lacking insurance, preventing them from accessing either Medicaid or subsidies for marketplace coverage.

The ACA employer mandate requires all companies with 50 or more full-time employees to offer minimum standard coverage. Walmart, the largest employer in the United States, was previously labeled stingy due to the high cost and minimal coverage of the health care it offered to its employees. In 2007, less than half of its 1.4 million U.S. employees were insured. Responding to national- and local-level pressures, Walmart started providing better benefits for full- and part-time workers and endorsed the ACA employer mandate in 2009 (Barbaro and Abelson, 2007; Stolberg, 2009). In response to the employer mandate requirements and rising coverage costs, however, Walmart ended coverage in 2015 for all employees working fewer than 30 hours a week. This impacts about 30,000 employees, or 2% of the company's workforce (Layne and Cavale, 2014).

In reality, over 90% of businesses are considered small businesses under the ACA. Thus, only a small number of businesses are legally required to provide health insurance. In an effort to increase worker coverage, the ACA also included provisions to offer incentives to small businesses for providing employee health benefits through its Small Business Health Options Program.

Since passage of the ACA, wide disparities remain in private health care coverage across racial and ethnic lines. Table 2.1 shows that in 2013, 72% and 68% of Whites and Asians, respectively, had employment-based or direct purchase private health care, compared to less than half for Blacks

Table 2.1 Type of Health Insurance Coverage by Race and Ethnicity: 2013

Race/ Ethnicity	% Any Health Insurance	% Private Health Insurance	% Gvmt Health Insurance	% Uninsured
White	90.2	72.1	32.5	9.8
Black	84.1	49.6	43.8	15.9
Asian	85.5	68.1	25.8	14.5
Hispanic	75.7	45.6	36.4	24.3

Source: U.S. Census Bureau (2014).

Note: Private insurance includes employment-based and direct purchase. Government insurance includes Medicare, Medicaid, TRICARE, CHAMPVA, and other Veterans Affairs care.

and Hispanics. The passage of the ACA was highly controversial, and there have been delays in implementation of key provisions that would lessen coverage disparities.

There have been significant efforts by states as well as the business sector to undo the ACA, citing its harm to the economy. However, the United States is the only advanced industrialized nation not to have universal health care (UHC). Some of the nations—whose economic and standard of living advances we rank highly—have long had UHC (year in parentheses is when UHC began): Canada (1966), Finland (1972), Germany (1941), Japan (1938), Singapore (1993), South Korea (1988), Switzerland (1994), and the United Kingdom (1948) New York State Department of Health (2016).

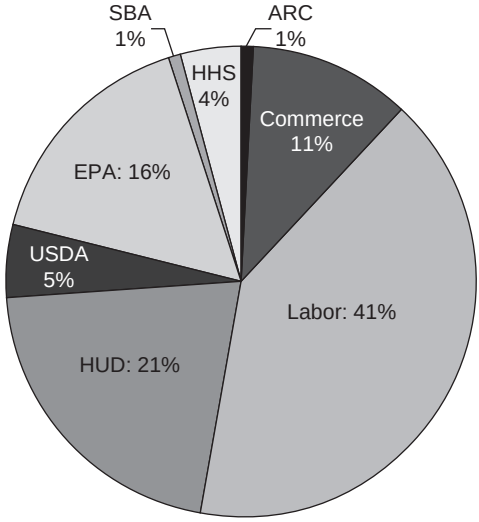
Employment Policy

Through much of the 1960s, employment and training plans were designed to improve the employability of the "hard-core" unemployed, or to improve the ability of certain areas of the country or segments of the population to enter the job market. The problem was perceived as a deficiency of skills in an abundant job market. Training would and could solve the skills dilemma. This was only partially true at the time the program was conceived. Discrimination, lack of social skills, and poor aggregate job formation in lagging regions of the country or inner-city areas were key factors preventing entrance into the job market. Nevertheless, the investments in human capital formation were appropriate for the time.

By contrast, the introduction of the Comprehensive Employment and Training Act (CETA) during the Nixon administration initiated a new wave of employment policies driven by economic development. It was recognized that training programs could not solve unemployment problems because there were not enough jobs—and clearly not enough "good" jobs. As a result, training had only marginal impacts on the very poor. Therefore, employment planners became concerned with increasing the number of jobs above the poverty line that would pay decent wages and offer some form of benefits. The CETA program and its successor, the Jobs Training Partnership Act, built expressly on the notion that investments in the workforce must be matched by investments in job creation and retention. More recent policies to reduce unemployment and retrain workers for new enterprises, such as the Workforce Investment Act (WIA) and Clinton's jobs programs, have continued this emphasis.

However, the "jobs crisis" today shows a clear spatial distribution inequity that presents difficulties for national policymakers: Depressed rural

Figure 2.1 Economic Development Funding by Major Federal Agency, FY 2014



Commerce	Department of Commerce
Labor	Department of Labor
HUD	Department of Housing and Urban Development
USDA	Department of Agriculture
EPA	Environmental Protection Agency
SBA	Small Business Administration
HHS	Department of Health and Human Services
ARC	Appalachian Regional Commission

Sources: U.S. Government Printing Office; Congressional Research Service; Department of Commerce Budget in Brief; Department of Labor; U.S. Environmental Protection Agency (EPA); Appalachian Regional Commission. (See Appendix 2.1 for full listing of sources.)

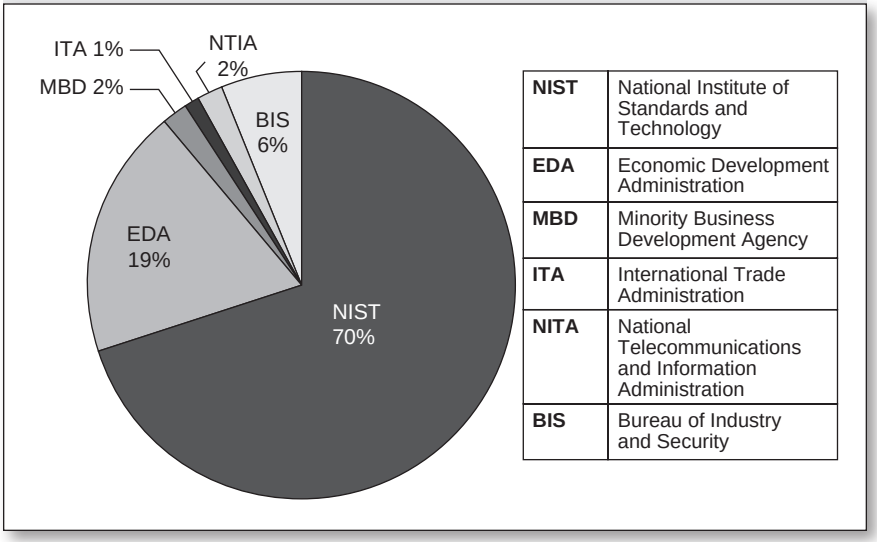
Note: Excluded is funding of the business loans within the Small Business Administration (SBA).

farms, factory towns, and inner cities and inner-ring suburbs with abandoned industrial sites are in sharp contrast to affluent, predominantly White suburbs and gentrifying city centers with strong employment rates. Macroeconomic solutions are inadequate to address these disparities. Thus, the need for federal policy to be coordinated with local development efforts has increasingly been recognized (see Figures 2.1 and 2.2).

National Policy Targeting Local Economic Development

The national government has always played a role in local economic development planning, though the level of its engagement has varied over time. The federal influence can stem from legislation, policies, or programs for which federal budget expenditures are made. However, *explicit* economic development activities where economic development is the principal focus constitute

Figure 2.2 Funding of Economic Development in the Department of Commerce, FY 2014



Sources: U.S. Government Printing Office; Congressional Research Service; Department of Commerce Budget in Brief; Department of Labor; EPA; Appalachian Regional Commission. (See Appendix 2.1 for full listing of sources.)

a very small percentage of total federal expenditures (less than 1% in 2014).[1] This suggests a low level of engagement, but there are other federal programs and policies that strongly impact economic development. For example, the U.S. government pursues key science and technology initiatives such as the National Nanotechnology Initiative Strategic Plan (see www.nano.gov). In response to the Great Recession, the federal government increased substantially its investment in economic development for a period of time through the 2009 American Recovery and Reinvestment Act (ARRA).

The U.S. Economic Development Administration (EDA), located within the Department of Commerce, is charged with leading the federal economic development agenda to promote innovation and competitiveness as well as to prepare regions for growth and success in the global economy. EDA has numerous memoranda of agreement with other bureaus within the Department of Commerce as well as other federal agencies, most of which are shown in Figures 2.1 and 2.2 and Appendix 2.1, to leverage its economic development initiatives. As can be seen in Appendix 2.1, there is wide array of activities that receive economic development funding, and they take place in every type of location, including Indian reservations, rural areas, inner cities, downtowns, and suburbs.

Although national economic policy is important, it is limited in its ability to meet the twin needs of economic sectoral adjustments and regional or local employment requirements. Many federal economic stimulators are designed to facilitate overall economic growth rather than to address specific population groups or localities. To stimulate employment growth, national policies must improve the ability of firms to compete and increase the capacity of communities to create employment.

This requires more regionally and locally targeted economic development strategies. Development policies for lagging areas were the cornerstone of President Roosevelt's New Deal program to bring the country out of the Depression. The development of the Tennessee Valley Authority (TVA), Rural Electrification Administration (REA), Cooperative Extension, and a plethora of other programs aimed at underdeveloped rural areas were essential vehicles for modernizing the rural economy. A key regional focus of President Johnson's War on Poverty was Appalachia. Presidents Kennedy and Johnson also focused on inner cities to stimulate internal development of urban neighborhoods and central business districts hard hit by the development of the suburbs. The federal government enticed many local governments to embark on a set of social and economic development experiments in an attempt to aid communities and individuals who were not benefiting from economic expansion. Neighborhood and central-city revitalization was proposed through the Model Cities Program, along with a new urban focus for the EDA, which had previously served a rural constituency. Urban renewal activities, as well as other government programs, provided local governments with the first impetus to plan for the local economy in a systematic way.

During the Reagan–Bush era (1980–1992), however, many economic development programs to assist localities with physical improvements or industrial support were reduced or eliminated. In the 1970s, for example, the federal government had poured nearly $60 billion a year into urban aid projects ranging from community revitalization projects to schools and job training. It spent more than $5 billion on public service job training alone (Ferguson and Dickens, 1999). These funds almost disappeared in the 1980s, and as a result, the hope and spirit associated with urban recovery seemed to fade as well.

But in the 1990s, local economic development—particularly of urban communities—once again moved to the forefront of national policy. There was a dawning realization that the economic success of cities and suburbs were linked, which, in turn, meant addressing the problems of the inner cities (Rusk, 1993). Over the previous decade, urban economists had painted a grim picture of what could happen to the national economy if the human and economic resources of the cities remained untapped. Finally, the message was heard—not just in cities but in the suburbs as well. Civic leaders in

cities and suburbs began to see across their borders that they had a common economic agenda. Furthermore, it became more generally recognized that the economic and social problems of both the cities and the suburbs threatened the country's ability to invest in productive enterprise. As a result, the national administration was free for the first time in three decades to call for regional and metropolitan redevelopment. When the Clinton administration took office in 1992, it found allies for a national metropolitan policy among state governors of both parties. Henry Cisneros, secretary of the U.S. Department of Housing and Urban Development (HUD), began to fashion a new agenda for urban America aimed at rebuilding community with social capital–forming citizens at its core.

The idea was to create economically and socially integrated communities as the backbone of the national economy. The White House and Congress worked together to build physical and human capital through programs of various loosely linked federal agencies, such as programs to end housing discrimination in lending; establish urban Empowerment Zones (EZs); increase aid to inner-city schools; and offer tax credits for jobs, housing, and economic development (HUD, 2000). More recently, federal programs attempt to build human capital into new enterprise formation: investing in new businesses start-ups in low-income communities rather than trying to persuade firms to move into those communities. This approach is designed to rebuild communities and the local skill base by combining the establishment of enterprise zones with welfare reforms, rebuilding of inner-city infrastructure, and school improvements. For example, the Labor Department has introduced a variety of demonstration programs targeting youth employment that are aimed at linking job formation with skill building and new enterprise creation. Some of these programs show young people how to start businesses; others have strong mentorship components, connecting large and small firms with local schools to work more directly.

The George W. Bush administration, like the Clinton administration, pushed for ending housing discrimination in lending, increasing aid to inner-city schools as well as offering tax credits for jobs, housing, and economic development. Policies endorsed by President Bush had a place-organizational emphasis, but they were less concerned with increasing social welfare supports than with using market forces and community institutions like churches to revitalize communities and strengthen their social structure.

The George W. Bush administration was particularly proactive in promoting brownfield redevelopment activity through market-based activity. While the EPA is the lead agency for brownfield redevelopment, other federal agencies—in particular, HUD—have been active as well. The role of the EPA began with its 1995 Brownfield Action Agenda that included brownfield

pilot grants to communities; clarification of liability issues for brownfield property owners; partnerships between federal, state, and local agencies to promote brownfield redevelopment; and job development and training for brownfield remediation. Its proactive stance was significantly enhanced with the Small Business Liability Relief and Brownfields Revitalization Act in 2002. HUD administers the Brownfield Economic Development Initiative (BEDI) to promote the return of brownfields to productive economic use. It provides financial assistance to public entities in the redevelopment of brownfields. The Brownfields National Partnership Action Agenda, begun in 1997, brings together more than 20 federal agencies to address brownfield cleanup and redevelopment issues in a more coordinated approach and to link environmental protection with economic development and community revitalization.

The Obama administration's economic platform (2008–2012), responding first to the downward spiral that the nation found itself in due to the Great Recession, had to focus on strengthening the social safety net and the market simultaneously. After saving the U.S. auto and banking industries from collapse, its economic platform has been focused on job creation, reform and fiscal responsibility, and increasing security for the middle class. ARRA created a number of supports for urban communities. Among these were Neighborhood Stabilization Program funds, increased spending for disadvantaged school systems, and broadband access to underserved areas. In particular, the administration's policy reflects a "new metropolitan reality—that strong cities are the building blocks of strong regions, which in turn, are essential for a strong America" (The White House, 2012).

The Obama administration is particularly focused on boosting manufacturing, energy production, and entrepreneurship for job creation. It is focused on regulatory, health care, and tax reform as well as deficit reduction and eliminating federal government waste. While these areas are practically an automatic focus of each administration, their explicit tie to middle-class security is unique. For example, the administration linked the reform of the financial industry to a law that created the Consumer Financial Protection Bureau to protect consumers and homeowners from exploitive mortgage and payday lending practices.[2] President Obama also passed comprehensive health insurance reform that allows adult children to stay on their parents' health care plans until they are 26, prevents coverage denial for preexisting conditions, and provides tax credits to small business, among other provisions.

National policy can have unintended and negative consequences for economic development. In fact, the need for federal action to spur brownfield redevelopment stemmed from an unintended consequence of the 1980 passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This act was the federal government's attempt to address the environmental contamination that was the legacy of more than a century of

industrial and commercial activity. Its initial intent was to promote cleanup of contaminated land and to provide opportunities for EPA to recover cleanup costs from all potentially responsible parties (PRPs), including past and present property owners as well as lending institutions. However, it had the effect of steering potential investors and developers away from previously developed properties for fear of becoming liable for the contamination on brownfield sites. The subsequent federal brownfield initiatives have been aimed at eliminating this unintended consequence as well as providing market stimulation.

Two recent issues are also demonstrative of the unintended consequences that national-level decisions can have for local economic development. The first was the Supreme Court case *Kelo v. City of New London*, which was about the taking of private property by eminent domain for local economic development purposes. The second was the Federal Reserve Bank's focus, during the George W. Bush administration, on increasing home ownership as a means for improving economic opportunity. Traditionally, the power of eminent domain—the right of the government to take ownership of private property for a "public purpose" without the owner's consent—has been limited to the specific needs of public infrastructure development (i.e., utilities, highways, railroads). The city of New London sought to use the power of eminent domain to acquire the property of Julie Kelo and several private owners who did not want to sell for a redevelopment initiative that would put these properties into other private parties' hands. Kelo sued, and the case went all the way to the Supreme Court. In the June 2005 *Kelo v. City of New London* decision, the Supreme Court expanded the definition of "public purpose" to include economic development considerations, thereby giving New London permission to condemn Kelo's and others' properties and transfer them to another private party. There was a significant outcry over the decision at the state and local levels throughout the country. Within 2 years of the court's decision, in an effort to make sure it could not happen in their location, 35 states had enacted reform and the voting public in 10 states had passed ballot measures limiting or prohibiting the use of eminent domain or regulatory takings for economic development purposes (Shigley, 2007). *Regulatory taking* refers to land for which the use has been so heavily regulated that it effectively becomes a form of eminent domain. The intent of much of the property rights backlash to the *Kelo* decision was to limit the use of eminent domain as an economic development tool to areas of blight. Further, the definition of what constitutes a blighted area was narrowed in many states.

Key economic development organizations around the country have tried to stop the backlash against using eminent domain for economic development purposes. For example, the International Economic Development Council (IEDC) argued that judicious use of eminent domain was critical to local economic growth and development: Its use to assemble land helps to

revitalize local economies, create much-needed jobs, and generate city revenues. The council argued that, "[If] eminent domain for economic development is prohibited, one person could veto the redevelopment of an *entire distressed community*. This would have the practical effect of making such projects *virtually impossible*" (IEDC, n.d.).

The subprime mortgage lending crisis that began in 2007 created economic shocks throughout the economy (and affected foreign countries, which have been large investors in the U.S. mortgage market). By the end of 2008, it was clear that the economy had entered into the most severe downturn since the Great Depression: It was in a "Great Recession" from which recovery has been very slow.

The subprime crisis has its roots in the Federal Reserve and the George W. Bush administration placing a high priority on "promoting 'financial innovation' and what President Bush has called the 'ownership society'" (Andrews, 2007a). In essence, the traditional criteria for mortgage lending were significantly loosened (e.g., requiring a down payment). The subprime lending was focused on individuals with weak credit who are most often found among the poor. Aggressive financial institutions targeted minority communities. Subprime lenders offered adjustable rate mortgages (ARMs). Borrowers were qualified for the loans based on their initial low teaser interest rates rather than the significantly higher rates that they would have to subsequently pay and that many had no realistic chance of meeting. Mortgage delinquency rates, as well as foreclosures, rose dramatically in 2007, and lenders and home builders have gone into bankruptcy. Dan Immergluck, a national expert on the housing market, observed that the federal role in promoting the subprime crisis, which disproportionately affected minority communities, stemmed in part from a lack of enforcement of the Community Reinvestment Act (CRA) and fair lending laws (personal communication, 2007). Further, foreclosures affect not only the homeowner but also the surrounding neighborhood and community. For example, Immergluck and Smith's (2006) research found that a foreclosure on a home lowered the price of other nearby single-family homes, on average, by 0.9%. They also reported that the downward pressure on housing prices extended to houses that sold within 2 years of the foreclosure. Further, this negative impact was cumulative—that is, each additional foreclosure on the block lowered values an additional 0.9%. The impact was even higher in lower-income neighborhoods, where each foreclosure dropped home values by an average of 1.44%.

Large portions of cities were affected by the subprime mortgage crisis, to the extent that some entire cities were in crisis (see Economic Developments 2.1). The crisis did not just affect inner cities in older areas throughout the nation; it also affected fast-growth suburban areas, particularly in places like California with high levels of minority population.

ECONOMIC DEVELOPMENTS 2.1
Crisis and Response: Lasting Effects of the Great Recession*

In 2008, the city of Cleveland filed a lawsuit against 21 of the country's largest financial institutions, including Citigroup, Bank of America, Wells Fargo, and Merrill Lynch. The city sued them for hundreds of millions of dollars in damages from "knowingly plunging the city into a financial crisis by flooding the local housing market with subprime mortgage loans to people who could never repay" (Maag, 2008).

Cleveland's economy was severely affected by the Great Recession. There were more than 7,500 foreclosures in 2007, and entire blocks became vacant with houses falling into disrepair. The city could neither afford to maintain the abandoned properties nor address the rising rates of violent crime, drug dealing, and arson. Officials attributed the "widespread abandonment of homes" and neighborhood deterioration to the Wall Street bankers' careless behavior and hoped that the lawsuits would be a successful means of winning back resources to rebuild the city (Maag, 2008). Rather than target the original lenders that handed out subprime mortgage loans in Cleveland, many of which had gone out of business, the lawsuit went after the larger firms that knowingly profited from bad credit loans, first by approving the loans and then grouping them into securities that would be divided into shares and sold on the stock exchange (Maag, 2008).

After a 2-year costly litigation, the U.S. Sixth Court of Appeals supported the district court's decision that Cleveland could not recover funding, as the connection between the bankers' risky behavior and the city's foreclosure crisis was insufficiently direct. Senior Judge Richard Suhrheinrich argued that Cleveland's high rate of foreclosures could have been due to other factors, "including home buyers themselves choosing to enter into subprime mortgages" (Stempel, 2010). The judge argued that instead of a citywide lawsuit, a claim from a particular neighborhood might more effectively prove the connection between individual foreclosures and unfair bank practices.

In February 2012, the U.S. Justice Department and 49 state attorneys general reached a $25 billion settlement in a joint federal–state lawsuit against the five biggest lenders involved in the subprime mortgage crisis, including (1) Ally, (2) Citigroup, (3) Bank of America, (4) JP Morgan Chase, and (5) Wells Fargo. Though most of the settlement money went to individual borrowers, several billion dollars were dedicated to anti-blight activities in cities or regions left with high numbers of abandoned, vacant properties. Cuyahoga County, where Cleveland is located, still had 22,000 vacant homes in 2014. Two million dollars of the settlement went to the North Coventry neighborhood, the location of which is split between East Cleveland and Cleveland Heights. This money has been combined with other community funding sources to tear down vacant and dilapidated houses. The properties are being acquired and rehabilitated by the Cuyahoga Land Bank, which, in turn, increases the neighborhood's home values and potential for redevelopment (Sandrick, 2015).

(Continued)

(Continued)

Funding and revitalization programs are critical for addressing the uneven housing recovery of lower-income neighborhoods relative to that of middle- and upper-income neighborhoods. There has been a much stronger recovery in housing prices in wealthier communities, often returning close to what they had been before the Great Recession. As of March 2015, in wealthier neighborhoods with homes valued above $200,000, only 6% remained underwater, meaning those homeowners owe more than their houses are worth. In contrast, in neighborhoods with homes valued at less than $200,000, the underwater rate was 15%, or two and a half times greater. Even when homeowners remain current on loans for underwater homes, risk-averse banks frequently deny their applications for refinancing that would lower interest rates and strengthen financial circumstances. Owners who cannot refinance tend to invest less in their homes, further driving down neighborhood property values and increasing foreclosures. With more vacant properties, housing values further decline, leading to more foreclosures. Low-wage workers during the recovery have experienced very little income growth, making it even more difficult to break out of this vicious cycle (Light, 2015).

Not unrelated to income trends just discussed, African American neighborhoods that were disproportionately targeted for underwritten subprime mortgages have had weaker recovery rates than those of majority White neighborhoods. In Cleveland, east side neighborhoods with the highest percentages of at-risk loans (ARMS and high-cost mortgages) and, consequently, the highest foreclosure rates, were also the neighborhoods with the highest African American populations (Dillman, 2010). Now that banks apply more stringent mortgage regulations, they have reduced the number of loans to Black borrowers by 50%, compared to a 31% reduction to White borrowers (Raymond, Wang, and Immergluck, 2015). Since banks are less willing to lend to lower-income Blacks, demand for homes and investment in minority neighborhoods has declined, resulting in more vacant and derelict homes and greater decline in home values.

Income and racial disparities have been exacerbated by the uneven economic recovery. These disparities intensify the need for cities to incorporate a strong focus on equity in their local economic development strategies.

*Research assistance provided by Ashley Bozarth.

Coordination of Local and National Development Efforts

Communities across the nation develop their own industrial and broader economic development policies using various approaches. If a national policy—for example, one to promote advanced manufacturing or to increase exports—is adopted at the national level, it will have little effect unless there

is companion policy at the local level to take advantage of available federal resources as well as to muster local resources.

In general, almost all federal *development* efforts have had a brick-and-mortar orientation. The role of the federal government in stimulating economic development in the poorest regions has been to provide the physical conditions and infrastructure to induce development rather than direct intervention in the private sector (except for the War on Poverty). Some marginal interventions have been companions to these physical programs, like the location of military facilities and government offices.

Both the federal government and local officials have tacitly agreed that federal government should remain in the background, using its money but not its muscle to bring about economic change. But now federal funds available for local use are diminishing, and although local officials have more need for federal assistance, less is forthcoming. For example, military base closures have affected hundreds of communities over the years. As a result of smaller budgets, local and state governments are hard pressed both to meet social commitments to the unemployed and to stimulate development. The liberal use of economic incentives has to be reconsidered given shrinking state and local government revenues.

The federal government's response to the need to curtail the growth of public programs and subsidies has been to reduce the red tape and strings attached to its funding as a means of increasing positive impacts. Essentially, the national government has given local officials more authority to deal with the fewer resources they receive for their locality. This gives many local residents the impression that local policymakers have more discretion over federal funds and more options to cure local problems. But the simple truth is that there are more problems than there is money. Local officials have to use the funds they have as investments in the future, not as temporary aids to meet current emergencies. This is why local economic development is both necessary and difficult.

The federal government's response to the needs of communities and individuals has been and will continue to be under significant revision since the War on Poverty era. But whatever the federal government response, communities faced with plant closures and other business failures, high unemployment, labor skills shortages, environmental degradation and climate change impacts, growing inequality, and public assistance burdens simply cannot afford to risk a laissez-faire approach to their own destiny.

State Economic Development Approaches

Although the national government has been somewhat reluctant to develop active economic development policies, our federalist system gives states great powers to do so. Almost every state in the union has an explicit or at least a

discernible implicit economic development policy. State policies range from a statewide tax or incentive plan to more complicated programs that provide targeted incentives for specific industries. In fact, the states offer a bewildering array of policies. For example, several states have abolished certain taxes as implicit development incentives. Some, like Oregon, have no state sales tax; others, like Texas and Florida, have no income tax. Nevada has almost no taxes on residents and builds its state budgets on tourism and hotels, along with gambling revenues. This policy has induced a number of durable goods and transportation firms to relocate from California to Nevada.

Most states have a state development plan and a state economic development office. In some states, the economic development office is in the same location as the governor's office. In many other states, it is a major state department with responsibility for recruiting businesses, as well as creating and retaining jobs in the state. State economic development offices do everything from coordinating other state agencies to promoting the state via glossy brochures and a long list of incentives. Bradshaw and Blakely's (1999) study of state economic development policies and programs found that those concentrating on business retention, human skill development, and infrastructure building showed the best overall economic development results (see Table 2.2).

Table 2.2 Characteristics of Innovative State Economic Development Programs

Leadership
• Emphasis by governor on economic development • Business "welcome" events • Business councils, industrial associations • Worker compensation and tort reform • Environmental ombudspersons • Lotteries • Building community capacity to do attraction and retention
Information
• Technical assistance and standards • University outreach programs • Electronic bulletin boards • Site information • Partnerships to do planning and promotion
Brokering
• Permit one-stop shops • Coordination of economic development with other programs (e.g., housing) • Interstate regional cooperation • Marketing

Source: Bradshaw and Blakely (1999, p. 241).

Phases of Economic Development

There has been an increasing array of services and inducements offered by states as well as sophistication of state policy and program tools for promoting economic development. In general, the evolution of these tools follows the pattern of what can be seen as five waves of economic development practice at the state and local levels (see Fitzgerald and Leigh, 2002). The transition from business attraction to broader perspectives on economic development is a predominant theme of the descriptions of these phases (Bradshaw and Blakely, 1999; Fitzgerald and Leigh, 2002). The phases are both chronological and overlapping—that is, while their emergence may be associated with a particular point in time, the predominant practices associated with each have not disappeared. Instead, state and local economic development agencies typically engage in practices from more than one of the phases.

The first phase, that of industrial recruitment, began in the 1930s. Economic development practice was concentrated on creating a good business climate through tax abatements, loan packages, infrastructure, and land development. While its beginning is often associated with the post-Depression period, in reality the southern states were actively recruiting industry from the end of the Civil War onward (e.g., see McMath, 1991). This phase was informed by two theoretical perspectives: a regional and community development perspective drawing on international development theory and an industrial location perspective drawing from firm behavior theory. Both perspectives sought to identify the causes of regional growth and development and how local efforts can alter this path. Further, economic development potential was seen to be predicated on the local area's export base. The directing of public funds to private-sector firms to influence their location in this phase marked the beginning of what later came to be labeled "corporate welfare" (Bartlett and Steele, 1998).

After World War II, southern states with declining agricultural bases were particularly aggressive in using inducements to attract manufacturing plants to their low-wage and low-union environments. Millions of jobs moved into southern states due to these strategies. Ultimately, virtually all states were competing for jobs that were moving around the country, professional industrial relocation agencies were established in all major cities, and incentives became expected costs of obtaining a factory for any of the many regional industrial parks that were being established with federal funds. Not surprisingly, this strategy was termed *smokestack chasing*.

Civic leaders viewed the industrial attraction concept and methods positively during the long wave of economic growth because there were generally enough new firms and growth for all communities to share. Though

spirited competition existed among different localities, the general view was that the economy was dynamic enough to accommodate any reasonable bidder.

However, as growth subsided and as most states became involved in business attraction, the price of the incentives needed to induce a plant skyrocketed, and businesses learned to play one location against another to extract more costly incentive packages. The National Governors Association became concerned that states were losing money and gaining few new jobs from this reckless activity. Moreover, existing businesses saw that their out-of-state competitors were receiving benefits that placed older, loyal, local firms at a distinct disadvantage compared with the newcomers.

The second phase was characterized by political critiques of local economic development practices that began in the late 1960s and were spurred by factors such as manufacturing decline and failure of urban redevelopment efforts. Economic development analysis shifted its focus from implementation of various techniques and strategies to identifying the participants in the economic development process and their motives as well as the beneficiaries of the process. Political economist Molotch's (1976) classic article "The City as a Growth Machine" argued economic development activity was led by landholding elites interested in increasing the value of their property. He argued that job creation, one of the main justifications of local economic development practice, was not increased by the activities of economic development practitioners; instead, jobs were merely transferred between locations. By the late 1970s, rising global competition along with a stagnant world economy led some to dismiss business attraction efforts as smokestack chasing of footloose industry that did not provide the jobs and wealth creation promised. The interests of cities and states, and the businesses within them, were not mutual: Cities and states sought stability of employment and tax base, while firms sought mobility to produce in the place of lowest costs or highest profits. Approaches in the second phase retained a component of business attraction but added strategies to retain and expand existing businesses and incubate new enterprises. The tools of the second phase included offering incentives to businesses that were losing their competitive edge and providing expansion loans and grants to firms with new markets that could expand locally or globally, such as firms in new technologies. They also included the establishment of small business units to assist small business formation and growth.

Two more strategies, both in reaction to the failure of the first two traditional strategies, were introduced in the third phase of local economic development. First, the entrepreneurial strategy represented a shift from supply-side industrial attraction to developing new business and

industry, particularly in sectors perceived to be high tech. Other entrepreneurial strategies included international trade promotion, venture capital funds, and small business development (Eisinger, 1995). More recently, creative class attraction and development schemes (Florida, 2002) can be seen to be an extension of the entrepreneurial strategy. Second, the equity strategy emerged in the late 1970s and early 1980s to confront growing issues of inequality. It advocates place-based strategies that focus on issues of equity and redistribution. It also expands the notion of who participates in local economic development decision making to include neighborhood organizations, civic groups, and labor unions, and it introduces new ways of examining old problems (i.e., identifying race and gender implications).

The third-phase programs that emerged in the 1990s focus on using regional resources to support the growth of specified industrial clusters of related firms as well as providing new emphasis on building local capacity through education and training of the local workforce.[3] They attempt to link technology, human resources, and capital in such a way as to give networked firms a global competitive advantage. These programs are based on the recognition that the skill of the labor force is essential to the ability of new-economy firms to compete, so they strengthen the links between schools and colleges and industry—for example, by establishing specialized certificate programs. They also emphasize local participation in industrial associations, collaborative product-testing facilities, and the like. Third-phase programs, unlike their predecessors, offer few direct investments or gifts to businesses. Instead, they help businesses to finance expansions and respond to technological change by a variety of funding options that involve access to credit or low-cost lending. Rather than simply assuming that communities will benefit from individual firm decisions, current programs attempt to create the context in which locational advantages and industrial bases can be used to the advantage of the region.

Numerous states have now developed third-wave initiatives based on increasing the real competitive advantages of the state in national and international terms. As Fosler (1991) noted, they are interested in "achieving high levels of productivity and competitiveness that increase income and provide a high standard of living and quality of life for all residents. . . . They are concerned with the ways in which workers and businesses interact in networks and clusters" (p. 5). To this end, states on an international border, such as Texas and Washington, are even creating cross-border economic development strategies. Many states now have international offices to coordinate goods, services, and people exchanges as a bridge to long-term economic partnerships across international cultural boundaries.

Bradshaw and Blakely (1999) found that the most progressive states (e.g., Washington, Nevada, and Florida) had designed well-thought-out plans that included the active participation of state stakeholders, including nonprofits, community groups, and business. That is, economic development policy had moved beyond the sole province of the private sector. State officials recognized that important actors like schools and churches had to be included in any attempt to rebuild a civic agenda that would induce new business and keep existing firms. State strategies, like California's, have built on successful public–private collaborations, such as the joint venture Silicon Valley. This recognition complements the widening of professional focus during the third phase to confront issues of socioeconomic inequality and to become advocates for those passed over in the development process. The introduction of equity planning into economic development necessitated a different set of questions in creating and evaluating economic development strategies and particularly focuses on who benefits and who pays in the development process. As Fitzgerald and Leigh (2002) observed, "In addition to expanding participation in the planning process, equity planning introduces new ways of examining old problems such as identifying the race and gender implications of economic development strategies and programs" (p. 17). They went on to note that equity planners still represent only a minority voice in economic development practice.

The fourth phase can be characterized as sustainable economic development. Economic development was called on to be environmentally sensitive and responsible to the equity criterion of the third phase. Campbell (1996) argued that economic development planning was required "to 'grow' the economy, distribute this growth fairly, and in the process not degrade the ecosystem" (p. 297). Jepson and Haines (2003) interpreted sustainable economic development to be that which emphasized self-sufficiency over an export-based economy and development over growth. Newby (1999) argued that sustainable local economic development (SLED) should be the vehicle by which to achieve sustainable improvements in quality of life. She observed that it is too often "assumed that what is 'good for the economy' is automatically good for society." Further, how economic development is implemented has profound positive or negative impacts on society and the environment. Consequently, the practice of SLED considers the entire range of economic development and regeneration options available, appraises their individual impacts, and prioritizes "those approaches that yield social, economic and environmental benefits together, rather than one benefit at the expense of another" (p. 68).

The fifth phase of economic development, beginning in the 1990s, was originally characterized by two approaches: the first relying on market solutions and the second promoting metropolitan or regional strategies. Porter's

(1998) work on competitive advantage has been highly influential in this stage. Economic developers are called on to identify unmet demand, provide government facilitation and financing, and encourage public–private partnerships for minority firms and market developments. In recognition of the negative consequences of urban sprawl and associated traffic congestion on local economies, economic developers and other development officials have been taking steps to revitalize obsolete or underperforming areas. The approaches first pursued in major metropolitan areas have diffused to smaller metro regions and even small towns as the high auto and truck dependency of U.S. local economies of all sizes has resulted in pervasive sprawl. The market emphasis of this stage can be seen as akin to the viewpoint Newby (1999) critiques in this quote: "What is good for the economy is good for society." Without explicit commitment to larger sustainability principles, the phase has the potential to yield unintended consequences such as new gentrification trends whereby the higher-income residents of a region are returning to enjoy newly revitalized downtowns and urban life, and the poor are displaced to declining suburbs that lack necessary support systems and public transportation needed to give them access to the economy. While the spatial focus of this phase is regional or local, states have played a significant role in fostering its implementation.

As was noted at the outset of this section, the five phases that have been described are overlapping. We can continue to observe the dominant characteristic of each phase in economic development practice today. The continued implementation of strategies associated with different phases rests on the explicit or implicit definition of local economic development held by the practitioner and the economic development.

Challenges and Opportunities Inherent in Economic Development Policy Making

To implement strategies appropriate to economic development, states will need, more than ever, to strengthen ties with policymakers in specific regions and localities within their purview. Simultaneously, community policymakers taking up the challenges of local economic development will be well served if they maintain a broad, realistic view of their available alternatives. To implement the most effective, most integrated policies, whether state or local, almost all U.S. communities will have to come to terms with the following:

- Economic development will be much less about a community having lower costs of production than about a high quality of life and

community assets that attract and retain knowledge-intensive and innovative firms and their workers. This means that communities must provide for quality housing and neighborhoods, educational systems, mobility, health, and cultural facilities.

- Attracting new manufacturing firms continues to fade as a viable strategy for communities seeking to increase local employment opportunities. However, communities should recognize that existing manufacturers may continue to be competitive and sources of good jobs. Further, there may be opportunities not only for the development of small- and medium-sized advanced manufacturers but also for the birth of artisanal manufacturing and 3-D manufacturing activity. Furthermore, communities and regions need to become directly involved in cultivating firms from the advanced information and service sectors mentioned earlier, or from other areas of activity, as their new base employers. Communities must look to human capital as the critical engine for economic development. Job creation is now based on talent pools that create new economic activity rather than competing to move existing firms around the nation or the world.
- American communities could once rely exclusively on their regional and national market positions to determine local economic stability, but this is no longer the case. Today, a global economic system predominates. In many instances, as in the cases of Los Angeles, New York, San Francisco, and Miami, regional ties to the international economy are more significant than their ties to the domestic economy. Numerous programs are showing that because of the major changes in the international economy—rather than in spite of them—local communities can pursue development policies that complement national economic objectives. Clearly, larger metropolitan export-oriented economies can take advantage of international development options more readily than can smaller rural communities. Nonetheless, it is important that every community pursue economic policies that enhance or facilitate local industries with international potential and that meet the employment needs of all community residents.
- Communities based on a single industry (such as agriculture or mining) or a few major employers will be more vulnerable than those with a more diverse economic base. As a result, communities with narrow or declining economic bases will have to develop more sophisticated economic strategies to remain economically and socially desirable places.
- All American communities have increased pressure to develop programs that deal with adult long-term unemployment. In addition, new (young) entrants to the labor market, particularly teenagers, will have

location-specific employment problems related to job access as well as to undereducation and undertraining. Poor job access can be due to inadequate transportation; lack of informal information networks that connect people in all communities to new opportunities; or lack of knowledge regarding positions created with unfamiliar names and opaque skills requirements in new, small, fast-growing firms—or, as is increasingly the case, a mismatch between jobs and the social attributes and language skills of the job seekers.

- Comparative geographic or transportation advantage is no longer determined solely by the availability of natural resources. Increasingly, location per se, as that term relates to proximity to markets, natural resources, or transportation, is less important in today's economic circumstances than the availability of specialized technology-oriented infrastructures, such as research facilities, higher education services, high-quality up-to-date telecommunications, and special financial assistance to accommodate business start-ups or expansions. The quality of support services in a locality directly determines the potential for new economic activity. Thus, irrespective of their geographic location, localities may be able to construct alternative economic futures by carefully assessing and achieving the best match between their physical, natural, and human resources.
- As the first decades of the 21st century make clear, local economies and major portions of state economies can be devastated by acts of terrorism or nature. Economic Developments 2.2 recounts the economic costs of several recent natural disasters. The extent to which communities can recover their economic development positions and move forward will depend on how well they anticipate and prepare for disasters. Resiliency planning should be seen as a fundamental component of long-term economic development policy and planning.

Conclusion

From the national government point of view, the rationale for state and local economic development policies is to bring about a more equitable distribution of development and to take advantage of the enormous capacity of localities to promote and sustain the development process. The underlying assumption is that local economic adjustment is a vital component of facilitating sustained national economic performance.

In our evolving economy, economic development at the local level is set within the context of national and international forces that inevitably affect local economies and create local economic development

ECONOMIC DEVELOPMENTS 2.2
Natural Disasters' Impacts on Economic Development*

The 2007 Georgia drought has repeatedly been called one of the most severe in the state's recorded history. Even before the drought intensified in the fall, the University of Georgia Center for Agribusiness and Economic Development estimated $787 million in agricultural losses alone (estimate as of July 2007). The landscaping industry's early estimated financial losses were $1.2 billion, and the industry's estimated job losses were around 12,000. Not included in these early estimates are the recreational establishments, hardware stores, feed stores, and others that depend on rain and the health of Georgia's Lake Lanier. It will be years before the state's sizable forestry industry can estimate its losses due to drought-induced slowed growth or premature death of trees, or economists can comprehensively determine the drought's secondary economic impacts to farm equipment and supply dealers and retailers, and others that agricultural businesses (and their employees) regularly utilize. The economic losses incurred were a major factor in Georgia drafting its first Comprehensive Statewide Water Management Planning Act, despite calls for such a plan for many years. Key economic development and industry representatives in the state were involved in drafting the plan.

The year 2007 also marked one of the most devastating and costly series of wildfires in California. In October 2007, a series of 23 fires ravaged Southern California, with San Diego County's "Witch Fire" being the most significantly destructive. Seven deaths have been attributed to the fires, and early estimates are that the fires' economic impact will be well above $1 billion when all insurance, job, and income losses as well as other measurable losses are considered. Some estimate the impact in San Diego County alone will be $1 billion. California's farm and tourism industries experienced unrecoverable losses, government budgets were stretched by the necessary emergency services expenses and infrastructure cleanup in the aftermath, and homeowners will experience as of yet unknown losses in property values and increased insurance rates. Early estimates from the state's Labor Market Information Division were that the fires directly impacted 3,135 businesses, 41,394 jobs, and $512 million in wages. Add to that the as-of-yet-unknown estimate of losses in sales, and the direct impact to businesses and wage earners was significant.

The 2007 Georgia drought and California wildfires—projected to be the "most costly" drought and fire events in U.S. history—follow just 2 years after what has been determined to be the most expensive natural disaster in U.S. history: the 2005 ravaging of the Gulf Coast by Hurricane Katrina. The U.S. Department of Commerce National Climatic Data Center reports that Hurricane Katrina's preliminary cost estimate was $125 billion as of March 2007. Much of the comparatively high cost can be attributed to the foreseeable break in New Orleans' levee system, which caused significant flooding, deaths (approximately 1,833), and devastating economic losses to the city of New Orleans.

These increasingly costly natural disasters raise the question of what factors are within local economic development professionals' control to curtail the cost of these events to people, businesses, and governments. Could the costs of Georgia's drought have been less severe—or even avoidable—if state governments had previously negotiated a more favorable water sharing agreement? Would the losses in Southern California have been measurably less if land-use patterns had been more sensitive to potential wildfire patterns? And few, if any, can argue that New Orleans' losses would have been much less if the city's levees had originally been built to sustain the impact of a Category 5 hurricane. Pre-Katrina, engineers agreed that the levees would break and water would flood New Orleans should a hurricane of that magnitude hit the city. All levels of government failed to address this known threat to the city in time to save it from Katrina. The Katrina disaster can be said to have catalyzed a movement of resiliency planning, which will be discussed later in this book. The federal government has played a key role in helping communities become better prepared for such disasters.

*Original research provided by Dana King.

opportunities as well as challenges. Globalization provides significant benefits to local firms in terms of expanded markets, production efficiency, and sources of innovation and personal talent. But it also means that local companies are players in a global economy whether or not they want to be and as such are influenced by a wider array of forces outside their control than ever before.

From an economic development perspective, localities cannot control what happens in the global economic system and neither can their state government or even the federal government. However, this does not mean that local economies must simply be victims of unknown forces. Communities need to learn about the external economic forces shaping them and work to position themselves to take advantage of opportunities and to avoid external threats. They must be entrepreneurial in seizing opportunities, cutting losses, investing in strategic programs, and leveraging their assets to compete in the New Economy. No matter what actions they take, local communities will have to stretch current resources and find ways to increase public and private productivity.

Local communities cannot expect to succeed in the global economy either by looking for handouts, whether from the federal government or from corporate saviors, or by working independently. First, they must know the rules of federal economic development policy and understand how trade policy, money, labor, and technology are affecting the industries that are of central

importance to them. They must also identify what their assets are and mobilize them to respond to the changes occurring in the global economy without waiting for a federal program to assist them. If such a program or funding source exists, by all means the local community should take advantage of it, but that should be a supplement to the local initiative and not the whole package. Moreover, now that businesses are so mobile, big businesses and industries are not the core resource for local economic development that they once were. Thus, a broader strategy to increase employment is needed than just the attraction of large firms. Businesses and other resources flow toward communities that are successful and away from communities that are declining. But even the most destitute community has resources that can be leveraged to start business growth, and this will then attract other resources that are needed.

Second, communities in the global economy cannot work alone. This counters all the old wisdom about how communities are in competition with each other for a limited number of factories moving around, so that it is either your community or another that gets the factory. In an economy characterized by knowledge resources, specialization, and rapid change, local communities rarely can compete by themselves for an edge in the development process. Development is likely to come not in the form of a factory but in the form of a set of interrelated firms. Employees are drawn from a wide region, and specialized services in the area benefit several firms. Training facilities, transportation, information, and marketing in the area give local firms additional advantages. Thus, a network of communities joined by an effective collaboration to provide collective economic development resources will be more attractive than any single community by itself. Consequently, while national policy sets the context for successful local economic development, communities prosper by replacing competition with collaboration.

Appendix 2.1 Economic Development Funding by Major Federal Agencies (*in millions of dollars*)*

AGENCY Bureau Program	FY 2007	FY 2010	FY 2014	2007–2014 7-Year Change	2010–2014 4-Year Change	Purpose
COMMERCE[1]						
National Institute of Standards and Technology						
Hollings Manufacturing Extension Partnership[2]	104.6	125	153	47%	22%	Access to technologies, resources, and industry experts
Advanced Manufacturing Technology Consortia			21	N/A	N/A	Grants and research and development (R&D) funding for critical long-term industrial research needs
National Network for Manufacturing Innovation			1,000	N/A	N/A	Mandatory appropriations to strengthen U.S. manufacturing sector
Economic Development Administration						
Public Works	177	149	133	–25%	–11%	Support for "asset poor" communities for development of basic public assets
Trade Adjustment Assistance	13	17	8	–39%	–53%	Direct technical assistance to firms negatively impacted by global trade
Economic Adjustment Assistance	51	44	60	18%	36%	Technical assistance and investments of critical infrastructure

(Continued)

Appendix 2.1 (Continued)

AGENCY Bureau Program	FY 2007	FY 2010	FY 2014	2007–2014 7-Year Change	2010–2014 4-Year Change	Purpose
Creation of Investing in Manufacturing Communities Fund			113	N/A	N/A	Competitive grants to communities with strategies to attract global manufacturers
Regional Export Challenge			12	N/A	N/A	Competitive grants to sectors in regions with greatest export potential
Minority Business Development Agency						
Minority Business Development	29	31	28	3%	–10%	Funding to centers that provide MBEs with business assistance services
International Trade Administration[3]						
Interagency Trade Enforcement Center			7.3	N/A	N/A	Outreach to workers and businesses for reduction of foreign trade barriers
Select USA			7	N/A	N/A	Aid to state and local governments to attract foreign direct investment
National Telecommunications and Information Administration						
Broadband Programs Oversight of Broadband Technology Opportunities Program			24	N/A	N/A	Supply of broadband services in underserved areas with funding from American Recovery and Reinvestment Act (ARRA)
Spectrum Management/ Pilot Programs	7	8	7	0%	–13%	Research for sharing spectrum within geographical proximity

Bureau of Industry and Security	81	105	104	28%	–1%	Administration and enforcement of controls on the export of sensitive goods and technologies
LABOR[4]						
Employment and Training Administration						
Workforce Innovation Fund			51	N/A	N/A	Employment and training services
Adult Employment and Training Activities	864	862	766	–11%	–11%	Services for low-income adults to increase their occupational skills
Youth Activities	943	994	898	–5%	–10%	Services for low-income youth to prepare them for employment and post-secondary education
Dislocated Worker Employment and Training Activities	1,377	1,452	1,227	–11%	–16%	Employment and training services for recently laid-off or formerly self-employed workers and displaced homemakers
Indian and Native American Programs	55	53	47	–15%	–11%	Employment and training for Native Americans, Alaskan Natives, and Native Hawaiians
Migrants and Seasonal Farmworkers	80	87	82	3%	–5%	Job training and stable, year-round employment assistance
YouthBuild[5]		102.5	77.5	N/A	–24%	Workforce development program that provides significant skills training and leadership development to youth

(Continued)

Appendix 2.1 (Continued)

AGENCY Bureau Program	FY 2007	FY 2010	FY 2014	2007–2014 7-Year Change	2010–2014 4-Year Change	Purpose
Reintegration of Ex-Offenders	74	96	76	3%	–21%	High-wage industry job training for ex-offenders and at-risk youth
Job Training for Employment in High Growth Industries	111	248	124.5	12%	–50%	Workforce training based on current need in sectors of the economy
Job Corps	1,608	1,713	1,984	23%	16%	Career technical training and education programs for youth
Community Service Employment for Older Americans	484	820	440	–9%	–46%	Employment placement and work-based training for unemployed, low-income individuals, ages 55 and older
Trade Adjustment Assistance Community College and Career Training			464	N/A	N/A	Competitive grants to higher education institutions to improve education and employment outcomes for students
HOUSING AND URBAN DEVELOPMENT[6]						
Community Development Fund						
Community Development Block Grant (CDBG)	3,559	3,872	3,154	–11%	–19%	1,200 annual grants for states and local governments to support community and development
Indian Community Development Program	62	66	59	–5%	–11%	Grants to provide Indian and Native Alaskan Communities with economic opportunities

Brownfields Redevelopment	5	6	N/A	N/A	N/A	Cleanup and development of contaminated sites
Rural Housing and Economic Development	16	16	2	–88%	–88%	Funding for innovative approaches to serve rural housing/economic needs
AGRICULTURE[7]						
Rural Development						
Rural Cooperative Development Grants	5	11	9	8%	–18%	Funding for cooperative development centers that serve disadvantaged groups
Rural Economic Development Grants	10	13	12	2%	–8%	Funding for project feasibility studies, start-up costs, and incubator projects to foster rural development
Rural Microenterprise Investment Program Account Grants		7	3	N/A	–57%	Funding to provide skills and assistance to microentrepreneurs to establish and maintain rural microenterprises
Rural Economic Development Loan Programs Account	28	14	7	–75%	–50%	Loans to electric and telecommunication firms to finance rural development projects within their service areas
Rural Energy for America Program Grants		86	12	N/A	–86%	Grants to farmers, ranchers, and small businesses to purchase renewable energy systems and improve energy efficiency

(Continued)

Appendix 2.1 (Continued)

AGENCY Bureau Program	FY 2007	FY 2010	FY 2014	2007–2014 7-Year Change	2010–2014 4-Year Change	Purpose
High Energy Cost Grants	20	18	10	–50%	–44%	Funding to construct or upgrade energy generation or distribution facilities for areas with above average energy expenditures
Rural Waste and Water Disposal Program Account		1,262	678	N/A	–46%	Funding for water and waste disposal, emergency community water assistance, and solid waste management grants
U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)[8]						
Capitalization Grants for Clean Water State Revolving Funds	687.6	2,100	1,448.9	111%	–31%	Partnership between states, tribes, and federal government to provide funds for wastewater treatment facility construction
Capitalization Grants for Drinking Water State Revolving Fund	841.5	1,387	907	8%	–35%	Partnership between states, tribes, and federal government to provide funds for construction of drinking water facilities
Brownfields Projects	89.1	100	90	1%	–10%	Funding for research and technical assistance grants, for job training, and for assessment and cleanup cooperative agreements

SMALL BUSINESS ADMINISTRATION (SBA)[9]						
Entrepreneurial Development Programs						
7(j) Management Technical Assistance		3.4	2.8	N/A	–18%	Training, executive education, and one-on-one consulting to small businesses in underserved regions
Boots to Business			7	N/A	N/A	Entrepreneurial education program offered as part of the Department of Defense Transition Assistance Program (TAP)
Entrepreneurship Education			5	N/A	N/A	Training and counseling services that provide entrepreneurial information and resources for small businesses
Growth Accelerators Fund Competition			2.5	N/A	N/A	Grants for start-ups to expand and become more commercially viable
Historically Underutilized Business Zones (HUBZone) Program		2.2	2.3	N/A	5%	Support for small businesses to attain preferential access to federal procurement opportunities
Microloan Technical Assistance		22	20	N/A	–9%	Loans up to $50,000 to help small businesses and not-for-profit child care centers to start up and expand
Native American Outreach		1.3	2	N/A	54%	One-on-one counseling, training workshops, and management and technical guidance for Native American firms

(Continued)

Appendix 2.1 (Continued)

AGENCY Bureau Program	FY 2007	FY 2010	FY 2014	2007–2014 7-Year Change	2010–2014 4-Year Change	Purpose
Program for Investment in Micro-Entrepreneurs (PRIME) Technical Assistance		8	3.5	N/A	–56%	Training and education funds for low-income entrepreneurs to gain access to capital and expand their small businesses
Regional Innovation Centers			5	N/A	N/A	Regional economic collaboration between small businesses and public sector
SCORE, "Counselors to America's Small Business"	4.9	7	7	43%	0%	Volunteer business counseling services for aspiring entrepreneurs and business owners
Small Business Development Centers (SBDCs)	89	113	113.6	28%	1%	Funding and support for entrepreneurship and small business growth
State Trade and Export Promotion (STEP)			8	N/A	N/A	Grants to states to increase small business exports
Veterans Business Outreach Centers (VBOCs)		2.5	2.5	N/A	0%	Entrepreneurial development services for veterans who are current or future small business owners
Women's Business Centers (WBCs)	12.3	14	14	14%	0%	Management and technical assistance to enable and empower female entrepreneurs

HEALTH AND HUMAN SERVICES[10]						
Community Services Block Grants	630	700	667	6%	–5%	Funding to alleviate causes and conditions of poverty in communities
Rural Community Facilities	7	10	6	14%	–40%	Loan and grant program to develop facilities that provide essential services
Tribal Works Program	8	8	8	0%	0%	Funding to design welfare programs
Center for Faith Based and Community Initiatives	1	1	1	0%	0%	Partnerships to serve individuals, families, and communities in need
APPALACHIAN REGIONAL COMMISSION[11]						
	64.8	76	80.3	24%	–6%	Partnership for sustainable community and economic development in Appalachia

Note: In 2009, President Barack Obama signed into law the American Recovery and Reinvestment Act (ARRA), a federal stimulus package in response to the Great Recession. The cost of the package, approximately $830 billion, increased federal spending in education, health care, energy, unemployment service and benefits, tax relief, and social welfare services. ARRA accounts for the higher spending in 2010 compared to 2014 across many economic development programs.

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Notes

1. This was calculated by dividing the total expenditures in Appendix 2.1 ($15.264 billion) by the total federal expenditures for FY2014 of $3,506 billion.

2. The Consumer Financial Protection Bureau (2012) has defined these loans as follows:

> Payday loans are typically marketed to bridge a cash flow shortage between pay or benefits checks. They generally have three features: (1) the loans are small dollar amounts; (2) borrowers must repay the loan quickly; and (3) they require that a borrower give lenders access to repayment through a claim on the borrower's deposit account. Most loans are for several hundred dollars and have finance charges of $15 or $20 for each $100 borrowed. For the 2-week term typical of a payday loan, these fees equate to an annual percentage rate ranging from 391% to 521%.

3. See Blakely (2001) for a full discussion of these relations.

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3

Concepts and Theory of Local Economic Development

The predominant definition that has undergirded traditional economic development practice is increasingly recognized as insufficient. Even in the most prosperous economies, time and again it has been shown that the major economic development problems cannot be solved using this definition. Indeed, the legacies of this definition are global warming and growing inequality. These two trends are at the forefront of contemporary U.S. concerns precisely because inadequate attention has been paid to the distributional aspects and environmental impacts of economic growth in the past.

Defining *Local Economic Development*

What drives the diffusion of the phases of economic development discussed in Chapter 2 is the definition of economic development upon which they are based. The traditional and most widely referenced definition of *economic development* has long been that of wealth creation. This definition is the driver of the first and second economic development phases exclusively and the entrepreneurial strategy of the third phase. Increasing the tax base and creating jobs are the fundamental objectives of this definition that equates economic development with economic growth (Fitzgerald and Leigh, 2002; Malizia and Feser, 1999). There is nothing wrong with creating wealth and

jobs and increasing the tax base. But it is a great mistake to equate economic growth with economic development. The blind pursuit of economic growth can destroy the foundation for economic development. For example, if an economy's growth is based on an exhaustible natural resource supply (e.g., timber, seafood, coal), then it will eventually come to a halt. The workers will be unemployed, and, without proper attention to the education and skill development of the labor force or to the development of a more diversified industry structure, the community can enter a death spiral. The same scenario applies in the case of one-industry or one-factory towns. Shifts in the global economy or in technology can negate the community's desirability to its sole industry. The industry may move, or its owners may exit the industry and the town, taking their capital with them. These are the simplest of examples, and it should be understood that a town with more than one industry but with a narrow industrial base can be just as vulnerable.

At least in the public and nonprofit sectors, blind pursuit of economic growth simply to create more wealth and jobs needs to be rejected if it is likely to lead to increases in income inequality, irrevocably harm the environment, or worsen the plight of marginalized groups. Economic growth that is based on exploitation of workers with few or no alternative employment options not only is unethical but also may violate fair labor standards and other laws. Growing inequality can ultimately destabilize the economy and society and result in clashes between the haves and have-nots. Such clashes can result in community-destroying violence.

The sources of growing inequality are multiple but often reflect a failure in economic development leadership—for example, a failure to provide a skilled labor force that is attractive to advanced industries, thereby replacing the previous source of good jobs in industries that have declined; or to support entrepreneurs who create new jobs and might even grow into large local firms; or to judiciously provide economic incentives such that their costs do not undermine the ability to maintain quality schools and infrastructure that are foundations of real economic development. Perhaps one day the field of economic development planning will have progressed to the point where it is no longer necessary to state that economic development does not automatically equal economic growth. Nor will the use of the term *development* need to be qualified by *sustainability;* instead, it will be integral to the concept. Likewise, it will not be necessary to say *sustainable* and *equitable*; instead, it will be understood that the two terms have significant areas of mutuality. But for the foreseeable future, it will be necessary to do so to counter trends in global warming and growing inequality and to push local economic development practice to create the impetus for the fourth phase—sustainable local economic development (SLED)—to more widely permeate practice.

We offer here a three-part definition of *SLED* that focuses on the desired end state rather than growth-defined objectives:[1]

> Local economic development is achieved when a community's standard of living can be preserved and increased through a process of human and physical development that is based on principles of equity and sustainability.

There are three essential elements in this definition, detailed next:

First, economic development establishes a minimum standard of living for all and increases the standard over time.

Recognition of the need for a minimum standard of living in economic development translates into not just job creation but also job creation that provides *living wages* (earnings for full-time work that are high enough to lift individuals and families out of poverty). A rising standard of living is associated with consumption of better goods and services and quality housing as well as increasing the number of households receiving paid health care plans, being able to save for retirement, and being able to provide vocational or collegiate education for their children.

Second, economic development reduces inequality.

While the "economic development as economic growth" approach can mean that there is more wealth and assets, it does not try to ensure that everyone benefits from the additions to the economy. Consequently, certain groups and certain places not only are left behind but also can have a harder time securing the standard of living they once knew because economic growth has driven up the costs of living for all. Thus, economic *development* reduces inequality between demographic groups (age, gender, race, and ethnicity) as well as spatially defined groups such as indigenous populations versus in-migrants, or old-timers versus newcomers. Likewise, it reduces inequality between different kinds of economic and political units (small towns versus large cities, inner city and suburbs, rural and urban areas).

Third, economic development promotes and encourages sustainable resource use and production.

If economic development does not incorporate sustainability goals, then its process can create inequality between the present and future generations. Economic development requires recycling the goods cast off by an increasingly affluent and consumer-oriented society as well as greater controls on

growth to stem greenfield consumption and sprawl proliferation. Rising standards of living that are attained through sustainable resource use and production require different approaches to economic development (increasingly characterized as green development). They also create demand for new kinds of products, markets, jobs, firms, and industries that do not harm the environment and may even help it.

Theories of Growth and Development

Local economic development is an evolving field and, as we contend previously, should be distinguished from economic growth. Most of the body of theory that historically has sought to explain regional or local economic development has not made this distinction. Malizia and Feser's (1999) summary of all the significant economic development theories through the end of the past century is provided in Appendix 3.1. It describes each theory's underlying definition of development, strengths and weaknesses, and applications.

Further, Malizia and Feser (1999) did make a distinction between whether the theories actually focus on growth or development. Unlike the previously given distinction between growth and development, which clearly has normative elements, their distinction was simply descriptive (see Malizia and Feser, 1999, Chapter 11). They categorized growth theories as those that focus on the near-term expansion of the local economy and include, among others, economic base and neoclassical economic theory. Development theories are those that focus on the long-term process of evolutionary and structural change of an economy and include, among others, staple and entrepreneurship theories. But as Malizia and Feser (1999) stated, "Theory offers the underlying principles that explain the relationships we observe and thereby motivates and informs our action" (p. 16). Thus, if we find that growing inequality and global warming are problems that require action, then our theory of economic development will identify the causes of these problems and the principles by which to address them.

In this chapter, we focus on five theoretical strands that are either influential or descriptive of local economic development.[2] We discuss some developments since 2000, as well as the new directions economic development theory will need to take to explicitly incorporate sustainability.

We begin more generally, however, by describing several partial theories that point to the historical underlying rationale of local economic development. The sum of these theories may be expressed as follows:

Local and regional development = $c \times r$, where c equals an area's capacity (economic, social, technological, and political capacity) and r equals its

resources (natural resource availability, location, labor, capital investment, entrepreneurial climate, transport, communication, industrial composition, technology, size, export market, international economic situation, and national and state government spending). A *c* value equaling 1 represents a neutral capacity that neither adds to nor detracts from the resources of a community. A *c* value greater than 1 represents a strong capacity that, when applied to (multiplied by) resources, increases them. Strong organizations that can form effective partnerships to meet the needs of the local economy can multiply resources. And a *c* value less than 1 represents weak community capacity (low-functioning social, political, and organizational leadership), whether due to cronyism, corruption, self-interest, disorganization, or ineptitude that, when applied to resources, decreases them and hampers development.

Resource capacities are measured in many ways, and different theories give preeminence to different resources, including raw materials, infrastructure, government spending and markets, size of markets, access to money, and access to communications.

Theories of economic development have traditionally focused mainly on the *r* part of the equation (resources), neglecting the *c* part (capacity). For example, location theories emphasize the advantages that come from being close to markets. But central cities, though close to markets, are economically lagging because they lack the social and political capacity to take advantage of their geographical advantages. Other theories focus primarily on infrastructure and the need to invest in any number of programs, such as building industrial parks, roads, airports, baseball stadiums, or telecommunications hubs. But these resources, in the absence of fully developed programs to utilize them, do not add to the community capacity: Witness the thousands of rural industrial parks that have failed to attract businesses and remain empty. Thus, any theory of local economic development must consider resources and capacity together.

More community capacity can make up for limited resources in local economic development. A community lagging in the amount and variety of resources must work harder to use the resources available most effectively. Of most obvious benefit for local economic development are natural resources, such as iron ore, coal, forests, water, and agricultural land. However, natural resources are not enough for a strong economy, and they often shape the economy in ways that rely on excessive primary processing, which historically has often been associated with unstable and low-paying jobs. Most strong economies find their advantages in features other than natural resources. Labor, capital, infrastructure, proximity to new technologies, access to trade, federal government spending, and other factors are even more advantageous inputs to economic activity, and local areas

that have ample and easy access to these resources can create better economic opportunities.

However, from a development perspective, resources are often underused, and this is where local capacity comes in. The more varied types of capacity a local community has, the greater its ability to turn resources into development opportunities. For example, communities need an economic development organization (e.g., a business association, chamber of commerce, economic development corporation [EDC], or government agency for economic development) to effectively address the issues and problems of a lagging economy and enhance available resources.

Neoclassical Economic Theory

Neoclassical theory offers two major concepts for regional and local development: (1) *equilibrium* of economic systems and (2) *mobility* of capital. It asserts that all economic systems will reach a natural equilibrium if capital can flow without restriction—that is, capital will flow from high-wage/cost to low-wage/cost areas because the latter offer a higher return on investment (ROI). In local development terms, this would mean that ghettos would draw capital because prices for property and sometimes labor are lower than in the overall market. If the model worked perfectly, then all areas would gradually reach a state of equal status in the economic system. Much of this rationale has underlaid the recent wave of deregulation of banking, airlines, utilities, and similar services. In theory, all areas can compete in a deregulated market.

Neoclassical economic theorists like Nobel Prize winner Milton Friedman oppose any form of government or community regulations on the movement of firms from one area of the nation to another or even to other countries. They also oppose any restrictions on firms, such as those requiring minority or local equity participation, that could make it less advantageous for firms to locate in an area. They suggest that such regulation is doomed to fail and disrupt the normal and necessary movement of capital. Moreover, they argue that there should be no attempts to save dying or uncompetitive firms. Workers who lose their jobs should move to new employment areas as a further stimulus to development in such places.

These theories have been tested both in the United States and abroad. In developing nations, the International Monetary Fund (IMF), which oversees international emergency loans to nations, has required national governments to divest themselves of controls of assets and to reduce market and currency controls. The immediate impacts on these economies have been very severe—though in many instances, like that of Mexico, the national

economy has rebounded and is now making enormous strides. Detractors of IMF policy, for example, point to the increasing gap between the rich and poor in countries with deregulated economies to suggest that the market is not evenhanded in allocating resources and that some government controls and interventions are essential to deal with inequities.

Many regional and local economic development advocates reject neoclassical theories and the policies derived from them. Blair (1995), for example, pointed out that the development promoted by such theories "should not mask the fact that there are often some groups that will benefit from growth more than others" (p. 170). Furthermore, the neoclassical framework is generally viewed as antagonistic to the interests of communities as places with a *raison d'être* beyond their economic utility. Finally, classical models tell us little about the real reasons why some areas are competitive while others fail.

Nevertheless, some useful concepts can be derived from the neoclassical economic theory. First, in a market society, all communities must ensure that they use their resources in a manner that attracts capital. Artificial barriers, low-functioning governmental bureaucracy, and a poor business climate are barriers to economic development. Second, communities or disadvantaged neighborhoods can and should attempt to gain the resources necessary to assist them to reach an equilibrium status with surrounding areas. This can partially be accomplished by upgrading commercial properties through local government loans and grants as well as by offering training and other programs that enhance the value of local labor. These measures can act as inducements to equalize the value of inner-city neighborhoods and other disadvantaged areas with more prosperous places.

Economic Base Theory

Economic base theory proposes that a community's economic growth is directly related to the demand for its goods, services, and products from areas outside its local economic boundaries. The growth of industries that use local resources (including labor and materials) to produce goods and services to be exported elsewhere will generate local wealth and jobs.

The local economic development strategies that emerge from this theory emphasize the priority of aid to and recruitment of businesses that have a national or international market over aid to local service or nonexporting firms. Implementation of this model would include measures that reduce barriers to the establishment of export-based firms in an area, such as tax relief and subsidy of transport facilities and telecommunications or establishment of free trade zones.

Many of the current entrepreneurial and high-tech strategies aimed at attracting or generating new firms draw on economic base models. The rationale is that nonexporting firms or local service-providing businesses will develop automatically to supply export firms or those who work in them. Moreover, it is argued that export industries have higher job multipliers than local service firms. Thus, every job created in an export firm will generate—depending on the sector—several jobs elsewhere in the economy. There are regional economic methods that will test and measure such impacts of firms on the local economy.

It is important to understand that economic base theory is applicable in the short run only because its export sectors and economic structure—its primary focus—change over time. Staple theory is an extension of export base theory that has a long-run view. It seeks to explain a local economy's evolution based on how its export specialization changes over time. The staple of the economy is defined as an internationally marketable commodity (such as a natural resource or agricultural product) that generates related manufacturing activity (to process the staple), which generates supplying industries and attracts outside industries seeking to take advantage of a growing market (Malizia and Feser, 1999).

A key weakness of the economic base model is that it relies on satisfying external rather than internal demands. Thus, it ignores opportunities for import substitution that can provide another means of generating jobs and income in the local economy (and stop the leakage of income outside the economy in the purchase of imports). Overzealous application of the economic base model can lead to a skewed economy almost entirely dependent upon external, global, or national market forces. This model is, however, useful in understanding how a local economy grows or declines from changes in external demand for the goods and services it sells to the outside world. It is also useful for proactive industry sector targeting aimed for achieving economic growth, development, and stability. In Chapter 6, we discuss the methodology for determining the export base of a local economy.

Product Cycle Theory

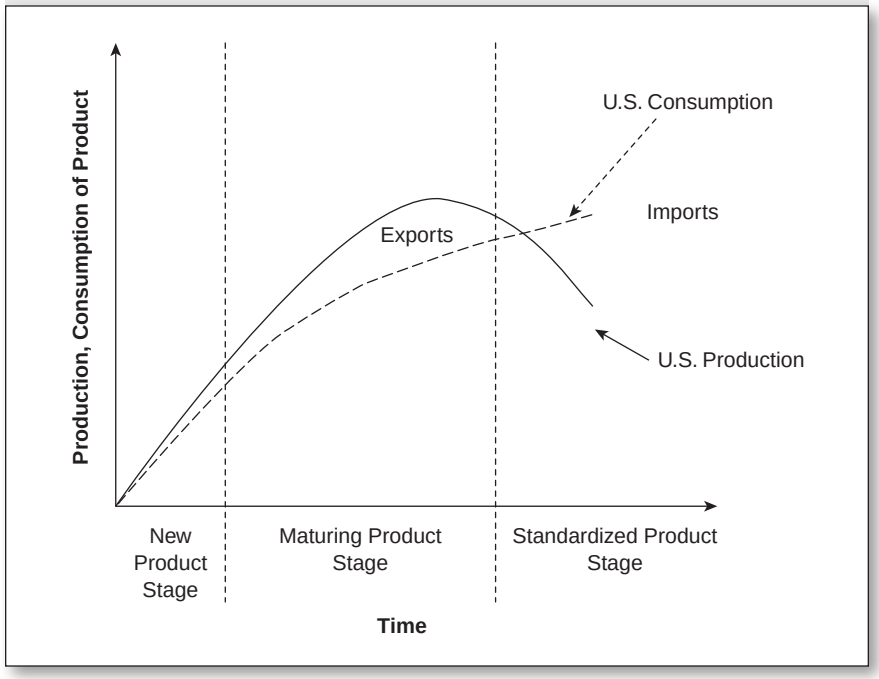
One aspect of economic base theory involves understanding industry product cycles that explain the fate of regions and localities through the innovation and diffusion process. Product cycle theory was first proposed by Raymond Vernon (1966), who showed how product development must take place in areas with greater wealth and capital to invest in the process of inventing and developing new products, supported by local markets that can pay higher prices for products that have not yet become standardized. For example, new

electronic products are likely to find first markets in areas where there are affluent and educated persons, not in areas lacking the income and skills with which to purchase and use these items. Over time, the product becomes standardized, and it enters mass production and markets. Its production process becomes so routine that it no longer needs to be done by specialized labor; thus, there is a decline in the wages and skills (or good jobs) it generates. At that point, production can move to less developed economies, where firms compete not on the basis of unique products but rather on price (Figure 3.1).

Malizia and Feser (1999) described the theory in this way:

> Economic development is defined as the creation of new products and the diffusion of standardized products. Development originates in the more developed region and is exported to the less-developed region through trade and then investment. Establishing a new industry in the less-developed region creates a progressive force that can help eliminate the barriers to interregional equality. Yet product cycle theory does not predict convergence of regional incomes; the development process can be convergent or divergent. (p. 177)

Figure 3.1 The Product Cycle



Source: Adapted from Vernon (1966).

The firms in a region and their prospects are both shaped by their place in the product cycle. Some industries have fast-changing product cycles in which new products are rapidly introduced, whereas other industries are relatively stable. For example, high-tech electronics industries are almost by definition rapidly changing, with diffusion of one product after another to cheap production elsewhere. Other industries are more tightly bound to their central location, and product innovation is not a factor. In investment banking, for example, each decision is so specialized that there is little potential to standardize.

Location Theories

Location theories seek to explain how firms choose their locations; thus, they also provide explanations for how local economies grow (or decline). Firms maximize profits by selecting locations that minimize their costs of production and of transporting goods to market. Early location theory focused on whether the product a firm created gained or lost weight in its production process, thereby either increasing or decreasing the transport costs of the final product relative to the inputs from which it was created. To minimize transport costs, a firm with a final product that weighs less than its inputs will locate at the source of the inputs and ship the final product to market. Such firms are labeled weight losing or input oriented in standard economics, and some classic examples of products they produce are listed in Table 3.1. If the final product created by a firm weighs more than its inputs, then the firm will locate at its markets, transporting the inputs required for production. Such firms are market oriented or weight gaining.

Location theory also considers other factors besides transportation costs that influence a firm's location. With the significant advances in efficiencies in the past three decades in trucking and ocean and air cargo transport, the influence of transportation costs on firms' location decisions has declined significantly. Today, it is more appropriate to think in terms of logistics rather than simply transportation costs. The logistics industry encompasses a range of activities for planning, storing, and controlling the flow of goods, services, and related information from point of origin to point of consumption. This includes not only transportation but also warehouse and distribution activities. Advances in information technology (IT) applications for logistics have played a key role in the development of our global production and market network.

Beyond transportation and logistics, other factors that affect the quality or suitability of a location are labor costs, the cost of energy, availability of suppliers, communications, education and training facilities, local government quality and responsiveness, and waste management. Different firms require differing mixes of these factors to be competitive. Therefore,

Table 3.1 Locational Orientation of Firms

Orientation	Relevant Characteristic	Example
Transport-cost oriented	Transport costs relatively more important	
Input oriented	Inputs weigh more than outputs Inputs bulkier than outputs Inputs more perishable than outputs	Ore refining Steel Fruit canning
Market oriented	Outputs weigh more than inputs Outputs bulkier than inputs Outputs more perishable than inputs	Bottling Auto assembly Baking
Production-cost oriented	Local input costs relatively more important	
Energy	Energy-intensive production	Aluminum
Labor	Labor-intensive production	Textiles
Intermediate inputs		
Specialized inputs	Localization economies of scale	Software
Business services	Urbanization economies of scale	Corporate HQ
Amenity	Weather, recreation, taxes, etc.	R&D, tourism

Source: Bogart, William Thomas, *The Economics of Cities and Suburbs,* 1st edition, © 1998, p. 61. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ.

communities generally attempt to manipulate the cost of several of these factors to become attractive to industrial firms. All of these actions are taken to enhance a location beyond its natural attributes.

In Table 3.2, we also see a reference to localization and urbanization economies of scale. These two concepts are variations of a key concept in the study of urban and regional economics—agglomeration economies—which refers to the cost savings that arise from spatial proximity. In other words, a local or regional economy generates particular production cost savings that a firm would not realize if it were located in an undeveloped area. Localization economies of scale mean that firms benefit from locating near other firms because they may use the same type of labor or inputs, or there is better access to information about competitors, suppliers, new technologies, and so on. Urbanization economies of scale mean that the larger the local

economy (i.e., the bigger the city), the greater the production cost savings and other benefits to the firm. These can derive from access to larger markets, to more specialized services (e.g., industrial designers, advertisers, venture capitalists), or to the transfer of knowledge and technologies between one industry sector and another in the larger economy.

The location of firms in overall economic space has long been of interest to economic developers (Malizia and Feser, 1999). Some of the early theorists who dealt with the issue of location during the 1950s include François Perroux (1983), who described "growth poles"; Gunnar Myrdal (1957), who produced a theory of cumulative causation; and Friedmann and Weaver (1979), who offered a core–periphery model.

Perroux's (1983) growth pole theory hypothesized that growth is stimulated by cutting-edge industries, firms, or other actors who are dominant in their field. Perroux wanted to refute the claim of classical theorists that growth would flow to less costly areas. In fact, the opposite often occurs with "propulsive industries" that have an edge in technology, wealth, and political influence. Perroux argued that these growth poles were linked to other growth poles but not necessarily to the periphery area of the central growth node. This helps explain why not every community in Silicon Valley, like Oakland or East Palo Alto, benefits from rapid economic growth in a nearby fast-growing area.

Myrdal's (1957) theory of cumulative causation sought to explain why some areas are increasingly advantaged while others are disproportionately disadvantaged. Market forces, by their nature, pull capital, skill, and expertise to certain areas. These areas accumulate a large-scale competitive advantage over the rest of the system. Casual observation of the decay of urban neighborhoods demonstrates the basic concept of cumulative causation: The interplay of market forces increases rather than decreases the inequality between areas so that a divergence in regional income is a predictable result. Myrdal (1957) gave the following example of cumulative causation:

> Suppose accidental change occurs in a community, and it is not immediately canceled out in a stream of events; for example a factory employing a large part of the population burns down . . . and cannot be rebuilt economically, at least not at that locality. The immediate effect is that the firm owning it goes out of business and its workers become unemployed. This will decrease income and demand. In its turn, the decreased demand will lower incomes and cause unemployment in all sorts of other businesses in the community which sold to or served the firm and its employees. . . . If there are no exogenous changes, the community will be less tempting for outside businesses and workers who

> had contemplated moving in. As the process gathers momentum, businesses established in the community and workers living there will increasingly find reasons for moving out in order to seek better markets somewhere else. This will again decrease income and demand. (p. 23)

Advanced technology and telecommunications have altered the significance of specific locations for the production and distribution of goods that early location theory sought to explain. Communities of significantly smaller sizes can compete with large cities for certain firms and industries because IT and reduction in transport costs have reduced the significance of distance in location decisions. Less tangible variables, such as the quality of community life, cultural and natural amenities, and reasonable cost of living, can now assume greater weight in the firm's location decision based on the preferences of the owners or the workers required by the firm. Rather than local economic developers being limited by the natural attributes or original features of a location for encouraging firm location, they now have the opportunity to improve the factors in location decisions that have surpassed the importance of minimizing transportation costs or physical proximity to markets for many firms.

Central Place Theory

Central place theory is a variant of location theory that is most applicable to retail activity. According to this theory, each urban center is supported by a series of smaller places that provide resources (industries and raw materials) to the central place, which is more specialized and productive. These smaller places are in turn surrounded by even smaller places that supply and are markets for the larger places. The urban center contains specialized retail stores that serve the entire region; professional specialists such as corporate lawyers, investment bankers, and heart surgeons; and headquarters for corporations as well as nonprofit organizations. When inhabitants of a very small place need a specialized product or service, they must go to the central place, though they can find many less specialized products and services in their own community. For example, residents of a small place do not need to go to the central city for groceries or car repair, though they must leave home to hear a performance by a world-class symphony orchestra.

Regional development models for rural areas have relied heavily on central place theory to guide resource allocations on the assumption that the development of a central place will improve the economic well-being of the entire region. The application of central place theory can be observed in rural service bureaucracies like the Tennessee Valley Authority (TVA), the Rural Electrification Administration (REA), and the U.S. Economic

Development Administration (EDA). Each of these organizations attempted to develop a regional economic plan with one or two communities either designated or emerging as regional nodes for development.

However, as Bradshaw and Blakely (1979) observed three decades ago, rural communities in advanced industrial society are increasingly able to take advantage of specialization that once was limited to urban areas. While lacking some of the advantages that are available in urban settings, such as proximity to other specialists, rural communities are competing for advanced manufacturing, professional services, sophisticated communications, and other types of businesses because people value the rural environment and are willing to use electronic linkages to minimize the disadvantages of being located in a small place. The Internet and the megamall have greatly altered the commercial relations of central and peripheral places. Today, several billion dollars a year are spent by consumers in Internet transactions with both existing retailers and new e-tailers.

Central place theory has relevant applications for both urban and rural local economic development. It is necessary, for example, to differentiate the functions of various neighborhood areas so that they can remain viable centers. Some areas will become regional core cities serving an entire region; others will be smaller villages or towns that serve only the local resident community. Local economic development specialists can assist communities or neighborhoods to develop their functional role in the regional economic place hierarchy and electronic hierarchy.

At the same time, central place theory is unable to explain why, within major market areas, individual neighborhoods can be seriously lacking in retail services. This is particularly the case in low-income and minority neighborhoods and has been the focus of economic development attention since the late 1990s, leading to the development of the "new markets" strategy discussed next.

Translating Theory Into Practice

Economic development theory has influenced practice, as the following sections demonstrate.

Attraction Models

Models of community attraction are based on location theory and employed widely by communities seeking economic development. Communities across the globe have initiated policies and programs to make their

area more attractive to investors, firms, new migrants, entrepreneurs, and others and thereby to gain a competitive advantage over other areas with similar resource endowments.

The basic assumption of attraction models is that a community can alter its market position with industrialists by offering incentives and subsidies. This assumes that new activity will generate taxes and increased economic wealth to replace the initial public and private subsidies. A more cynical view, supported by considerable evidence, is that the cost of such efforts is, in fact, paid by the workers and taxpayers of the community while the benefits go largely to landowners and firms (Bluestone, Harrison, and Baker, 1981). Consequently, inequality can increase.

A new approach in attraction is the change in emphasis from attracting factories to attracting entrepreneurial populations—particularly certain socioeconomic groups—to a community or area. New middle-class young retirees to an area bring both buying power and the capability to attract employers. In addition, recent migrants are more likely to start new firms. As a result, many communities have reassessed their firm attraction efforts and reoriented them toward "people" attraction. This approach has been particularly effective in rural areas where the quality-of-life factor can attract new populations—leading to increased economic growth as a response to both internal demand and new export enterprises created by the new migrants. Furthermore, it has been suggested that some localities can offer special "knowledge networks" to act as incubators for high-tech firms or inventors. These areas are increasingly described as "innovation districts."

In attraction models, communities are products. As such, they must be "packaged" and appropriately displayed. The objective evidence of this packaging can be observed in magazine and newspaper advertisements extolling the virtues of certain places over other communities. Anecdotal evidence suggests that community promotion works and that failure to use it may be a political liability. No city or neighborhood should hide its virtues "under a bushel basket." Some form of marketing is necessary, though the means and the rationale are as important as the desired result in undertaking this mode of development planning, since the ends have not always justified the means in the past. Communities have also learned from the past, and a growing number are adding restrictions or conditions to the public incentives they offer to attract firms. These are intended to recoup the public investment made if the firm does not stay in the community long enough to generate taxes and wages that meet or exceed the investment. The conditions imposed can also specify that the jobs created by the firm go to local residents and pay living wages.

New Markets Model

According to the U.S. Department of Housing and Urban Development (HUD), in the year 2000, America's inner-city neighborhoods possessed an unrealized potential purchasing power of $331 million, or nearly one third of the retail capacity of the nation's urban cities. Rural areas containing new migrants also have large unrealized market potential—for example, the counties that make up the Kentucky highlands in Appalachia are estimated to have more than $1.3 billion in retail purchasing power (Cuomo, 1999). The reason these communities are underserved relates to misperceptions and poor information regarding these markets. Retailers have either left these communities or resisted serving them because of the belief that incomes were too low and crime too high to make such markets valuable. But as the national economy has prospered, crime in these communities has fallen to levels that have not been observed for more than three decades. Further, while inner-city household incomes may be lower than those of the suburbs, the greater population density creates higher foot traffic and strong buying power. Moreover, employment participation in both the inner city and rural areas has increased. Finally, the Internet has equalized opportunities for many rural areas to draw service jobs.

According to Michael Porter (1995), inner-city areas have features that place them in the forefront of the New Economy. Not only do they have proximity to a large downtown area with concentrated activity, making them prime markets for retailing, but also, more importantly, they have proximity to crucial competitive clusters:

> The most exciting prospects for the future of inner city economic development lie in capitalizing on nearby regional clusters: those include close-to-a-region collections of related companies that are competitive nationally and even globally. For example, Boston's inner city is next door to world class financial services and health care clusters. South Central Los Angeles is close to an enormous entertainment cluster and a large logistical-service wholesaling complex. (p. 60)

In the new markets model, ghettos and declining rural areas are economic opportunity zones that are not being utilized appropriately. Economic development of these areas, according to James Carr (1999, p. 20), requires the following:

- Understanding the value of community assets
- Creating or matching financing tools to these assets
- Designing value-recapture mechanisms to recycle the new wealth generated by these assets back into the communities from which they

originated so that these resources can stimulate more economic activity in the community, from new businesses and housing to social and community services
- Determining ways in which the wealth generated can be shared by a wide range of community members
- Developing methods to evaluate the long-term benefits of these investments

Although these concepts increase the opportunity for new investment and reinvestment in inner-city and low-income areas, they also require some form of subsidy to get started. New forms of economic finance, such as community development financial institutions (CDFIs), have been created to enhance both equity and debt finance targeted to low-income areas. The creation of these new financing vehicles, combined with a new infusion of capital from the federal treasury in the form of $26 billion in loan guarantees, acts as a stimulus for larger firms to take the risk of investing in low-income areas. But an even greater stimulus for brand-name firms like Gap and Starbucks to invest in the inner city is the need to find new consumers via brick-and-mortar retailing. Furthermore, the influx of immigrants to formerly low-income, predominantly Black neighborhoods has altered the market opportunities for retailers in these communities. The new markets model is the creative realization of old market economics in a new economy.

Theories, Models, and Fads in Local Economic Development Planning

In this chapter, we have highlighted five significant theories that have been employed to explain local economic development outcomes and to shape planning for economic development (albeit where development is equated with growth). Economic development is not an academic discipline per se but rather a field or subfield in which scholars specialize from a number of disciplines, including business, city and regional planning, demography, education, economics, geography, political science, public policy, regional science, and sociology. Theories of economic development, consequently, can be influenced by any of these disciplines. We noted at the beginning of this chapter that local economic development is an evolving field. Further, as we will discuss in Chapter 4, those working in the field come from a wide variety and range of levels of academic and professional experiences.

Overall, economic development professionals are action oriented. Indeed, their jobs often depend on producing results. They are drawn to new ideas and theories to help them do so for their localities. While their motivations

are laudable, past experience has shown that they sometimes latch on to unproven ideas and theories to which the always-limited resources of time, personnel, and dollars are committed. A particularly notable example occurred during the 1980s, when David L. Birch (1979) put forward the theory that small business is the true engine of the economy and job creation as well as the true source of innovation. This was based on findings from his analysis of Dun & Bradstreet data that 80% of the jobs created between 1969 and 1976 were produced by businesses with fewer than 100 workers and nearly two thirds by firms with fewer than 20. However, his methodology was subsequently faulted (White and Osterman, 1991), and it was ultimately concluded that "the largest business organizations continue to account for the great majority of jobs, to pay the highest wages and benefits, and to dominate the coordination of production among networks of firms, the control of finance, and the adoption and implementation of new technology" (Harrison, 1994). By this time, however, localities throughout the country were already on the "small business bandwagon," using their resources to create new centers and programs to foster small business. Encouraging small business development is not a bad economic development idea, but it was also not the panacea for economic development problems brought on by restructuring and employment shedding of the U.S. manufacturing industry during the 1980s and beyond. Economic development professionals needed to maintain focus and assistance to manufacturing plants and other large firms that formed the economic base of their communities.

We introduced two recent and very popular theories in Chapter 1 that are currently garnering a lot of economic development attention: Kim and Mauborgne's (2004) "blue ocean" theory and Richard Florida's (2002) concept of the creative class. Blue ocean is focused on firms that create new markets, which in turn will bring substantial economic development to localities in which they are located. In contrast, the creative class theory focuses on people as drivers of economic development. Each concept has garnered substantial attention and generated private- and public-sector initiatives for economic development. But each is receiving substantial criticism for claims of originality, the analysis used to prove its theses, and the validity of its theories.

On the creative class, Jamie Peck (2005) observed the following:

> [The thesis] that urban fortunes increasingly turn on the capacity to attract, retain and even pamper a mobile and finicky class of "creatives," whose aggregate efforts have become the primary drivers of economic development—has proved to be a hugely seductive one for civic leaders around the world, competition amongst whom has subsequently worked to inflate Florida's speaking fees well into the five-figure range. From Singapore to London, Dublin to Auckland, Memphis to Amsterdam;

> indeed, all the way to Providence, RI, and Green Bay, WI, cities have paid handsomely to hear about the new credo of creativity, to learn how to attract and nurture creative workers, and to evaluate the latest "hipsterization strategies" of established creative capitals like Austin, TX or wannabes like Tampa Bay, FL: "civic leaders are seizing on the argument that they need to compete not with the plain old tax breaks and redevelopment schemes, but on the playing fields of what Florida calls 'the three Ts [of] Technology, Talent, and Tolerance'" (Shea, 2004: D1). According to this increasingly pervasive urban-development script, the dawn of a "new kind of capitalism based on human creativity" calls for funky forms of supply-side intervention, since cities now find themselves in a high-stakes "war for talent," one that can only be won by developing the kind of "people climates" valued by creatives—urban environments that are open, diverse, dynamic and cool (Florida, 2003c: 27). Hailed in many quarters as a cool-cities guru, assailed in others as a new-economy huckster, Florida has made real waves in the brackish backwaters of urban economic development policy. (p. 740)

Returning to our distinction between growth and development, the creative class thesis has been criticized for prescribing strategies that do not address issues of inequality, gentrification, and the working poor and for focusing on a narrow concept of diversity as an enabler of economic development (e.g., gays only). Thus, even if its premise about what causes economic growth is correct (and at least one author—Malanga [2004]—has published data that claims the so-called creative class cities have underperformed compared to the traditional corporate and working-class cities), a wholesale adoption of creative class development strategies could exacerbate the enduring economic development problems of inequality and improving the standard of living for the poor. As was the case with the small business development fad, economic developers need to critically assess the creative class thesis before devoting substantial community resources to its pursuit.

The Continued Evolution of Economic Development Theory Into Local Practice

Existing development theories must evolve in order to reflect changing economic structures and maintain relevance for local economic development activities. In Table 3.2, we have reformulated the concepts emphasized by various theories—locality, business and the economic base, employment resources, and community resources—to create a new foundation for local economic development.

Table 3.2 A Reformulation of the Components of Local Economic Development

Component	Old Concept	New Concept
Locality	Physical location (near natural resources, transportation, markets) enhances economic options.	A quality environment and strong community capacity multiply natural advantages for economic growth.
Business and the economic base	Export base industries and firms create jobs and stimulate increased local business.	Clusters of competitive industries linked in a regional network of all types of firms create new growth and income.
Employment resources	More firms create more jobs, even if many are minimum wage.	Comprehensive skill development and technological innovation lead to quality jobs and higher wages.
Community resources	Single-purpose organizations can enhance economic opportunities in the community.	Collaborative partnerships of many community groups are needed to establish a broad foundation for competitive industries.

Locality

Technology has shattered the traditional view of physical location as the major determinant of development. Firms—even large-scale manufacturing operations—are not as tied to a specific location as they used to be, especially as they reduce dependence on natural resources and substitute the more mobile resource of knowledge as their critical input. Firms increasingly have the ability to be footloose. And even those firms that choose to stay put have the ability to outsource increasingly advanced tasks due to the globalized information and production network. What is known is that firms consistently value a place in which physical and social or organizational factors cooperate to make a quality environment in which to live and do business. Thus, the traditional view that the availability of transportation and market systems determines a community's economic viability is outmoded.

The new location logic is most clearly seen in the changing opportunities for rural economic development. Whereas rural communities previously spent most of their energy attempting to acquire roads, industrial parks, and

related infrastructure to promote manufacturing development, they now find this strategy less productive. Fewer footloose firms are finding remote rural areas attractive at any cost, regardless of services, especially when they can relocate to Mexico, Asia, or many other places across the globe that provide cheap labor to produce goods that can be inexpensively shipped to markets due to logistics advances. Instead, growth in rural areas seems to follow from a pristine natural environment for recreation and ambiance and a quality social infrastructure, including civic organizations, cultural opportunities, and business networks. Thus, some rural areas are growing even without such large-scale investment in infrastructure. It does not seem to matter whether a rural community is a designated population growth center or a target area for increased industrial development or resource exploitation. A rural area's economic opportunities are determined by the quality of the available human resource base and preservation, rather than exploitation, of its natural resources.

Location, by itself, is no longer a "pull" factor. But the new local economic development model suggests that there are locational development-inducing factors. These factors apply more to the quality of the local physical and social environment than to larger-scale geographic considerations. Moreover, the development of a community's recreational, housing, and social institutions can determine economic viability. When a community concentrates on building a social and institutional network, it creates an *inviting environment* for a firm to develop or locate there. If the structure is organized properly, economic activity will ensue—it will not have to be pursued.

Business and the Economic Base

The economic base model relies heavily on a sectoral approach to economic development. The approach concentrates on transactions within the economic system rather than the failures and inadequacies of the system in which the transactions are taking place. This approach is based on the notion that the local economy must maximize its internal institutional linkages in the public and private sectors.

Local economic development theory builds on the premise that the institutional base must form a major component of both finding the problems in the local economy and altering institutional arrangements. Building new institutional relationships is the new substance of economic development. Communities can take control of their destiny when and if they assemble the resources and information necessary to build their own future. This is not a closed political process but an open one that places local citizens in a position to plan and manage their own economic destiny.

In the New Economy, business remains important to the economic development agenda, but the focus has shifted from individual firms to networks of firms or clusters of interdependent firms in industries in which human, natural, and technological linkage advantages are present. Rather than providing special incentives to individual firms, economic development involves brokering among firms to explore how they can benefit from each other. It also involves shifting business practices to those that are environmentally benign and helping firms create new sustainable products and processes that may well use as their inputs the wastes of other firms.

Employment Resources

Boosting local employment has been the major and sometimes the sole rationale for communities to engage in active development efforts. In the neoclassical model, lower wage rates and cheaper costs are sufficient to create employment. This model thus suggests that areas benefit from having low-cost labor, which often is linked to low taxes and limited education and training opportunities. Firms are recruited on the basis of how many jobs they can provide, regardless of the skill level or wages paid. Too often, firms enter areas seeking low wages and generate many minimum-wage jobs that leave residents of the local community in poverty. This does not raise the community's standard of living, reduce its level of inequality, or provide a foundation for sustained development.

Firms in our advanced economy need highly skilled labor and are willing to pay for it. Highly competitive firms recognize that the firm and the community must continuously invest in assuring a highly skilled workforce. The myriad job training and job development schemes in this country are testimony to the importance of transforming the existing labor force into a more productive resource for existing and new employers.

The quality of an area's human resource base is a major inducement to all industries. If the local human resource base is substantial, either new firms will be created by it regardless of location or existing firms will migrate there. Therefore, communities must not only build jobs to fit the existing populace but also build institutions that expand the capability of this population. Rural communities and inner-city neighborhoods seldom have higher education or research institutions that serve them. Indeed, rural communities and urban neighborhoods seldom consider the need for such resources beyond the teaching function or community problem-solving requirement.

Local economic development, however—both now and in the near future—will be dependent on the ability of communities to use the resources of higher education and research-related institutions. Rather than attracting

a new factory that may initially employ thousands, a community may be better served by attracting and retaining a few small, related research labs in leading-edge technologies that could eventually create jobs and stability for the total region.

The goal of local economic development is to enhance the value of people and places. Thus, the community builds economic opportunities to "fit" the human resources and utilize or maximize the existing natural and institutional resource base. In essence, the emphasis shifts from the demand (firm) side of the equation to the supply side of labor and natural resources.

Community Resources

In the classical model, the economy is developed by a business-oriented organization that can advocate for the interests of the firms in the region. In the New Economy, the community has many organizations representing diverse interests, and only through a collaboration among the organizations is economic development possible. For example, government, business organizations (such as chambers of commerce), workforce development organizations, and community-based organizations must work in partnership to ensure that the necessary preconditions for economic development are present. The entity responsible for delivering economic development is no longer one organization but a virtual organization made up of all the organizations that can contribute to the success of a particular economic development project and then, when that project is completed, disband, to be replaced by a different network of organizations that are appropriate for the next project.

Conclusion

The conceptual and theoretical framework for economic development shown in Table 3.2 defines the changing context for economic development in our advanced economy. It suggests that local economic development is not as "spatially free" as the market and that old efforts focused on single-minded expansion of firms and jobs will not generate local well-being in the economy. In the changing economy, specific locations must be tied to specific people. In local economic development, we are concerned with both people and place. Therefore, local economic development is a process that emphasizes the full use of existing human and natural resources to preserve and increase a community's standard of living that is based on principles of equity and sustainability.

Old theories are not necessarily incompatible with the definition of economic development we put forth in this chapter. But this definition does ask for a careful consideration of the impacts of uncritical application of strategies based on these theories. In an increasingly technological age, the old emphasis on employment generation actually has increasing merit. But it must be qualified to focus on good jobs and to prepare workers and their communities for more dynamic labor markets and ongoing skill development to be relevant in these labor markets.

Thus, economic development theory must evolve to meet the challenge of explaining how communities create strong foundations for sustainable economic development that counters trends in global warming and growing inequality as well as preserves natural resources while raising standards of living. In turn, the public and private sectors must work together to identify and support sustainable economic development strategies. Government is responsible for reducing economic and social disparities while protecting natural resources. It uses its power and resources to foster a strong business sector that increases rather than diminishes SLED. Among other things, this requires reshaping existing strategies such as new markets as well as removing barriers in existing regulations and programs.

Appendix 3.1 Summary of Economic Development Theories

Theory	Basic Categories	Definition of Development	Essential Dynamic	Strengths and Weaknesses	Applications
Economic Base Theory	Export or basic and nonbasic, local or residentiary sectors	Increasing rate of growth in output, income, or employment.	Response to external changes in demand; economic base multiplier effects.	Most popular understanding of economic development in the United States and a simple tool for short-term prediction. Inadequate theory for understanding long-term development.	Industrial recruitment and promotion for export expansion and diversification, expansion of existing basic industries, import substitution by strengthening connections between basic and nonbasic industries, and infrastructure development for export expansion.
Staple Theory	Exporting industries	Export-led economic growth.	Successful production and marketing of the export staple in world markets. External investment in and demand for the export staple.	Historical perspective on economic development. Descriptive theory, difficult to apply.	Build on export specializations. State does everything possible to increase competitive advantage. Character of economic base shapes political and cultural superstructure.

(Continued)

Appendix 3.1 (Continued)

Theory	Basic Categories	Definition of Development	Essential Dynamic	Strengths and Weaknesses	Applications
Sector Theory	Primary, secondary, and tertiary sectors	Greater sectoral diversity and higher productivity per worker.	Income elasticity of demand and labor productivity in primary and secondary sectors.	Empirical analysis possible. Categories are too general.	Promote sectoral shifts. Attract and retain producers of income elastic products.
Growth Pole	Industries	Propulsive industry growth leads to structural change.	Propulsive industries are the poles of growth.	General theory of initiation and diffusion of development based on the domination effect.	Growth center strategies.
Regional Concentration and Diffusion Theories	Commodities and factors (Myrdal) or industries (Hirschman)	Higher income per capita.	Spread and backwash effects (Myrdal) or trickle-down and polarization effects (Hirschman).	Address the dynamics of development.	Active government to mitigate backwash effects and reduce inequality (Myrdal). Location of public investments spurs development (Hirschman).
Neoclassical Growth Theory	Aggregate (macro) or two-sector regional economy	Increasing rate of economic growth per capita.	Rate of saving that supports investment and capital formation.	Supply-side model.	Government should promote free trade and economic integration and tolerate social inequality and spatial dualism.

Interregional Trade Theory	Prices and quantities of commodities and factors	Economic growth that leads to greater consumer welfare.	Price adjustments that result in equilibrium terms of trade; price-quantity-effects.	Unique emphasis on consumer welfare and price effects. Ignores the dynamics of development.	Government intervention should promote free trade. Infrastructure development, efficient local government.
Product Cycle Theory	Products: new, maturing, or standardized	Continual creation and diffusion of new products.	New product development; innovation.	Popular basis for understanding development among researchers.	Development strategies promote product innovation and subsequent diffusion.
Entrepreneurship Theories	Entrepreneurs or the entrepreneurial function	Resilience and diversity.	Innovation process; new combinations.	Mediated theory.	Support industrial milieu or ecology for development.
Flexible Specialization Theories	Production regimes, industrial organization	Sustained growth through agile production, innovation, and specialization.	Changes in demand requiring flexibility among producers.	Detailed analysis of firm/industry organization; aggregate outcomes and relationships seldom specified.	Encourage flexibility through adoption of advanced technologies, networks among small firms, and industry cluster strategies.

Source: From Malizia and Feser, *Understanding Local Economic Development*, 1999. Copyright © 1999, Rutgers, The State University of New Jersey, Center for Urban Policy Research. Reprinted with permission of the publisher.

Notes

1. This version of the definition of *SLED* was published originally in Fitzgerald and Leigh (2002). It is a refinement of a definition that Leigh originally developed in 1985.

2. The serious student of local economic development planning is encouraged to read Malizia and Feser's (1999) comprehensive discussion of economic development theories.

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4

The Local Economic Development Profession and Professionals

Ask one hundred economic developers how they got into the field, the old adage goes, and ninety-five will tell you: by accident. . . . For many working in the field, this was not their profession, vocation or intended career—it was merely a job. . . . Further, local-level politicians, who are responsible for much of the hiring (read: political appointment) of economic developers across the country, have historically not realized that the skills of their economic developers should be similar to those of their town planners and city engineers. The times, they are a-changing.

—Waterhouse (1997, p. 84)

Economic development practitioners and planners now belong to a recognized profession. However, as the quote suggests, this recognition is relatively recent, even though the practice of economic development has been with us since the first individual tried to influence the location of business.

The economic development field has a number of formal associations, and the author of this quote was president of what was once the American Economic Development Council but has since experienced a merger that

increases its stature. Within the economic development profession, there are state associations of economic developers found across the United States, as well as national and international associations. These associations are distinct from economic development agencies and organizations such as chambers of commerce or small business centers, county economic development departments, state economic development agencies, or the U.S. Economic Development Administration (EDA). They are membership organizations that draw from all of these entities as well as others, including site location practitioners, real estate developers, utility companies, economic development consultants, and so forth.

The International Economic Development Council (IEDC) is the most significant economic development association in the United States and claims to be the world's largest economic development association (www.IEDConline.org). The IEDC was formed in 2001 from the merger of the American Economic Development Council, which had been the largest and oldest economic development society (founded in 1926), and the Council for Urban Economic Development (founded in 1967). IEDC provides economic development advocacy, education, technical assistance, and networking. It has established a Certified Economic Developer program, which consists of meeting a minimum level of economic development work experience as well as taking (nondegree) coursework and passing an examination testing broad-based knowledge of economic development. Certified Economic Developers are also expected to adhere to a professional code of ethics. A recent initiative of IEDC, to be discussed later in the chapter, has been to identify the core competencies required of economic developers.

While individuals of any academic background can become Certified Economic Developers, the economic development field does have academic roots in the applied disciplines of geography, business administration, public finance, political economics, and urban and regional planning. Further, within the urban and regional planning field, there has long been an economic development specialization that grounds the practice in both theory and method. The American Planning Association, the professional association for all planners, has a division of economic development planning with its own officers that was established in 1978. The focus on economic development within the planning field is more explicitly directed toward the public interest than is found elsewhere in the practice.

The origins of the American economic development profession are typically associated with the rise of industrial recruiters in the late 19th century who literally bought factories for southern cities. City business promoters and community boosters from chambers of commerce or similar business development agencies, as well as civic boosters, form another point of origin for the field.

Two decades ago, Levy (1990), writing from an urban and regional planning perspective, characterized the profession as a mixture of rational planning and salesmanship:

> The academicians who wish to increase the usefulness of [their] contribution to the practice of economic development at the local level or make useful suggestions regarding state and national policy direction must recognize the dominance of the sales side of the process in the practitioner's work. Efforts to tie local economic development into the broader context of community planning must be fitted into a setting in which sales is likely to remain the dominant mode. (p. 158)

Two years earlier, H. J. Rubin (1988) wrote an article characterizing the practice of economic development as "shoot anything that flies, claim anything that falls." In this now classic article, Rubin (1988) observed that, in the practice of economic development, "[the] search for administrative certainty and task closure leads to the public sector's favoring business interests" (p. 236). He also observed that economic development practitioners perceive their work environment to be "complex and undefined" and to involve "a difficult effort in bridging the gap between the public and private sectors" (p. 237). Thus, to promote the appearance of certainty, they have adopted the philosophy of shooting anything that flies and claiming anything that falls.

A 2004 survey of economic development practitioners in local government, conducted by the International City/County Management Association (ICMA), found the same dynamics dominating the profession. Covering municipalities with populations of 10,000 or greater and counties with populations of 50,000 and more with council–administrator or council-elected executive forms of government, the survey found only 52% of local governments had written economic development plans (ICMA, 2004). In responding to questions about their economic development activities, these practitioners indicated the largest proportion of their effort was spent on business attraction or recruitment (44%) followed by business retention (41%) and small business development (19%). When asked about other programs that could foster economic development activities from within the locality, approximately half indicated that they supported community development corporations (CDCs) and job training. However, nearly three fifths indicated they did not have a community development loan fund, more than three quarters did not have a microenterprise program, and less than one third supported child care programs.

Indeed, the predominant economic development activity in which local governments engaged continues to be marketing, with a heavy reliance on partnerships with private companies to carry this out. Even so, their efforts

have been overwhelmingly ad hoc. Despite the fact that nearly 100% stated they wanted to attract new business, 70% indicated they did not have a written business-attraction plan. This serves to reinforce the finding of Rubin's (1988) earlier survey that practitioners were concerned their marketing and promotion efforts amounted to little more than boosterism.

IEDC offers training to strengthen the marketing capabilities of local government and economic development organizations. For example, in 2011, it offered training in "Economic Development Marketing and Attraction," which focused on topics such as site selection fundamentals, target audience identification, community marketing plans and branding, generating support for the marketing campaign, engaging social media, and evaluating the marketing plan (announced at the IEDC 2011 Annual Conference).

Recurring themes in the economic development literature over the past two decades—particularly in response to globalization forces—have been that of the need to retain existing businesses as well as to foster homegrown small businesses. Yet 77% of the ICMA (2004) survey respondents indicated they did not have a written business retention plan, while 83% did not have a written small business development plan. In contrast, more than 70% offered business incentives. The top five incentives were (1) assistance with zoning and permits, (2) improvements to infrastructure, (3) tax increment financing (TIF), (4) tax abatements, and (5) one-stop permitting. This adds credence to another of Rubin's (1988) observations that economic developers believe the role of local government is to be "flexible enough with codes and regulations so as not to hamper business development" (p. 65).

More than 80% of local governments surveyed indicated that they measured the effectiveness of the business incentives they offered by the number of jobs created by new business (90%) and the amount of money invested in construction materials and labor (63%). However, nearly 90% indicated that they never required a percentage of new employees to be hired from within the community. Furthermore, when queried on whether they use performance measures to assess the effectiveness of their economic development efforts, such as program expenditures per estimated tax dollars generated, the majority (67%) responded negatively.

The emphasis on marketing and providing incentives to attract new business revealed by the ICMA (2004) survey is the most enduring characteristic of economic development practice.

The flexibility characterizing economic development can be an asset to practitioners who have limited resources with which to meet large but not always clear expectations. The flipside, however, is that the absence of standards makes it difficult to exclude any activities, even the most patently anticommunity activities, from being labeled as local economic development

initiatives. Moreover, any government or local community group can (and sometimes does) merely change the name of its activity or the name on the door in order to label its activities as economic development.

From the nonprofit community perspective, economic development is more than "bricks and sticks" or marketing and recruitment. It is an effort to reweave the social and economic fabric of broken places and the people who live in them—often because they have no other choice. From a more recent set of interviews of economic developers, Rubin (2000) captured this feeling. One of his interviewees said the following:

> Our mission is to empower and educate and advocate. . . . It's not to produce anybody's anything or deliver anything. It's to empower and educate and advocate for the kinds of changes that will make the neighborhood a neat place to live. (p. 138)

Another interviewee remarked this:

> We think of ourselves as catalysts . . . ignite activism and ignite a sense among people about what can be done when people work collectively and struggle for what is needed. (p. 139)

Yet another said the following:

> When there's an empty building we will serve as developer as a last resort. That's how we view ourselves. . . . We are losing money on the deal but it makes it all work. (p. 139)

Nonprofit community organizations take risks that for-profit developers would never assume. This risk entails organizing people of diverse ethnic and class backgrounds who sometimes fear and loathe one another. Although the nonprofits may or may not make money—mostly they don't—they are engaged in the hardest economic development work. That is, they are trying to make tough places livable.

The Role of the Economic Development Practitioner

The economic development profession can be viewed as comprising the interrelationships of five elements: (1) locational factors, (2) organizational role, (3) task functions, (4) nature of the clients served, and (5) the individual practitioner orientation. The economic development practitioner role may be seen as a function of all these factors. Supplementing the five elements of

the economic development profession that are discussed in greater detail in this chapter is the notion of competencies that these elements require of the economic development practitioner. As previously mentioned, the IEDC has recently engaged in an effort to identify the competencies that the practitioner should have. IEDC distinguishes the needed competencies by whether the practitioner has an executive or administrative role versus a professional or staff role. As can be seen in Table 4.1, there are six competencies identified for economic development staff and eight for economic development executives. While there is considerable overlap in the competencies described, the economic development executive needs higher levels of knowledge, as well as visioning and governing abilities.

Table 4.1 Economic Developer Competencies Identified by the International Economic Development Council

Economic Development Professional/Staff Competencies
1. **Analysis and Decision-Making Skills—**Make elective decisions and solve problems in complex or ambiguous situations by gathering, diagnosing, and judiciously analyzing the information about the situation and environment in order to identify and evaluate options and select the best course of action. 2. **Industry Understanding—**Aware of and interested in the economic development industry. Deeply learn service area(s). Develop professional capabilities. 3. **Leadership and Influence—**Inspire and influence by communicating a compelling vision of the future, conveying an executive presence (e.g., confidence, poise, connecting with others), and being sufficiently agile and self-assured to lead others electively. 4. **Relationships and Teaming—**Electively build relationships with individuals and teams across the organization and external stakeholders by being inclusive, considerate, and responsive to the needs of others; by communicating electively, collaborating with others, and sharing resources; and by being receptive to feedback. 5. **Responsibility and Achievement (Self-Management, Ethical Integrity)—**Demonstrate initiative, commitment to excellence, and elective self-management skills, including integrity, ethical behavior, responsibility, dependability, and follow through. 6. **Communications Skills—**Electively communicates through verbal and written media to stakeholders.
Economic Development Executive/Leader Competencies
1. **Analysis and Decision-Making Skills—**Make elective decisions and solve problems in complex or ambiguous situations by gathering, diagnosing, and judiciously analyzing the information about the situation and environment in order to identify and evaluate options and select the best course of action.

2. **Economic Development Expertise—**Understand the principles and general trends within the economic development industry. Demonstrate experience in economic development programs. Speak the industry language to stakeholders.
3. **Governance Skills—**Build channels of information between all stakeholder groups. Provide feedback to the board. Look ahead and plan for the future business and leadership succession.
4. **Industry Vision—**Stay abreast of economic development industry knowledge. Identify opportunities for future growth. Think and act in an entrepreneurial manner.
5. **Leadership and Influence—**Inspire and influence by communicating a compelling vision of the future, conveying an executive presence, and being sufficiently agile and self-assured to lead others electively.
6. **Management Skills—**Manage the work of others by providing direction, structure, and clear expectations; maintain an open flow of communication and a sense of urgency to drive results; hold others accountable; develop others by providing timely and relevant feedback and opportunities for development.
7. **Relationships and Teaming—**Electively build relationships with individuals and teams across the organization by being inclusive, considerate, and responsive to the needs of others; by communicating electively, collaborating with others, and sharing resources; and by being receptive to feedback.
8. **Responsibility and Achievement (Self-Management, Ethical Integrity)—**Demonstrate initiative, commitment to excellence, and elective self-management skills, including: responsibility, dependability, planning and organization, detail-orientation, and the ability to follow through.

Source: IEDC, Executive and Professional Economic Development Competencies, prepared by Corelli, Meyer and Associates, Washington, D.C., 2012.

Returning to the five elements, each *could* have the hallmarks of the "shoot anything that flies, claim anything that falls" point of view. In some instances, an individual economic development practitioner may achieve things the environment does not dictate and claim credit for the result. Further, the tasks the economic developer chooses or is assigned may themselves generate a productive or counterproductive environment. More than two decades ago, Luke, Veattriss, Reed, and Reed (1988) critically observed the following:

> The experience and working knowledge of the seasoned economic development manager are increasingly ineffective and, in many cases, even detrimental when applied to the new interconnected economic context. Competing with other cities for scarce industrial prospects creates adversarial, competitive relationships that can actually hinder future economic development. New collaborative strategies are required for several reasons. One is the expanding and crowded economic

> development arena. . . . Policy-making responsibility is dispersed and shared by a multiplicity of elected and appointed public officials. Another is a significantly reduced capacity for any one government agency or individual manager to effectively act unilaterally. A third is the slowness of policy formulation and implementation. . . . A fourth is the inevitable increase in vulnerability and openness to outside economic forces, with cities and states increasingly influenced by corporate investment decisions made in other cities on the globe. Economic development is now set in an intergovernmental and intersectoral web of pulling and pushing, and governments can seldom deal with economic problems independently. (p. 227)

While this critique is still too often relevant, there is also evidence of a sea change in the awareness and motivations of the profession. The following discussion is intended to help frame the context for this sea change.

The Community

Almost all communities or regions present different circumstances, irrespective of the causes of their economic ills. Many intervening factors can influence the situation. For example, one community may easily be mobilized because there is a clear pattern of leadership, while another has virtually no identifiable leaders. The goals in both circumstances may be identical and the tools or methods used by the practitioner may bear superficial similarity, but the precise mode of operation will vary based on the conditions. As a result, not only the objective circumstances but also the milieu for development are significant issues for the economic development practitioner.

The total community or area circumstances must be taken into consideration when assessing economic development needs. The atmosphere in which the change is to be made is as important as the change itself. As a result, the economic development practitioner must reach well beyond technical know-how to help the community see itself as a social and physical entity that in many instances goes well beyond the parochial boundaries of the municipality. This identification task is a necessary and important ingredient in the development process, and failure to come to grips with the real "locational" issues can doom even the most dedicated economic development practitioner.

In addition to getting the economic geography right, the economic development practitioner must also assist the community in getting the cause of economic problem(s) right. This is not an easy task. Many communities identify their problems as external, such as competing with lower-wage places of foreign nations or unfair international competition. This may or may not be the case. In most instances, however, dwelling on the external will

not create any new options. Therefore, the economic development practitioner's job is to identify the economic problems that can be solved within the context of that locality. This frequently means helping the community recognize that remedies selected elsewhere (high-tech, tourism, factory attraction, etc.) may not suit a particular locality. In essence, the situation determines both the means of and the limits on local economic development. The economic development practitioner must be aware of this and use appropriate skills to assist the community to find the correct path to a sustainable economy.

The Organization

As previously discussed, local economic development activities are conducted by a variety of institutions at both the local and state levels. Primarily, the economic development practitioner works in municipal or multijurisdictional local government organizations. Therefore, most of the comments in this section concern practice at the local level.

Each economic development organization is formed to fulfill some preconceived mission. That mission may be clear or fuzzy, but it forms the justification for the organization's existence and imposes a limitation on the authority of the economic development practitioner. In many—perhaps most—circumstances, economic development organizations are coordinating bodies that take few direct actions themselves. In such instances, the economic development practitioner is more of a resource person than an expert. Because other organizations are carrying out the action, the economic development practitioner must possess the skill of encouraging without displacing and monitoring without ruling. It is a difficult role to play.

In other circumstances, the organization may view itself as a developer or development partner. In these circumstances, the economic development practitioner must be creative and aggressive and seek opportunities to participate in new economic activities on a broad front, ranging from housing to industrial development to green development. The economic development practitioner might even be required to design new financial instruments or help firms organize themselves to take advantage of government or other development programs.

Increasingly, the economic development practitioner is part of a larger government or nonprofit organization bureaucracy. As a government agent, the economic development practitioner may have limitations imposed from a variety of sources, ranging from advisory boards to elected officials. The tensions created in this environment can be overwhelming, especially when different constituencies have widely varying concepts of the role and responsibilities of the economic development practitioner.

Economic development organizations grow and specialize. As a result, the economic development practitioner may operate within a large economic or planning bureaucracy. Organizations of this type expect the economic development practitioner to have certain definable subareas of special skill such as housing, finance, entrepreneurship, and brownfield redevelopment.

Finally, economic development organizations operate in a wider framework of organizations and institutions at the local, state, and national levels and, more recently, at the international level. The interorganizational scope of local economic development is expanding. The need to create links with larger or more specialized organizations such as airport authorities or international development agencies, as well as the substantial lobbying required with state and federal legislatures, provides an exceptionally dynamic situation for the economic development practitioner.

The Task Functions

The practitioner's task is complex, to say the least, but falls into the general categories of analysis, program development, and marketing. These activities are difficult to separate because they are intertwined in carrying out the activities of any practitioner. The marketing dimension involves activities associated with organizing people, selling ideas, and mobilizing resources for economic development. No amount of technically correct activity will help a community revitalize or direct its economy unless there is sufficient internal capacity. It is the process side of the ledger that helps build capacity in terms of leadership and organizational strength.

The analysis dimension refers to the set of strategies and approaches that the economic development practitioner either fashions or identifies as suitable for the situation. Various types of analytical methods and processes will be elaborated upon in Chapter 6. They entail (1) identifying community problems, (2) providing technical and analytical assistance, (3) determining the resource mix required to meet the economic development needs of the situation, and the process skills of (4) developing networks among individuals and institutions and (5) stimulating interaction among diverse groups to achieve a common objective.

The specific tasks of economic development practitioners are as follows:

1. *Building development organizations.* One of the most important functions of an economic development practitioner is to develop a strong, viable, and continuing organization. Capacity building relates both to helping the organization gain expertise and to identifying and developing future leadership. In addition, the economic development

practitioner must assist the organization in strengthening its network with institutions at the local, national, and international levels.

2. *Taking inventory of area resources.* Keeping track of community or area resources goes well beyond physical assets inventories. An area's development resources extend to its culture, its leadership, and the quality of its community social life. The economic development practitioner must not only know the resource base but also find new ways to use it to achieve community objectives. Of course, the economic development practitioner must also find ways to build resources where there are deficiencies or to transform other resources to meet the need.
3. *Selecting strategies.* The community selects strategies, but the economic development practitioner helps guide the community in the process. This is one of the most important process skills of a practitioner. The economic development practitioner must be careful to "assist" rather than push or sell a particular strategy. Moreover, the economic development practitioner must help the decision makers see the need for comprehensive approaches, incorporating several methods over single-component strategies, such as tourism.
4. *Marketing the area.* Marketing a community is not like marketing a product. Products remain constant in terms of their performance. Communities change. They both add and lose capacity depending on events. No matter what role the economic development practitioner plays, marketing will be a component. The marketing of the place is also associated with the marketing of many other factors—for example, human resources, organizational capacity, and community incentive programs.
5. *Using data development and analysis.* Economic development data are not always clear or clean. The economic development practitioner constantly attempts to find good information on the local situation, ranging from demographic to institutional analysis. Usually large-scale data sources are inadequate for the purpose. Therefore, the economic development practitioner must refine data from the census and other sources, conduct surveys, or identify unobtrusive methods to measure any particular development dimension. Having data and determining what they mean are not easy tasks. As a result, the economic development practitioner must frequently develop ways to display complex information for the layperson. This requires exceptionally good analytical and presentation skills.

All of the previously stated tasks relate to the institutional and locational circumstances of the community. All five are required at different times.

The Clients

The economic development practitioner must work with a wide variety of clients. Clients are both individual and collective. In many respects, the total population of the community or area forms the client base. The economic development practitioner usually has direct contact with a regular group and more limited contact with a wider constituent base. Generally, the economic development practitioner will work with a single advisory body or group and maintain contact with others through organizations or other collective agencies.

Lay leaders are usually the clientele for local economic development. Such persons are generally volunteers working for the good of the community. As laypersons, they may have little or no preparation in the field. They may well represent community groups with considerable influence but without any special expertise. As a result, the economic development practitioner must respect these individuals for the knowledge they bring from their constituents and use this information in program development. However, the professional must provide training and technical assistance to the group. This is a delicate role. The economic development practitioner needs to balance the group's lay knowledge with professional expertise.

Local officials are frequently the employers of economic development practitioners. Economic development departments or agencies are important components of local governments. Economic development practitioners may direct such departments and, in doing so, report directly to local elected officials. The economic development practitioner's success in such circumstances depends on supporting these officials in meeting the needs of the community. This role may require anything from general economic development planning to community education to consultation with community groups.

Civic and economic development organizations are frequently the prime sponsors of economic development. These organizations, described earlier, are public–private institutions that take on the mantle of local development, generally with official sanction from the local or multijurisdictional authorities. Although these groups are also organized by volunteer laypersons, they frequently include individuals with considerable business expertise and resources. The economic development practitioner usually facilitates the activities of this type of agency. Because such groups tend to have substantial resources, the professional role requires coordinating economic development activities, including the hiring of additional specialized expertise. In addition, the economic development practitioner acts as the principal contact person with other organizations and agencies.

In sum, the clientele for local economic development depends on the organizational form and task. The economic development practitioner must be attuned to the circumstances of the community and work with laypersons as well as professionals. The economic development practitioner role requires one to utilize the expertise of the clients as well as the profession to fashion economic development alternatives for the community.

The Professional Roles

The tasks of the economic development practitioner are also related to the three work roles of (1) *consultant,* (2) *enabler*, and (3) *community organizer*. Sometimes the circumstances prescribe the role of the economic development professional; more often, the organization's mission defines it.

The consultant role does not refer to a professional occupation but to the mode of delivery. As consultant, the economic development practitioner provides expertise and problem-solving skills in the situation. The consultant acts as the provider of accurate technical information, showing the options available to the decision-making group.

The enabler is essentially a facilitator. In this role, the economic development practitioner is a catalytic leader who focuses on bringing people together and providing a structure for resolving community economic development issues. The enabler may also mobilize resources but seldom acts as the sole expert. Moreover, the enabler will attempt to create a continuing problem-solving capacity rather than addressing single economic or social issues (Luke et al., 1988).

The community organizer role has much more of an advocacy orientation. A community organizer is usually partisan or an advocate for a specific group or area and acts as the catalyst to propel it to political and economic action.

The organizer model requires a certain type of institutional structure, such as a CDC, to be effective in an economic development role.

Clearly, some of these roles are merged or even evolutionary. An economic development practitioner might start out as a community organizer and subsequently adopt the role of enabler and consultant as the group increases its power and capacity. The essential factor is that both the process and the content or methods task be delivered to the community in some reasonably responsible manner. The framework here is merely an outline of the role models related to the task function of the economic development practitioner, not a conclusive definition.

Economic Development Careers

There are many different career paths that economic development practitioners can take. Three of the most common are as follows:

1. *Manager*. The top level of manager involves managing economic development organizations as separate or component agencies and requires considerable managerial skill. The economic development manager must be an expert in process areas and have deep knowledge of the economic development fields as well as a good background in both business and economics. Within large economic development agencies, there can also be manager opportunities at the program level.
2. *Analyst*. Nearly all economic development organizations and consultant firms require individuals with very strong analytical skills, particularly in the area of regional economic development, economics, or urban planning/business.
3. *Neighborhood/community worker*. At the neighborhood and small community levels, overall development and process skills are required; community organization and development training is especially useful when working at this level.

Economic development practitioners are both process (community organization, leadership, and capacity building) and task (economic and data analysis) oriented. The tasks and roles of economic development practitioners are related to the needs of the situation and the resources required. Individuals who want to become professional economic developers can build on degrees in urban and regional planning, public policy, economics, regional science, geography, or related disciplines, tailoring their coursework to focus on economic development. There are a few undergraduate economic development degrees in the country. Further, as previously discussed, there are opportunities for postdegree economic development training and certification through the IEDC.

Summary and Conclusion

The tasks and roles that economic development practitioners take have historically been contingent upon *where* they practice. Economic development practitioners working in smaller towns or counties typically define their jobs as marketing and industrial attraction. Industrial attraction also dominates

the tasks for those who work in the economic development arms of utility companies and chambers of commerce. Those working in the planning departments or development agencies of large cities have a much wider range of responsibilities. In addition to marketing and recruitment, these can include small business development, industrial retention, commercial revitalization, implementation of TIF districts, workforce and sector development, and brownfield redevelopment.

To date, economic development practitioners have been engaged primarily in marketing and recruitment, deal making, and program implementation. However, as the field matures, it is increasingly becoming self-reflective and self-critical, as the earlier discussion in this chapter suggests. This is a critical element of professionalization in general (Schön, 1987) as well as in establishing and meeting the goals of the economic development profession specifically. Up until this time, the focus on strategic planning and implementation, wise use of resources, and development of standards and ethics has been based on traditional definitions and goals of economic development—that is, growth, wealth, and job creation. However, going forward, self-reflection and criticism will be especially necessary if economic development professionals are going to incorporate the criteria of equity and sustainability into their definition and practice of economic development to more effectively meet the challenges of a flatter and climate-challenged world.

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5

The Local Economic Development Planning Process

The planning of local economic development is a *process meant to deliver a product*. Most of us understand the possible products of economic growth—more and better jobs, increased wealth and income, increased opportunities for personal fulfillment, and so on. It is important to realize that the goal of community capacity building also involves a complex, multitasked process featuring many actors. Moreover, this process affects the entire environment of the community—physical, regulatory, and attitudinal—and determines the nature and quality of its economic products.

However, the planning process includes more than ascertaining when, where, and how new employment may be stimulated. In fact, the acquisition of more job opportunities may deliver little or no benefit to an area. For example, bringing high-tech jobs to a coal mining community may not assist currently unemployed coal miners, though it broadens the local economic base. Therefore, it is important to determine both the short-term and the long-term impacts of any proposed development alternative.

In recent decades, there have been some noteworthy planning misattempts. Real estate–oriented economic development in the 1980s aimed at increasing office workers in downtowns but neglected to match the new jobs to the existing population base. In the 1990s, every community in the nation turned its attention to small business start-ups, ranging from boutique enterprises like antique sales to Internet dot-coms. But, in too many instances, the fledgling enterprises required unavailable talent or created unexpected real

estate demands, both on commercial properties and on housing, that effectively displaced the indigenous population.

Generally, new firms that are locally and regionally based or owned may have a greater impact on the stability and future of a community than branch plants. Similarly, recent research has shown that small, innovative businesses may be more labor intensive than larger plants. Nonetheless, the type of human resource assets and educational and training opportunities, along with the use of local infrastructure, should form the basis for any decision as to what kind of economic development strategy a community might pursue. In brief, local economic development planning takes hard work, careful analysis, well-defined goals, and long-term commitment of resources to achieve positive outcomes.

Preliminary Tasks of Local Economic Development Planning

Two tasks must precede the local economic development process. First, the organization or group of institutions responsible for implementing or coordinating the economic change must be identified and mobilized. Second, the geographic scope of the plan must be determined.

Identifying the Planners

Establishing an effective organizational structure for economic development is essential to the success of the effort. The most common organizational unit for a local economic development program is an economic development corporation (EDC) or similar specialized economic development organization charged with helping develop programs in a city, county, or region. Economic development agencies that are part of local government are also frequent nodes for development programs. In addition, chambers of commerce, business associations, workforce training agencies, or any other local group may become interested in promoting economic development. Strong organizational capacity is always based on communitywide participation, leadership, and legitimacy.

Participation. The primary task of the planning organization is to ensure the full participation of critical sectors of the community. Business must be involved along with government and civic-minded individuals. The importance of business involvement may seem obvious, but in too many cases local individuals in service clubs, labor organizations, or other community groups begin the economic development process without the

active participation of business, labor, and government. As a result, while everyone may applaud the initiative, nothing comes of it.

Leadership. Economic development planning is the process of empowering a local leadership organization that has two key capacities: the vision to see economic potential and the ability to achieve widely shared desired results. Organizations must be willing and capable when it comes to taking on this leadership role, or they should not be selected to lead the economic development planning effort.

Legitimacy. A leadership organization should be perceived as legitimate—that is, it needs implicit approval from a wide range of community members to represent the community well-being. However, organizations often are not trusted because they represent only a single interest (e.g., an industry, a powerful family, the utilities) or because they are corrupt. Thus, legitimacy in the community is an earned quality and is easily eroded by secrecy, favoritism, and indecision.

Determining Geographic Scope

The second preliminary task of economic development planning is to target the effort's geographic scope. Areas or zones of concern can be as small as a city block that needs support or as large as a county, multicounty region, state, or even multistate region. Most important is that the economic area be a unit with internal consistency and cohesion. The area's economic configuration should be determined carefully because, irrespective of political boundaries—especially in areas with large counties—these seldom correspond to economic regions. In any case, the key to effective planning is to realize that no economy begins and ends with neighborhood or city boundaries.

The reality of economic development is that all small areas are ultimately nested in a larger regional enterprise that, of necessity, involves all communities sharing a common market, transportation system, and flow of goods and materials. The area to be focused upon is usually determined by the regional labor force (labor shed) or an equivalent interconnected zone that is physically and economically integrated. However, smaller and larger areas may also be the focus of effective economic development if desired. At its most efficient, the economic development process plans for an entire economic zone, maximizing the area's total resource base.

The Six Phases of Planning

After the preliminary tasks have been accomplished, the six widely recognized phases of the economic development process can begin. To a large

Table 5.1 Phases and Tasks of the Local Development Planning Process

Phase 1	Data gathering and analysis Determining economic base Assessing current employment structure Examining opportunities for and constraints on economic development Examining institutional capacity
Phase 2	Selecting a local development strategy Establishing goals and criteria Determining possible courses of action Developing a targeted strategy
Phase 3	Selecting local development projects Identifying possible projects Assessing project viability – Community – Commercial – Location – Implementation
Phase 4	Building action plans Preassessing project outcomes Developing project inputs Establishing financial alternatives Identifying project structures
Phase 5	Specifying project details Conducting detailed feasibility studies Preparing a business plan Developing, monitoring, and evaluating the program
Phase 6	Preparing and implementing overall development plan Preparing a project plan implementation schedule Developing an overall development program Targeting and marketing community assets Marketing financial needs

extent, they follow the order shown in Table 5.1. Although there is no need to follow this order slavishly or to pass up a crucial opportunity because the final development strategy has not yet been set, ad hoc economic and employment development efforts may be both wasteful and unfortunate. Chapters 5 through 12 of this book describe the tasks associated with each phase of planning. A review of these tasks is included in subsequent chapters.

The basic planning approach for local economic development is self-education first, strategy development second, and projects third, according to the six phases.

In *Phase 1*, planning organizations are involved in gathering information about the character of their economic base and the problems they have in generating more jobs and wealth. Without accurate, impartial data, development projects will surely be unable to maximize the use of community resources. In many cases, data gathering is complicated and requires surveys and sophisticated analysis, but in others it simply involves collecting data on industry, employment, the labor force, and institutional structures in the community.

In *Phase 2*, planners select one of several broad strategies to solve the problems that were identified in Phase 1. Chapter 7 describes the strategy selection process, and Chapters 8 through 11 document alternative strategies that can be used as the basis for meeting different development goals.

Phase 3 focuses on the projects that can be done within the selected strategy. Projects are concrete programs, facilities, investments, and marketing efforts that implement a strategy. Examples of projects are given throughout the book.

Once the projects are selected, the economic development planner begins *Phase 4*, building action plans to implement the projects. Action plans look at alternative ways of designing, financing, and doing a project. This subject is covered in Chapter 12.

Phase 5 continues planning for projects by specifying project details and establishing a monitoring and evaluation plan.

Finally, in *Phase 6* the project is implemented, facilitated by detailed financial plans, schedules, and other concrete arrangements. After an evaluation of community assets and support is completed, the project is launched.

Managing Planning Resources in the Community

Determining the Physical Environment

One way to approach Phase 1 of developmental planning is to research three aspects of the process that will need to be managed. These areas can also be considered as planning resources. Local governments are normally concerned with the physical environment—physical infrastructure—which is certainly important to business and industry. The private sector usually has both particular and general requirements for a physical environment. Particular needs often include special transportation services or waste disposal services. In many cases, these forms of physical environment can be

"custom made." In other words, local government can provide the special service or facility for a known and defined business or industry requirement, the fulfillment of which is likely to lead to new local jobs.

One of the most important factors influencing locational decisions for new private sector investment is the attractiveness or amenity of a particular area or city, more commonly referred to as *quality of life*. Many local governments and neighborhoods have been very much concerned about improving the quality of life in their municipalities, but how often have councils regarded a proposed performing arts center as increased potential for attracting private economic development? The same question applies to reduced vandalism or traffic congestion. Industry and business regard livability as an important locational factor, and local government is in the best position to improve the local quality of life.

Livability can mean different things to different people. Nearly every community possesses natural features, facilities, or simply an aesthetic quality that endears it to certain people. Local governments must identify their quality-of-life attributes, build on them, and effectively promote them to the business community. Indeed, many local governments have already begun this process.

Many urban and rural communities throughout the nation suffer serious economic problems and desperately need a revitalization of spirit and an effort to improve economic circumstances. A revitalized feeling can be created using various mechanisms. For example, small towns can undertake major improvement projects that create a sense of cohesion and beauty. These projects may be as small as improving street signs and trees or as major as the restoration of the whole civic center. The type of project undertaken should coincide with business improvements and should not merely be physical improvements for their own sake.

A good example of the use of physical resources as central to the planning process is the Le Droit neighborhood of Washington, D.C. This historic area bordering the campus of Howard University contains beautiful post–Civil War housing stock and a fenced-in reservoir at the center of the community. In 1999, the city of Washington, D.C., Fannie Mae, and Howard University, along with the community, entered into an innovative partnership to restore the housing, reduce crime, revitalize retailing, and rehabilitate the reservoir into a community park and recreational asset. There are thousands of similar examples of quality housing and underused infrastructure that can be repositioned to create a more livable environment, thus reattracting the vital middle class to neighborhoods. These assets can trigger the reinvestment by local businesses and entrepreneurs into the community as well as attract new investors.

Facing the Regulatory Environment as a Planning Resource

Financial incentives and policies are important inputs to the economic development process. Indeed, they are critical to creating an environment for economic development. Many local governments are now undertaking very thorough reviews of their procedures to ensure that "the cost of doing business" in their locales reflects their desire for economic growth. For example, some cities have recently established "one-stop" business-assistance centers. Such centers are still fairly novel in spite of much publicity regarding their effectiveness.

Regulation can be a boon or an impediment to the development process. Fast, responsive regulation is more important than reducing regulatory burdens. A blue-ribbon commission looking at the regulatory framework in the city of Los Angeles concluded that the conflicting interpretations of existing regulation by various bureaus and agencies combined with conflicting regulations were the culprits in discouraging business from the city. Many other cities have faced similar regulatory problems. A good example is the city of New York, which has consolidated arcane regulation, streamlined jurisdictional overlaps, and authorized the creation of business improvement districts (BIDs) that act as advocates for local businesses. This regulatory cleanup has reduced considerable friction between city agencies and local businesses.

Preparing the Attitudinal Environment

The decisions the private sector makes about investment expansion or relocation are not always based exclusively on hard data. In fact, final decisions—particularly between competing options—are most heavily swayed by gut feelings or seat-of-the-pants reactions. A business may choose not to locate in a certain area because residents are known to be hostile or antagonistic to business, for example. The company does not want to jeopardize its employees and may instead select the next best location on the basis of the latter's being more receptive and appreciative of the industry. Because all locations worldwide have increasingly equal market access, a community's presentability makes a very big difference to its future.

Often, local governments adopt a quasi-adversarial role toward developers rather than a facilitating one. Developers generally agree upon the difficulties in dealing with local neighborhood activists who are uninterested in the economic and social merits of any project. This criticism applies as well to many areas of local government administration, including the executive

and technical levels. The unanimous criticism of developers is the primary problem of delay: delays in presenting applications to the city council and in receiving decisions. Another criticism applies to imposed conditions—that is, city officials who want to "win at all costs" and are reluctant to think beyond petty regulations. To counter this situation, all stakeholders need to adopt a positive attitude toward city planning matters (e.g., development applications, resubmissions, and rezonings) and deal expeditiously and reasonably with each one.

A number of small communities have combined information resources and other strategies to create a better attitudinal framework for local enterprises. Alvin Sokolow and Julia Spezia (1990) provided some instructive examples of 17 small rural communities—from Seaford, Delaware (population 5,500), to Maui County, Hawaii (population 85,000)—that have used attitudinal leadership resources as the keys to economic turnarounds. Although the projects in each of the communities differed (e.g., creating new industrial parks, attracting or retaining enterprises), the underlying theme in all cases "was the frequent boost in community identification and spirit. 'Attitudes have changed, and that feeling is contagious,' noted one mayor" (Sokolow and Spezia, 1990).

Good attitudes do not necessarily generate good projects, but bad attitudes—be they from individuals in political or business authority or from the community or other interest groups—can impede and may even kill a good idea. We all know of communities that are antidevelopment or organizations that challenge all forms of economic activity, irrespective of their merits.

As a matter of policy, cities can establish procedures for all development and other related planning applications and make these available as public information. A public chronology of all development decisions would be an effective way to disprove any unfounded or unfair claims of excessive delays by developers. At the same time, it would encourage a more efficient and time-effective approach by city staff. Some communities are assigning the exclusive responsibility for business or industrial development applications to a senior officer in the planning department. This includes the receipt, processing, and approval or rejection of applications as well as the monitoring of their progress to conclusion.

Selecting a Local Economic Development Role

Once the planners have been identified and the zone of concern specified, an initial planning step must be completed during Phase 1. Any organization

interested in local economic development needs to be clear about the role it wants to play in the process. The stance an organization takes will shape planning at all stages and determine the tools it can ultimately use to initiate economic development.

Organizations have constraints derived from their current or historic roles or set by their charters. It is always difficult for an organization to go beyond its mandate. Therefore, the role definition must precede any attempt to shape the local economic environment. There are basically the following courses of action open to organizations: to act as the entrepreneur or developer, the coordinator, the facilitator, the stimulator, or any combination of these roles.

Entrepreneur or Developer

In this role, the organization takes on the full responsibility of operating a business enterprise. Local government or community-based organizations may decide to operate commercial enterprises themselves. Land or buildings in local government control for conservation or for future development can be made available for economic purposes. Local governments may wish to retain commercial land and buildings in public ownership or turn over these resources to local community groups.

It seems apparent that local governments can make greater use of the commercial potential of land or buildings under their control. Beaches, road verges, reserves, and civic centers may be used for a variety of activities that provide jobs. Local governments could take an active approach to identifying and assessing the possible range of commercial opportunities and balancing these against other objectives. Development of a specialization or "theme" for particular localities may increase visitor traffic and, therefore, the potential for commercial operations.

Both rural and urban local governments have found new ways to promote small business and other creative enterprises by better use of existing facilities and opportunities. For example, an Internet kiosk has been established in South Central Los Angeles by the local transit authority as a service for commuters and a hub for new Internet and graphics entrepreneurs. Small towns have provided seed capital and land for the establishment of new enterprises like "aquaponics" in rural Floyd County, Kentucky (Eddie Patton Clark Allison of Sandy RC&D Floyd County Fiscal Court, Kentucky, personal communication). Clearly, some entrepreneurship and risk taking is required on the part of local elected officials and policymakers to promote new opportunities for local residents.

Community-based organizations are in a good position to run enterprises as employment generators where private enterprise is unable to do so, or to

ensure provision of a service where private enterprise is unwilling to take the necessary risks. There may also be a case for local governments providing goods and services (and therefore employment) for their own operations, particularly where such goods and services would otherwise be imported from outside the area or region. Examples may include hotels, bakeries, and caravan parks in isolated areas, and concrete or crushing plants and nurseries in urban areas.

When a local government has as its objective the redevelopment of depressed industrial or commercial areas in order to increase local trade, employment, revenue, and so on, it can take an active role either individually or in partnership with community-based groups or private enterprise. Use of planning expertise, compulsory acquisition powers, and provision of incentives for relocation or upgrading of premises are some of the options available.

Coordinator

Local government or a community-based group can act as a coordination body to establish policy or propose strategies for an area's development. Because services delivered both by governments and by community and business organizations have a local impact, local councils are increasingly attempting to provide some leadership in the planning and coordination of services within their areas. An extension of this role to economic development might involve community groups in collecting and evaluating economic information (e.g., employment levels, workforce, unemployment, establishments). It might also involve working with other government agencies, business, and community interests to evolve economic objectives, plans, and strategies. Such an approach ensures that all sectors focus their approaches and resources on similar goals and that limited resources are used in more effective ways. This approach can also ensure consistency with state economic programs and strategies so that the local economy receives maximum benefit from them.

Regional tourist development plans, or economic development plans that have been prepared in some areas, represent a possible approach where such plans are developed as joint statements between the three spheres of government and other sectors. Plans developed and imposed by government alone are unlikely to have the same level of commitment or resource input that joint plans will have.

Regional planning bodies with representation from each sector usually work most effectively with governments to produce these plans. A regional approach will normally be more effective because government attention will be focused on regional economies. It will also represent a more manageable

level of cooperation between state and local governments. Regional bodies that adequately represent all sectors and that produce realistic analyses and approaches are likely to have high credibility with government and thus considerable political influence. Regional organizations formed by local governments are well placed to play an information and catalyst role for their members. Some communities have formed nonprofit organizations that assemble economic data for communities as well as provide a research capacity from which services can be shared.

Facilitator

Some community groups and/or local governments have decided they can best promote development by improving the attitudinal environment in the community or area. This might involve streamlining the development process and improving planning procedures and zoning regulations.

A city or community group may bring together a range of approaches from different functional areas into a policy statement on economic development. This need not involve the commitment of additional resources but rather the provision of a statement of objectives. It would provide a focus for the local government's existing resources and energies and a base for additional programs as and when that course is determined.

Positive use of planning powers may also include establishing employment or development zones and standards that encourage a particular class, scale, or character of development. Although such approaches are often related to environmental conditions, they can also have economic objectives. These opportunity areas then have the potential to be marketed to prospective business clients through direct approaches and advertising in one form or another.

Finally, local council members, as elected community representatives, can advocate local concerns and bring economic problems and opportunities to the attention of higher levels of government. Their advocacy role will be strengthened to the extent that local government can demonstrate community and business sector support for this position and put forward realistic and achievable remedies.

Stimulator

Both community groups and city councils can stimulate business creation or expansion by taking specific action that induces firms to enter or remain in the community. Stimulation may range from developing brochures to actually building industrial estates or small manufacturing workshops.

In some cases, approaches have even included providing industrial buildings. In at least one state, small manufacturing workshops have been built and leased to operators at reduced rents for the first few years of operation. This is an option for local governments in areas where the provision of suitable premises is a problem.

In tourism, a local government may itself promote a particular theme or activity in a key venue when private sector action is not forthcoming. Outlets for crafts, craft demonstrations, or a periodic market are some of the possible uses for council-owned premises.

In numerous overseas examples, local governments have provided premises at reduced rents to community-based enterprises and cooperatives to help meet local employment objectives. The course(s) of action a local council decides to take will depend on the local situation. It would be inappropriate for a council not to use its resources in intelligent ways to benefit the total community. Although local development initiatives are not a panacea for local government or the solution to all local problems, they are significant complements to state as well as federal efforts to stimulate economic and employment development. The issue is seldom whether the council should or should not act but what action to take and how to take it.

Typology of Planning Approaches

There are two conditions that affect any local planning approach: (1) the reality of current pressures exerted by international and domestic circumstances and (2) the fact that each place is affected differently—that is, some have growing industrial sectors while others are experiencing industrial decline.

What, then, are the effects of these conditions on community orientation toward economic development? The orientation or expectation of the community during Phase 1 shapes its view toward the economic development process. Moreover, localities need to be aware of their developmental orientation in order to improve or alter their strategy. For instance, there are two basic economic development perspectives: responsiveness to external needs and responsiveness to local community needs. For reasons mentioned earlier, responsiveness to external needs characterizes much of prevailing practice, and local responsiveness is identified with a new, emerging (or latent) practice.

This knowledge sets the stage for proposing a typology of four distinct planning orientations: two prevailing models (recruitment planning and

impact planning) and two emerging models (contingency planning and strategic planning) for local economies that are growing or declining (Bergman, 1981). The first two models are in response to conditions as they emerge. Recruitment planning represents what is known as a *preactive* approach to external conditions. That is, the community initiates activities to build or maintain its economic base in response to competitive conditions. Impact planners wait until circumstances change. This is *reactive* planning in recognition of the loss of the existing industrial base. The subsequent two approaches are more thoughtful and responsive to the total dimensions of the regional and national economic conditions. Strategic planning is genuinely *proactive* and builds a long-term responsive community system to the conditions a locality faces, whereas the contingency approach is an *interactive* approach that recognizes the need to be flexible to conditions just as they emerge (see Table 5.2 for a summary of planning approaches).

Table 5.2 Planning Approaches

	Responsive Perspectives		**Planning Perspectives**	
	Preactive (I)	**Reactive (II)**	**Proactive (III)**	**Interactive (IV)**
Planning				
Model of practice planning	Recruitment planning	Impact planning	Strategic planning	Contingency planning
Policy				
Industry	Industrialization	Deindustrialization	New indigenous firms	Building on existing firm base
Enterprise types	Corporate adjustment assistance	Government sponsored	High tech/ new tech	Community-based
Development				
Intervention model	Industrial inducements	Government program expenditures	Public-initiated development	Community-initiated development

Source: Adapted from Bergman (1981). Used by permission.

Recruitment Planning (Preactive)

Recruitment planning is the traditional approach to economic development used by most localities to attract corporate expansion. Public involvement in this approach is quite limited. Private-sector vitality and initiative tend to displace expressions of local concern for explicit planning or policy making. Policies associated with this approach tend to operate on the assumption that all business is good for the community. Industrialization of the area is taken for granted as obvious policy. This is generally linked to a tacit understanding that industrialization will be beneficial to the entire community.

Typical planning for this approach includes a wide array of industrial inducements and efforts to enhance the image of the area's business climate. Because it is the most familiar style of local economic development planning, variants of recruitment planning can be found in nearly every locality in the country.

Impact Planning (Reactive)

Impact planning is a more recent practice that tries to mitigate or reduce the worst effects of industrial losses in a local economy. It derives from a concern for the effects of plant shutdowns in some communities—particularly the impacts on the labor force—and is episodic in nature. For most of the nation, this activity constitutes the most recognizable public sector planning approach to economic development. The approach relies heavily on the continued availability of federal funds.

The main assumption underlying federal and local impact policies is that action is short term and taken only in time of crisis. The best example of this type of policy is the nearly $1 billion set aside to rebuild the business base of South Central Los Angeles subsequent to the Rodney King disturbances in April 1992.

This does not allow for flexibility in response and puts too much emphasis on securing external federal funds. Although federal policies are usually explicit, local policies are usually understood implicitly as background assumptions. Nonetheless, few planners would have difficulty in recognizing local industrial, labor, and enterprise policies if they were stated explicitly. In declining areas, firms close or gradually reduce operations in older, less profitable plants. This strategy, of course, is the mirror image of the industrial cycle for growing areas. Local communities can accept the risks associated with corporate modes of decision making and investment behavior, or they can develop their own strategies to deal with corporate decision making.

By extension—although it is increasingly contested in most localities—the acceptance of risk involved with corporate market-driven decisions implies that corporations can move such plants and reinvest elsewhere without implied community obligations. Labor force impacts will be borne primarily by relocated workers and their families and indirectly by other workers in businesses whose employment depends on local wage purchasing power. Loss of wages, psychological and physiological distress, higher tax burdens, greater social program expenditures, and continued obligations to amortize industrial infrastructure are included in the costs that all workers in the community ultimately bear.

Development activities are clearly implied by the term *impact planning*. The typical model is a program brought on by sudden, unexpected plant closures and similar employment activity. Development policies and planning in this approach are formed in order to deal with the local impacts of necessary—but equally uncontrolled—acts of corporate mobility. The programs associated with such policies are generally targeted to the real long-term needs of the community.

Two consequences arise from planning solely for impact effects. First, because they rely on national and state programs in response to these needs, planners pay less attention to efforts to plan for the coherent development of their local economies. Directives that specify criteria for triggers, targets, and related aspects of program grant seeking displace thoughtful planning. Second, the planner's role in redeveloping a local economy is jeopardized when federal funds are withdrawn (as they often are), when localities can no longer afford the costs of standard impact program models, or when the economic development planners have no alternative style of planning to guide them.

Contingency Planning (Interactive)

Contingency planning is an emerging approach that grows out of the ineffectiveness of impact planning in declining areas and from awareness that planning must anticipate impacts rather than react to them. As plant shutdowns and adverse economic impacts increase—and as civic leaders come to recognize the scale of the problem—some have questioned the assumptions behind the reactive posture of the impact-planning model. Because impact planning responds to episodes of economic distress only *after* they happen, actions taken seldom fit into an overall plan for the area. Moreover, efforts to mitigate these impacts are primarily devised to reduce the effects of corporate relocation. Some local officials have now begun to question their past responsiveness to corporate needs.

Repeated episodes of plant closures, bank failures, and real estate debacles have altered the perspective of local officials toward economic development planning. Contingency planning anticipates the worst and best possible outcomes. It can help mobilize an area's resources and inherent capabilities to deflect or accommodate impacts brought on by external forces.

Contingency planning also assesses the strength of all economic sectors and anticipates prospects for plant shutdowns, plans potential economic redevelopment projects, and provides community organizations and leaders with the information necessary to initiate local actions. To carry out these tasks effectively, such planning needs the direction of a local economic development organization or an existing municipal planning and development department. The change of emphasis requires impact program planners to move beyond their grant-writing skills. They must now apply practical knowledge of how their local economy actually operates, analyze key elements of that economy, and design both economic development projects and policies that can be implemented effectively.

Under the contingency planning model, local policies toward industry, labor, and enterprises would respond to local need. Local development policy would attempt to stabilize industrial sectors with the long-term goal of protecting the locality's economic base. Local economic development planning would be responsible for estimating an area's "sustainable" level of industrial activity. Knowing the structure and linkages among the full complement of remaining industries and their likely tenure, as well as new industrial investment potential and the total need for local resources that can be provided, planners would be expected to help local officials devise industrial stabilization policies geared to the realities of the situation.

Worker buyouts, employee stock option plans, producer cooperatives, worker–community enterprises, community development corporations (CDCs), and other recent innovative efforts to stabilize job-loss economies are worthy of close examination. Many of these approaches require early public involvement in the planning, financing, and implementation phases. Local labor and enterprise policies should be established *before* the need arises. Here again, economic development requires the study of conditions and circumstances under which others have successfully stabilized local economies and prepared contingency plans for planners' active involvement in each of the phases.

The development activities associated with contingency planning include many of those discussed previously for recruitment and impact planning. But within the contingency planning style of economic development, these activities tend to be community initiated. It might be said that contingency

planning, as a style, began to emerge only after community-initiated efforts demonstrated a clear need for them. Established first as a device for disadvantaged groups to exercise economic power in otherwise strong local economies, community economic development has gone beyond its early concerns to include worker- and community-initiated responses to plant shutdowns.

Strategic Planning (Proactive)

Strategic planning is the most appropriate approach for all communities. This is a future-oriented approach that builds a local economy on the basis of local needs. As used here, a dictionary definition of *strategic*—minus its military sense—provides all the essential elements: "Utilization of all of [a locality's] forces, through large-scale, long-range planning and development to ensure [success]."

To help ensure the successful development of a stable and prosperous economy, localities adopt a *long-range* view of economic development. This posture avoids the problems occasioned by rapid, almost haphazard growth so prevalent in growing areas. It also allows an area time to organize its capacity to plan for economic development and to accommodate desirable expansion of the economic base. Studying lessons learned the hard way in other places is well worth the time, even if local business leaders become a bit impatient with this deliberate approach. A long-term view fosters open discussion and full consideration of plans and policies that affect all segments of the community.

Strategic planning also necessarily entails a *large-scale* effort to deploy available resources. This does not necessarily mean heavy doses of local government expenditure or large state government subsidies—in fact, it could mean reducing current expenditures from all sources and lowering the risks of heavy long-term public and individual costs. The term *large-scale effort* implies that economic development becomes a long-term objective for all ongoing local community governance functions. The full set of regulations, tax policies, public works, and local government program expenditures is framed with long-term economic development objectives firmly in mind. A strategic view of planning would put economic development specialists at the focal point of budgets, tax policies, public procurement, expenditure patterns, and public finance. A local economic planning unit or development board would implement strategic management, targeting conflicting policies and areas with no direction. The strategic style of planning thus boils down to doing the everyday business of local government with one additional long-term objective firmly in mind: economic development.

Finally, the enterprise types to be developed are selected on the basis of the community needs and resources rather than on the availability of opportunities. In this respect, nearly all actions subject to local decision making would favor no particular enterprise form. Thus, corporations, franchise businesses, small businesses, cooperatives, community–worker enterprises, and all other potential forms of economic enterprise would find themselves on an equal footing with respect to local economic development. Such a policy will doubtless require actions by localities to reduce favored treatment of some enterprises and to increase it for others.

The intervention model proposed here is dependent on publicly initiated development. Success comes from many public actions toward economic development, sophisticated strategic planning within appropriate departments and agencies, and integrated policy positions on the part of major actors. There is evidence that localities are considering the adoption of some of these features, but we know of no place implementing a fully developed version of strategic economic development.

Example of Proactive Strategic Planning

In 2002, Paducah, Kentucky, established an innovative Artist Relocation Program to revitalize one of the community's oldest neighborhoods, Lowertown, which is adjacent to its downtown. The program has since attracted more than 80 artists from cities ranging from Los Angeles to New York to relocate to this northwest Kentucky town of 25,000. Its success can be attributed to the creative advertising campaign that targets arts publications and an incentives program that focuses on encouraging ownership and rehabilitation of existing structures. The available incentives include 100% financing for purchase and rehabilitation work, a 30-year fixed loan rate of 7%, free lots for new construction, and up to $2,500 for architectural or other professional services. Also key to the program's success are Lowertown's zoning regulations, which allow gallery owners to live and work in the same structure. Since the program's start, total private investment has been approximately $28.4 million, at a public sector expense of only $2.6 million. Thanks to a growing tourism industry focused on this new arts district, Paducah estimates potential sales are $20 million and growing (Barnett, 2007).

The program has also had a transformative physical impact on the Lowertown neighborhood. Figure 5.1 shows before and after pictures of some redevelopment projects funded by the Artist Relocation Program.

Figure 5.1 Before and After Images of Rehabilitated Properties in Paducah's Lowertown Neighborhood

Sources: Photographs reprinted with permission from the city of Paducah.

Features of Local Economic Development Planning

Local economic development planning is based on a number of key concepts that are still unfolding because the direction of the process is not yet fixed. Meanwhile, local economic development, as an area of practice, remains a collection of historical activities and reactions to current circumstances that guide its course. Although it is not a recognized area of government activity—like planning and zoning or even city administration—some local economic development practitioners work for local government in development departments. Others are associated with chambers of commerce or industrial development or attraction offices, and still others are employed by neighborhood- and community-based organizations.

Even though circumstances associated with local economic development are still quite diverse, the following salient features are truly developmental and, thus, important for all planners to consider.

Targeting Zones of Action

This central idea recognizes a geography of employment and economic distress. There is therefore a need to direct resources, concern, and energy to specific localities, irrespective of what macroeconomic or social policies are pursued. Local economic development programs are designed to intervene in the right place at the right time, affecting both people and place, irrespective of political boundaries.

Building Community-Level Institutions for Development

Locally relevant institutions and organizations can traverse political, economic, and social barriers in both the public and the private sectors in order to promote development. These institutions are inclusive, bringing together community actors who can effect change. Their mandate is to locate the capital necessary to combine with existing resources as the base for economic development.

Expanding Local Ownership

Creating new businesses or retaining existing ownership in a community is important because local firms form the base for development headquarters and use local resources, both human and physical, in their operations. In essence, they are usually good community citizens and contribute to the area's progress.

Merging the Resources of the Social Welfare System

Public social welfare is both the bane and boon of depressed communities. Although it provides an immediate shock absorber for the disadvantaged, it can also create a cycle of dependence. Corrective measures attempt to merge welfare and job skills formation into the same projects—for example, by using welfare payments as wage supports or involving recipients in various economic development programs. Social welfare also comes in the form of nonprofit organizations that provide a wide range of programs, including language and skills development, housing, and psychological care and drug treatment. When used in a positive manner, these resources can stimulate increased local economic activity. For example, simply using existing buildings to house these services may generate new foot traffic or create more security for an area.

Linking Employment and Economic Development Policies and Programs

One goal of local economic development is to diversify employment options within the local economy. Public resources can be used to improve the link between jobs available and people available to work. There will never be a perfect match, but there can be better matches.

Building Quality Jobs

Attracting firms is not always equivalent to improving circumstances in the community. It is important to determine which jobs "fit" the local populace while offering opportunities to increase skills to competitive levels, both currently and in the future. As an intervention in the market system, local economic development thus increases the potential for secure jobs, which in turn stabilizes the community—both economically and socially.

Public–Private Venturing

The hallmark of the U.S. experience in local economic development—whether in government or in the neighborhood—is the combining of the resources of the public sector and the private sector in just the correct balance to attain objectives neither could attain alone.

Conclusion

In sum, the circumstances and character of U.S. political institutions have forged a new and unusual blend of processes and institutions to create a concept called *local economic development*. Its key feature is the recognition of the capabilities and resources of local people. It depends on the self-help mentality of the community.

The national government has been a stimulator, a leveler, a financial resource, and a provider of technical assistance to localities. The national government, for better or for worse, has engaged in industrial and national development policy only by default, when other approaches have not worked. It has continued to modify market mechanisms rather than create new ones. It has used the existing local institutional base in the form of local governments—and more recently neighborhood-level institutions—by increasing their political standing.

For their part, national and local governments have steadfastly believed that the cure to any problem in spatial or human allocations of development will result from correcting imperfections in the existing market system. It is these imperfections, both large and small, to which localities must attend in order to build or rebuild their economic base and, thus, to ensure long-term economic viability.

Putting It All Together: Creating a Local Economic Development Strategy (Part 1)

The West Central Georgia region case is intended to give you a chance to review the first four chapters of the book. You should read the case along with the theories and concepts of local economic development discussed in the four chapters. Based on your reading and understanding of the material, determine the following:

1. What are the national and international economic forces at work in Georgia's West Central region? How did they arise, and what implication(s) do they have for the future of the community?
2. Who are the important actors in the economy of West Central Georgia?
3. What are West Central Georgia's assets, and how do you propose to use them in building an economic development strategy for this region?
4. What is the role of government with respect to West Central Georgia? Consider all levels of government: local, state, and federal.
5. What planning approaches seem to be at work in West Central Georgia, if any? Explain why you think so.
6. Describe the economic planning approach you propose instead.
7. Within your economic development plan, what role should the local governments in West Central Georgia play?

PLED PROBLEM SOLVING 5.1
Case Study, Part 1

Many historic mill towns in the southeastern United States lost significant numbers of jobs from textile manufacturing operations relocating to overseas locations with significantly lower labor costs. Faced with high unemployment rates, these communities have been engaged in ongoing efforts to reinvent their local economies.

One high-profile example is that of Kannapolis, North Carolina. In 2003, the economies of Kannapolis and its neighboring town, Concord, were devastated when manufacturer Pillowtex closed and laid off 3,000 workers (Textile Plant Closings and Layoffs, 2007). Today, the location of the former textile mill is now a major science research campus. David H. Murdock, owner of Castle & Cooke, Inc., and Dole Food Company, Inc., bought the site in 2008. Approximately $1 billion was invested in the creation of the North Carolina Research Campus (NCRC), which has one of the largest collections of advanced scientific equipment in the world. Nineteen corporations, academic institutions, and health care organizations located on the campus have formed a successful public–private partnership. The NCRC employs at least 1,000 people, 50% of which were locally hired (NCRC, 2014).

Textiles is not the only U.S. manufacturing subsector to experience significant job losses, but there are others that, thus far, have not succumbed to the pressures destroying most of the U.S. textiles industry. These manufacturing sectors—particularly the advanced technology sectors—are expected to fuel job growth in the United States. The most promising sectors are those that rely on innovation and a higher-skilled workforce. Because the expected earnings for the American workforce can never compete with the low wages found in many international labor markets, the United States needs to ensure its current and future workforce has a skills-based competitive advantage. The Kannapolis reinvention is one contribution to this effort.

The West Central Georgia region is a larger example of an historic textile-dependent local economy and notable for the diversity of economic activity it has cultivated in recent years. A 10-county region adjacent to the Alabama border, West Central Georgia also extends into the Atlanta metropolitan area (two of its counties are within the U.S. Census Bureau–defined metropolitan statistical area of Atlanta). The regional economy can be divided into three distinct subregions: (1) Atlanta Area (Carroll and Coweta counties), (2) Rural Area (Butts, Heard, Lamar, Meriwether, and Pike counties), and (3) Textile Area (Spalding, Troup, and Upson counties). Troup is home to LaGrange, the largest city in the region, with an estimated 30,557 people in 2014 (information obtained from 2010–2014 ACS 5-year estimates).

The following are a few of the region's demographic factors of note:

- As illustrated in the map in Figure 5.2, except for Troup, the textile subregion and adjacent rural counties declined in population between 2010 and 2014.

(Continued)

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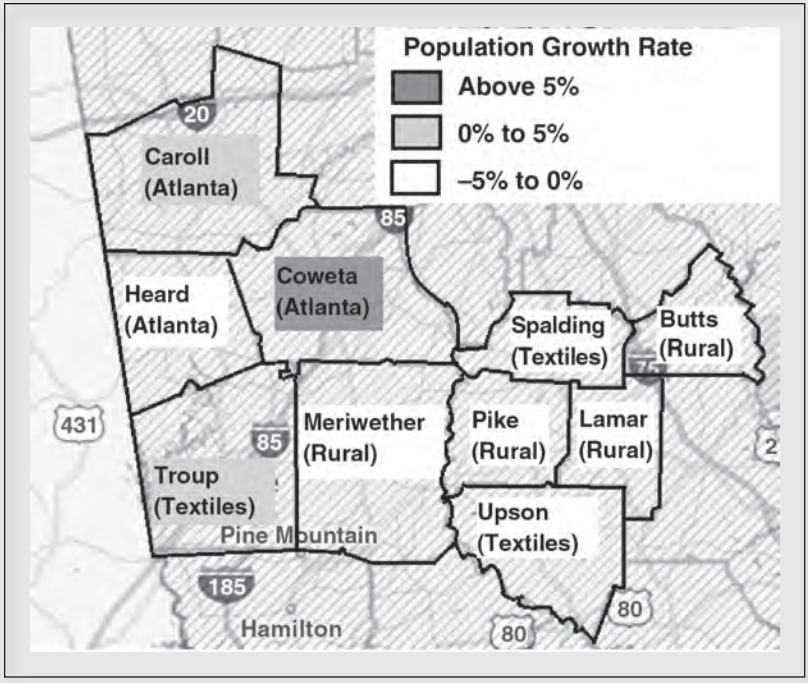
- The region's population is older than average, as measured by the percentage of the population in the over-65 category.
- The region has a higher-than-average population lacking a college education.
- Educational attainment is particularly low in the historic textile community of Thomaston in Upson County. (Information obtained from 2010–2014 ACS 5-year estimates)

Figure 5.2 West Central Georgia Population Growth Rate, 2010–2014



Source: Created by authors from Population Division, U.S. Census Bureau, 2014.

The region has had a number of job losses, many of which can be attributed to the textiles industry and its impact on other businesses in the regional economy. Between 1997 and 2007, the region lost a total of 4,870 jobs due to textile plant closings. The closing of Thomaston Mills alone resulted in the loss of 1,955 jobs in Upson County, 150 in Spalding County, and 145 in Pike County. Westpoint Steven's closing resulted in 1,550 jobs lost in Troup County (Textile Plant Closings and Layoffs, 2007).

There have been facility closings in other business sectors but on a much smaller scale than the textile losses. Nontextile plant closings have included the 347-employee Cooper-Standard Automotive facility in Spalding County, the 308-employee Inflation Systems facility in Troup, and the 270-employee Nacom Corporation facility in Spalding (Business Layoff/Closure Listing, 2007).

Textile industries still have a role in the regional economy, as carpet manufacturer Interface Flooring Systems is one of the region's largest employers. Additional top employers include Kia Motors Manufacturing Georgia, Southwire Company (manufacturer of wire and cable products), Tanner Medical Center, Walmart Distribution Center, and the University of West Georgia (West Central Georgia Local Workforce Area Labor Profile, 2014).

The area's future has begun to look more hopeful, due in large part to the strengths of the Columbus, Georgia, economy, immediately south of the West Central region. Columbus is home to the U.S. military base Fort Benning and the national headquarters of insurance provider AFLAC. In 2009, Kia Motors began its first U.S. automotive assembly operation in West Point, Georgia, and, including its supplier network, employs over 11,000 in the region. Blue Cross and Blue Shield of Georgia recently constructed a new office in Columbus's Muscogee Technology Park, which employs 1,500 residents in the region (The Valley Partnership, 2014).

Benefits of Columbus's growth are being felt in West Central Georgia from LaGrange to Thomaston. Numerous counties have created speculative buildings to entice Kia's suppliers and others to locate in the area. The region's unemployment rates fell from 12% in 2009 to under 8% in 2014 (West Central Georgia Local Workforce Area Labor Profile, 2015). A recently closed Yamaha Music plant was replaced in 2011 by an Animal Health & Sciences biochemical manufacturing facility in Thomaston, adding over 200 new jobs to Upson County. In 2012, a biorefinery demonstration plant, based on a partnership between Diamond Alternative Energy and American Progress, Inc., also began operations in Upson County (Southerland, 2011). These additions contribute to West Central Georgia's approach to rebuilding a more diverse and resilient economy.

The economic future of West Central Georgia is hopeful, but the region continues to face the impact of job losses and an unemployed workforce skilled for textiles-based employment.

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6

Introduction to Analytical Methods for Local Economic Development Planning

Successful economic development planning is based on a solid analytical framework that accurately describes the local economic context, including the identification of groups that have special needs; the local resources available to address these needs; and the place of the community in the larger regional, state, national, and global context. The national economy is a composite of all the local economies within it, whether they are urban or rural, large or small, growing or declining. As we noted in Chapter 3, economic *development* occurs when a community's standard of living can be preserved and increased through a process of human physical development that is based on principles of equity and sustainability. The economic development planning process begins by analyzing the current economic conditions and capacities of the community.

Information and Analytical Requirements for Local Economic Development Planning

Economic development planning and implementation requires analyses across a wide range of categories that make up the local economy. These analyses can be descriptive, predictive, or evaluative. From descriptive analyses, the

community can determine how its economy is faring relative to its position in the past or to its current position as measured against development goals that may have been set or measured against other referent economies (e.g., the nation or a similar-sized country for which it competes for resources). Descriptive analyses are also often used for marketing purposes—that is, to provide information that can aid in attracting firms, major development projects, employers, employees, and residents.

Predictive analyses in economic development often take the form of impact or causal analysis. This type of analysis seeks to assess what the impacts of growth or development will be on the local economy but can be extended to a wider set of community concerns. For example, Edwards (2007) outlined a development impact analysis that identifies anticipated economic, fiscal, environmental, social, and transportation-related impacts from specific development projects. Within this grouping, fiscal and socioeconomic impact analyses are most commonly used for economic development. Fiscal impact analysis estimates the impact of a particular development project on the costs and revenues of the local government units that will provide services to the development. Socioeconomic impact analysis assesses how development changes community demographics, demands for housing, retail and other services, levels of employment and income, as well as the aesthetic quality of the community (Edwards, 2007).

Much of what is labeled "impact analysis" specifically focuses on building and land development associated with new economic development activities. It is only over the past three decades or so that fiscal impact analysis has been practiced. A longer-term focus of causal economic development analysis (particularly as it intersects urban and regional analysis) has specifically been on forces affecting change in employment, since these, in turn, can create changes in population, migration, regional income, and a host of related phenomena (Isard et al., 1998).

Evaluative analysis seeks to determine how well specific goals of economic development planning efforts are being met in addition to gauging shifts in economic development conditions. For example, have recent employment and business additions lessened or widened existing inequality in earnings? Have they significantly altered the cost of living? Did public investments in a specific industry cluster strategy lead to the creation of new firms and jobs, create more high-skilled jobs and higher average wages, or increase tax revenues? Of the three areas of economic development analyses, it is performed the least. In part, this is because rigorous evaluations require a control or comparison group to demonstrate that the economic development strategy or program implemented actually created results that would not have occurred on their own. It is difficult and expensive to create

such comparison groups. Other reasons for lack of economic development evaluation have also been cited, including the fact that those paying for the evaluations are typically not the beneficiaries of the economic development program, and the suggestion that program administrators can be fearful of the consequences of a negative evaluation (Bartik and Bingham, 1993).

Each of the three areas of economic development analyses warrants substantial study on its own. Scholars in a wide range of academic disciplines engage in research that contributes to and advances these analytical areas, including (but not limited to) city and regional planning, demography, economics, geography, political science, and regional science. Serious students of local economic development planning will go on to take coursework specifically in methods of economic development analysis. Much of the remainder of this chapter will be devoted to providing an overview of descriptive analyses, which are the first step in preparing a strategic economic development plan as well as in gaining any true understanding of how the local economy works. These descriptive analyses cover a range of substantive areas that can reveal a community's strengths and weaknesses for advancing its local economic development, such as demographics, economics, land use, infrastructure, real estate, and finance. Following our examination of these analyses, the chapter discusses four key methods of local economic development analysis: economic base, shift-share, input–output, and cluster.

Understanding an Economy's Strengths and Weaknesses

Economic development intervention requires a detailed analytical understanding of the strengths and weaknesses of the local economy as well as the forces that are constraining or driving it. Local matters must also be placed in the context of external economic forces from around the globe. New technology, changing availability of natural resources, and trade and monetary policy, for example, all strongly influence local economic needs and opportunities. The first step in understanding the strengths and weaknesses of the local economy involves creating a descriptive profile. To begin, the economic development analyst must determine the appropriate unit of analysis—that is, what are the geographic boundaries of the local economy? Is it a legally defined city or county, or a subarea such as a neighborhood planning unit? At times, the geographic focus of economic development planning does not coincide perfectly with the legal or administrative unit for which data are available. Further, McLean and Voytek (1992) observed the following: "The range of impact of economic activity almost never

coincides with the jurisdictional boundaries of political units. Spillovers occur in both directions: the policy decisions of one jurisdiction may affect economic activity in adjacent areas, even as economic activity flows easily across jurisdictional lines" (p. 10).

The economic analyst must also choose the time period of analysis, understanding that determining whether the local economy is better or worse off currently than at some earlier point in time, as well as determining exactly how it has changed over a period of time, is affected by two cyclical phenomena. The first is the national business cycle. Demand for certain goods and services that make up the national economy can temporarily shift due to shocks such as energy price increases, natural disasters, or supply bottlenecks. Since the national economy is made up of all subnational (i.e., local) economies, many smaller economic units such as cities will be affected by a slowdown or surge in the national economy. This is not to say, however, that all subnational economies are simply smaller but complete versions of the national economy. Indeed, the smaller the economy, the more limited or specialized it is compared with the national economy. The degree to which the subnational economy will experience the effects of the business cycle depends on the proportion of industry sectors it has that are affected by the cycle. Due to increasing globalization, we now see evidence of local economies and national economies being impacted by slowdowns and surges in the international economy.

This also holds true for the second cyclical phenomenon, which is long term and structural and is often called *long wave*. In this phenomenon, significant and permanent shifts in economic activity occur. These can be sectoral—such as the shift from manufacturing to services industries that has occurred since the 1970s—or, within manufacturing, the shift over the past century from steam to coal to electricity to microelectronics-based production processes. Structural shifts toward nanotechnology-based manufacturing activity are now occurring, so, if efforts to advance sustainability are successful, we can expect major structural shifts away from carbon-based manufacturing processes and products and perhaps a true industrial revolution.

Structural shifts can also be perceived as geographical. For example, a regional or local economy in which economic activity was largely associated with one particular sector may decline if the new sector originates in another region. The region of origin may, in turn, experience exceptional growth. Further, increasing internationalization has led to shifts of economic activity in both manufacturing and services out of local economies across the United States and into rising economies such as China, Korea, and India.

In the next section, we discuss the major categories of analysis that will help economic developers understand how their local economies are situated within the larger economic, industrial, and international systems.

The Economic Profile

We begin by presenting in Table 6.1 the major categories of descriptive statistics that should be included in a local area's economic profile, providing examples of the specific data that can be incorporated under each category. These statistics are the minimum amount of information that should be gathered for the economic profile. How much more information should be included will depend in part on the specific needs of the community as well as on the availability of information for the size of community under consideration. In general, the smaller the community or the less its geographic boundaries coincide with administrative or political boundaries, the more difficult it becomes to obtain detailed economic information from secondary sources.

Table 6.1 Components of the Economic Profile

1. Demographics
Population by age group Population by ethnicity Households Net migration past 5 years Workforce education attainment • Less than high school • High school • Some college • College • Graduate
2. Quality of Life
Climate (average temperature, snow/rainfall, sunny days) Housing supply and prices Workforce housing supply Education • Spending per student • Student–teacher ratios • Achievement test results • High school graduation rate • Percentage going on to college • Higher education (vocational and university) Health care (hospitals, outpatient clinics, physicians, dentists) Crime rate Culture • Museums, performing arts, sports teams, and events • Green space and recreational outlets

(Continued)

Table 6.1 (Continued)

3. Income and Wages
Median earnings and income level Distribution by quintile Working poor Proportion of jobs with health and retirement benefits
4. Labor Force Characteristics
A. Civilian labor force Unemployment rate Participation rate • Male • Female • Ethnicity • Total Working outside county of residence Median commute time B. Industry Goods-producing • Natural resources and mining • Construction • Manufacturing Service-providing • Trade, transportation, and utilities • Information • Financial activities • Professional and business services • Education and health services • Leisure and hospitality • Other services • Public administration C. Occupations Management Business and financial operations Computer and mathematics Architects and engineers Life, physical, and social sciences Community and social services Legal Education, training, and library Arts, design, entertainment, sports, and media Health care practitioners and technicians Health care support Protective service Food preparation and serving Building and grounds cleaning and maintenance Personal care and services

Sales Office and administrative support Farming, fishing, and forestry Construction and extraction Installation, maintenance, and repair Production Transportation and material moving Military specific
5. Business Establishments by Industry Sector and Employment Size
By industry and function (headquarters, back office, branch plant, R&D) New to the area Expansions/new facilities Downsizing/closing/layoff
6. International Linkages
Foreign-owned companies U.S. companies with foreign branches Foreign bank branches U.S. banks with international departments Foreign consulates Import/export bookers International education programs
7. Research Base
Corporate, nonprofit, university, government
8. Higher Education Resources
9. Transportation
Commercial airport • Hub status, carriers, daily nonstops, largest cities served Railroads Motor carriers/trucks Ports Foreign-Trade Zone designation Overnight express services Mass transit
10. Utilities
Water and sewage, electric power, natural gas, telecommunications
11. Taxes
Corporate Personal income Sales/use Machinery and equipment Property

(Continued)

Table 6.1 (Continued)

12. Land/Building Availability
Business parks (industrial, office, research, mixed use) Commercially zoned land and buildings Vacancy rates and average rents (warehouse, industrial, office class A–C) Approval length and type of local permits
13. Environmental Regulations
Attainment status for federal air pollution regulations Average permit approval time (air, water, hazardous waste) Landfills Recycling regulations and programs

Sources: Derived from authors' research and practice; International Economic Development Council (IEDC; 2016); U.S. Bureau of Labor Statistics (BLS); McLean and Voytek (1992); and Edwards (2007).

Demographics

A community's demographic characteristics tell whether it is large or small, growing or declining (when gathered for two or more periods of time), and homogenous or diverse. The age profile (usually analyzed in 5-year segments, or three broad segments of less than working age; working age, which is 16 to 64 years; or retirement age, which is 65 years and older) indicates whether the community has a good distribution of all age groups or one that is weighted more toward a young labor force or a retirement community. The implications for economic development goals and strategies will differ depending on the age profile. The education attainment levels of the workforce can provide an indication of how advanced the economic development strategy can be.

Knowing the age profile of the local population also helps an economic developer understand what is likely to happen if elderly people retire. For instance, in several large cities, analysts have noted that skilled machinists or tool and die makers were all largely the same age, having been trained just after World War II. Because the industry in these communities remained stable, today there are no trained apprentices ready to replace these very skilled workers as they retire. Such trades are often pivotal to the success of other firms, and communities need to be attentive to finding replacement workers for critical occupations that require years of training.

It is also important to be able to answer questions such as how much mobility is in the workforce. For example, are young people working locally or leaving to work elsewhere? After high school, are they going to nearby

cities to work or to attend college? Or, as is the case with many rural areas, do they never return to their local area because there are few job opportunities for them there?

Local community economic development often utilizes annual or semiannual *population estimates* that include the number of people in an area between census periods. Births are recorded and added to the population. Births, deaths, and migration factors (e.g., new houses, change of address, utility services, school enrollment, licenses) are added or subtracted from census data to give an estimate of current population in an area. Small areas are summed and balanced with larger county and state estimates.

Because few localities have any basis on which to estimate future migration patterns, either into or out of their area, trend data are used instead. In many cases, 5- and 10-year migration trends, such as those estimated from housing and school data, are extrapolated for the next 20 to 50 years. Consequently, the short-term trends typically distort future patterns and result in projections that are misleading. Economic developers need to be cautious using these projections, validating information with knowledgeable city planners and officials who have independent information by which to evaluate population trends.

Demographics also include knowing more about the changing ethnic mix in an area. A strong influx of specific ethnic groups can bring new opportunities and challenges to the economic development professional. For example, in spite of initial location around the nation, Hmong refugees (from Cambodia and Laos) displaced by the Vietnam War have tended to concentrate in a relatively few places, such as in California's central valley and in New York, and Russian immigrants have found their way in largest numbers to Brooklyn, New York, and West Los Angeles, California. In the San Gabriel Valley, east of Los Angeles, large numbers of migrants from Hong Kong and Korea have created a vibrant international community.

Finally, retirement complexes have been particularly attractive to rural communities. A retiree coming into a rural community after selling a house in an urban area not only brings considerable money to buy a new house but also brings social security and pension income. Often, this income greatly exceeds what would be brought into the community by good factory jobs. In short, the demographics of a community shape the local workforce and economy.

Quality of Life

Quality-of-life indicators are an important consideration in economic development because they influence the ability to retain and attract firms and employees. In general, firms in more advanced industry sectors and

workers in more advanced occupations have higher quality-of-life expectations. Opportunities for quality housing, education, health care, and cultural opportunities are important factors in a firm's or worker's location decisions. Increasingly, the supply of workforce housing is being recognized as a factor in quality of life. Housing price increases outpaced those of earnings in most urban areas for several decades and led to a shortage of decent and affordable housing for many workers. This was particularly acute in five vital occupations that receive low to moderate wages: janitors, elementary school teachers, police officers, licensed practical nurses, and retail salespersons (Bell, 2002). As a result, police officers and nurses have been unable to live within their employing communities, which would allow them to respond most rapidly to emergencies; local schools have trouble staffing and maintaining adequate student–teacher ratios, and the level of service in retail businesses is compromised. All of these reflect negatively on the local economy and its prospects for advancing.

While the Great Recession that began in 2007 caused a decline in housing prices ranging from 30% to 50% or more throughout most of the nation, this did not eliminate the shortage of workforce housing for either renters or buyers. In most communities, financing has become more difficult to obtain for those who want to buy, and the rate of foreclosures has created greater pressures on the rental market due to displaced homeowners.

Income and Wages

The income and wages subcategory is key to understanding what the standard of living is in the local economy. And, as previously discussed in Chapter 3, improving standard of living is one of three objectives of local economic development planning. Earnings and income levels are examined separately because not all households in the economy have earnings, or earnings are not the sole source of income. The distribution of income and wages by quintile is a key indicator of the level of inequality in the local economy, the reduction of which is also one of the three objectives of local economic development planning. The working poor indicator is computed by determining the number of workers in the local economy with year-round, full-time employment whose annual wages do not bring them above the poverty line. This represents a failure in economic development that should receive priority attention. Lastly, "good" jobs are often defined as those that provide health and retirement benefits along with adequate earnings. The cost of health and retirement benefits is typically 25% or more above the worker's wages. If employees must pay for these out of their earnings, then their overall standard of living is reduced. Further, in the case of

low-wage workers for whom it is a struggle simply to provide housing and basic goods, the inability to self-fund health insurance can lead to financial disaster when they experience serious health incidents.

Labor Force Characteristics

A key activity in local economic development planning is job creation. Earnings from employment remain the primary source of income for individuals to support themselves and their families, and earnings define the standard of living for the vast majority of individuals. As we shall discuss subsequently, the income generated from earnings is a key factor in determining the economic base of a local economy. Thus, characteristics of the labor force of a local economy are vital for determining its future, and strengthening them is an important economic development goal.

The labor force characteristics section of Table 6.1 is the most detailed because of the importance of this aspect of the local economy. We start with a basic understanding of the civilian labor force. While some local economies have a sizeable portion of their labor force employed by the government and the military, the reality is that local economic development planning efforts can do little, if anything, to shape these sectors; thus, they focus on the civilian labor force.

A low unemployment rate suggests a tight labor market that cannot accommodate new firms unless there is growth in the local labor market. Conversely, a high unemployment rate suggests there is hardship in the local economy and active economic development efforts are needed. It is important to determine whether the unemployment is associated with specific industry sectors and occupations. It is also important to determine whether the unemployment is associated with a national downturn in the business cycle or is specific to the local economic composition to which specific planning efforts can be directed.

A low labor force participation rate for a specific gender or ethnic group may suggest a lack of opportunity, systematic discrimination, and the presence of discouraged workers. The latter are those who have given up on finding employment, and, since they are no longer looking for work, they are no longer counted as being a part of the labor force.

Statistics on the proportion of the labor force that works outside the county of residence can be indicative of a lack of local job opportunities. The extent to which this is a valid issue will depend, in part, on the size of the county. For example, California, with a land mass of nearly 156,000 square miles, has only 58 counties. These counties can encompass many localities and local labor markets. On the other hand, Georgia, with a land

mass of almost 58,000 square miles, has 156 counties. The small size of Georgia's counties suggests that many local labor markets will cross county lines. A more revealing indicator is "median commute time." Excessive commute times suggest a jobs–housing imbalance (whereby there are either not enough jobs in the worker's home community or there is a mismatch between local jobs and local residents' occupations) that should be a focus of economic development planning. The excessive commute times associated with jobs–housing imbalances not only lessen the quality of life of workers but also contribute to road congestion, air pollution, and deterioration in the community's quality of life.

The next subcategory under labor force characteristics is industry. All economic activity is classified into an industry sector. Industry composition varies across local economies, and these create different dynamics. Officially, an industry is defined as a group of establishments primarily engaged in producing or handling the same product or group of products or in rendering the same services. The industry listing in Table 6.1 is the official North American Industry Classification System (NAICS) aggregated into the 11 sectors that the BLS of the U.S. Department of Labor considers the relevant major groupings. NAICS falls under the responsibility of the federal Office of Management and Budget. NAICS and the U.S. Economic Classification Policy Committee recommend changes to the system (U.S. Bureau of the Census, n.d.). NAICS uses a six-digit hierarchical coding system to classify all economic activity into 20 industry sectors, of which 5 sectors are mainly goods-producing sectors and 15 are entirely services-producing sectors (BLS, 2012a). NAICS is revised every 5 years (in year 2 and 7 of each decade) in order to reflect ongoing changes in the industrial system. For example, the 2012 NAICS reduced the number of industry codes to 1,065 from the 1,175 used in 2007. It added Alternative Energy Industries to the Utilities sector and reduced the number of 6-digit manufacturing industries by 108. All employment is classified into an industry sector, and likewise, all employment is classified into an occupation sector, the next subcategory in Table 6.1. There is also an official Standard Occupational Classification (SOC) system produced by the BLS. Listed in Table 6.1 are the 23 major occupation groups. These 23 groups are an aggregation of 97 minor groups and 461 broad occupations. Further, for each of the 461 broad occupations, the SOC includes detailed occupation(s) requiring similar job duties, skills, education, or experience (BLS, 2012b). Occupation data within each industry group are also published. The SOC was revised in 2010 and is planned for another revision in 2018 and then every 10 years thereafter.

The official industry and occupation classification systems' revisions to reflect the emergence of new types of jobs and business activity can

complicate trend analyses when economic activity is moved between categories from one system's revision to the next or when the classification system reflects the addition of entirely new forms of economic activity or removal of obsolete activity. Official "crosswalks" are available that guide the analyst in comparing and combining data from previous and the latest classification systems. The NAICS was last revised in 2012, when changes were made to 7 of its 20 sectors. NAICS is actually a replacement for the previously used Standard Industrial Classification (SIC) system that was used from the 1930s to 1997. The renaming and revamping of the system occurred to allow standardized collection and analysis of economic activity for Canada, Mexico, and the United States as part of growing recognition of the increasing globalization and integration of these three economies. The SOC was last revised in 2010. The U.S. Department of Labor conducts ongoing studies to determine what new and emerging occupations will be taken into account in the next occupational classification system revision that is being considered for 2018. These occupations involve significantly different work than that which is found in current occupations. There were 24 new occupations included in the 2010 SOC revisions, including information security analysts, web developers, community health workers, and wind turbine service technicians.

In a major development undertaken to help track the evolving green economy, since it cannot be done through NAICS or SOC, the BLS began developing a new Green Jobs classification in 2010. In 2011, it begin developing data on green jobs from establishment surveys of firms in 333 6-digit NAICS and will publish data annually for the nation, the states, and the District of Columbia that includes the number of jobs by industry and occupation engaged in producing green goods and services.

BLS defines green jobs as either of the following:

- Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources
- Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources (BLS, 2012c)

Business Establishments by Industry Sector and Employment Size

The fifth subcategory focuses on the characteristics of the business establishments found in the local economy. How many there are within a specific industry sector indicates whether the sector is competitively organized. The

function of the business establishment provides clues as to its role in the overall economy. Those with R&D functions may be the sources of new innovation and companies. Those with headquarters functions may be longer lasting in the local economy than those with back office and branch plant functions.

International Linkages

Due to ongoing economic globalization, economic development planners should be familiar with and may want to encourage international linkages and support for export-oriented businesses within their local economies. Section 6 of Table 6.1 provides some key categories for consideration, but the analyst may want to go further, such as determining the extent to which locally produced goods and services are sold in international markets.

Research Base and Higher Education Resources

Sections 7 and 8 identify research activity that can become a source of innovation and new business creation. Beyond training the labor force, for which higher education was listed in the Quality of Life section, higher education institutions can also be a source of support for local economic development by contributing activities such as manufacturing extension partnerships, Small Business Development Centers (SBDCs), and business incubators.

Transportation, Utilities, Taxes, Land/Building Availability, and Environmental Regulations

The remaining five sections of the economic profile highlight traditional requirements and costs of doing business in a local economy. The transportation data indicate how connected the local economy is to other economic centers and how efficiently products and people can travel to and from the local economy. How influential the local cost of utility provision and the availability of specific utilities is to any business location decision is dependent on the production requirements of the business. For example, is it a business that uses large quantities of water in its production process, or does it rely on sophisticated telecommunication infrastructure to deliver an information-intensive service or product?

The subsection on taxes illustrates that there is a range of taxes to which businesses and their employees can be subject. Taxation levels have traditionally been viewed as an issue of competitiveness in local economic development, though research results on how important they really are to

business location decisions are mixed. The flip side to the issue is that too-low levels of taxation may indicate the locality is not investing sufficiently in physical and social infrastructure, and this can undermine long-term economic development.

The availability of land and buildings to house new and expanding business is a critical factor in local economic development. Communities that are built out (all land has been developed) or that have excess land but will not zone for commercial and industrial uses create disincentives for expanding existing businesses to stay or new businesses to locate in the community. In the business world, "time is money" such that lengthy building permit processes can raise the cost of doing business and serve as a barrier to economic development.

This issue is also pertinent in considering data for the last subsection on environmental regulations, which lists the kinds of environmental permits that businesses may have to secure, depending on their production processes. Difficulties in meeting the attainment status for federal air pollution regulations can become a major barrier to further economic development.

Landfills can be a significant issue in local economic development because some industries generate more waste by-products than others, and those with hazardous waste by-products are subject to rigorous (and costly) waste disposal regulations. Though there are some states and localities that consider operating landfills as an economic development activity—and they actually import waste from other localities to receive the revenue from disposal—the prevailing view is that landfills are costly to maintain safely, generate negative externalities for development surrounding them, and are to be minimized. One way in which disposal of industry waste can be minimized is through recycling regulations and programs. The most forward-thinking localities are promoting recycling as a way to minimize environmental pollution impacts, promote economic development via the business and jobs that are created to reuse and recycle, and create new products from waste (e.g., see Leigh and Patterson, 2006).

Building on Comparisons

Data for economic development analysis build on *comparisons* that look at a community in relation to someplace else that is a valid referent. Typically, planners compare the strengths and weaknesses of their zone of action (local, county, or multicounty) with a much larger area (a state, multistate region, or nation), depending on the size of the units. California and Texas, for example, are good references for communities within their states, but a

community in Rhode Island or Vermont would better be compared with the New England region or the nation as a whole. As a result of comparison, planners may find that the local area has a higher proportion of electronics companies or that its hospital and medical firms, while seemingly highly represented, in fact are actually below the number expected in ratio to areas like the state or region. In addition, local areas may discover that their unemployment rate is consistently above or below the same rate of the state or region or that it changes differently over time. For example, some areas have rates that swing higher and lower than national cycles of unemployment, whereas other areas lag the national cycle, with unemployment peaking later and recovering more slowly.

Comparisons of a local area to its larger reference area must do more than simply count the employees or firms in each, because larger places would obviously have more firms or employees. The analytical task is to standardize the data with analytical tools that can account for the different sizes and scales of the various areas being compared. For example, economic developers use standard measures to compare areas in terms of average or per capita incomes (instead of total income), the unemployment rate (percentage of labor force not employed), the rate of small business formation (firms created as a ratio of all firms), or the number of doctors per thousand persons. In each of these cases, the economic factor of interest is standardized relative to the size of the place.

Data comparing local areas also need to be dynamic and show how change has occurred from one time period to another. This trend analysis describes how the local economy arrived at its present condition and projects what it may look like in the future—with and without intervention. Typically, economic development analysts look at change over periods from 5 to 10 years—long enough to show some dynamics but short enough to capture local developments that are manageable by planning policy. The time period used is often dictated by the frequency of data publication of the relevant secondary sources of data such as the U.S. Census Bureau's Economic Censuses or American Community Survey (ACS). The selection of time schedules also seeks to take into account the effects of the business cycle. Data from several points of time show, for example, employment growth in certain industries, increases in unemployment rates, greater rates of female participation in the labor force, and the impact of inflation on real earning power.

Local economic planners need to combine professional statistical and quantitative analysis with an appreciation of the uniqueness of the local community. They should prepare for an analysis by first understanding gaps in a local area's analytical sophistication, need for data, or ability to use it. However, the analysis process frequently needs rethinking as

patterns emerge—analysts learn more about the local economy and the community understands more about itself. Smaller communities often cannot support full-time economic development planning staff and thus seek the assistance of specialists who can assemble and help the community to understand relevant information as well as to develop an appropriate economic development planning process. Private economic development consulting firms, state and regional planning agencies, and university outreach centers may all be sources of economic development specialist assistance.

Gathering Available Descriptive Data

Data for local communities come from individual, government, and private sources, and each source has its strengths and weaknesses. The availability of this information is rapidly expanding, especially through Internet sources. Table 6.2 lists potential sources for the 13 categories of data suggested for the economic profile described earlier in Table 6.1.

Local Agencies and Individuals

Already available in many communities is a vast array of existing data held by local planning or service agencies. There are also persons who have experienced the place in every conceivable way and from every conceivable angle—often over lengthy periods of time. People who live, work, and play in the community can be involved in contributing their knowledge and ideas to the local economic development planning process through community fact-finding techniques such as the following:

- Personal interviews
- Public hearings
- Neighborhood meetings
- Church, fraternal, and trade organizations
- Press, radio, and television outlets
- Existing reports, case studies, and feasibility studies

Beyond this, special efforts should be made to invite community leaders, as well as other interested and knowledgeable citizens, to participate in *advisory committees* and other formalized groups associated with the planning process. These people often reflect the collective thinking and awareness of many other citizens who have valuable perspectives or expertise but cannot actively participate.

Table 6.2 Data Sources for the Economic Profile

1. Demographic Characteristics
U.S. Bureau of the Census Decennial Survey American Community Survey (ACS) Local/Regional Planning Agency
2. Quality of Life
National Climatic Data Center U.S. Bureau of the Census National or Local Association of Realtors State Department of Education or Public Instruction Local School District University System Office of the President Federal Bureau of Investigation (FBI) Uniform Crime Report for Locality Local Business Directories Local Medical Association Chamber of Commerce Visitors Bureau
3. Income and Wages
U.S. Bureau of the Census U.S. Bureau of Labor Statistics (BLS), National and Regional Offices State Employment Security or Labor Departments
4. Labor Force Characteristics
BLS Local Area Unemployment Statistics State Employment Security or Labor Departments U.S. Bureau of the Census County Business Patterns Economic Census Geographic Area Series Longitudinal Employer–Household Dynamics Annual Survey of Manufacturers
5. Business Establishments by Industry Sector and Employment Size
Statistics of U.S. Businesses (U.S. Bureau of the Census) Local Business Journals Local and State Industrial/Economic Development Agencies Local Surveys
6. International Linkages
USA Trade Online (U.S. Census Bureau) Industry Trade Associations Federal Reserve Board
7. Research Base
U.S. Patent and Trademark Office Trade Associations University Research Offices

8. Higher Education Resources
State University System Office of the President Local Offices of University and Community College Presidents Private College/University Offices of the President
9. Transportation
State Department of Transportation U.S. Department of Transportation Local Department of Transportation or Public Works
10. Utilities
State Utility Commission Local Knowledge
11. Taxation
State Department of Finance or Revenue or Taxation Local Office of Property Assessor
12. Land/Building Availability
National and Local Associations of Realtors Commercial Real Estate Vendors U.S. Census Bureau Residential Building Permits
13. Environmental Regulations
U.S. Environmental Protection Agency (EPA) Envirofacts State Environmental Agency Local Government Environmental Departments

Industrial Classifications

As referenced earlier, we use NAICS to help us understand the multiplicity of parts in the economy. This system is the replacement for the SIC system that served for more than 60 years as the structure for the collection, aggregation, presentation, and analysis of the U.S. economy. An industry consists of a group of establishments primarily engaged in producing or handling the same product or group of products or in rendering the same services. NAICS uses a production-oriented conceptual framework, grouping establishments into industries based on the activity in which they are primarily engaged. Establishments using similar raw material inputs, similar capital equipment, and similar labor are classified in the same industry. In the switch from SICS to NAICS, a new Information sector was created that combined communications, publishing, motion picture and sound recording, and online services in recognition of the information-based economy. Manufacturing was restructured to account

for new high-tech industries. A new subsector was created for computers and electronics, which includes reproduction of software. Eating and drinking places were transferred from the Retail sector to a new Accommodation and Food Services sector. The distinction between the Retail and Wholesale sectors was changed to reflect the way each store conducted its business.

A key criticism of the old SIC system was that it did not reflect the growth in the economy of the service sector. The NAICS revision added nine new service sectors and 250 new service industries. NAICS has now been revised twice since its 2002 introduction in an effort to keep up with the nation's changing economy. Though the U.S. Census Bureau provides "crosswalks" to facilitate time series analysis when classification systems are revised, it is important to understand that the revisions from SIC to NAICS were so major as to hamper time series analyses for specific sectors.

Occupational Data

Revisions to the occupational classification system, like the industrial classification system, require the use of crosswalks to do time series analyses. However, unlike NAICS, the SOC system is intended only for analyzing U.S. data.

SOCS data can be found in a number of public information sources. The U.S. Occupational Employment Statistics (OES) program provides occupational employment and wage estimates by industry and across industries. State- and area-level data are provided by state employment security agencies.

The U.S. Census Bureau publishes data on detailed occupations from the decennial censuses. Only aggregated data are published in paper form. Standard and customized tabulations of SOC data can be obtained through the U.S. Census Bureau's Web-based American FactFinder site.

Biennially, the BLS Office of Employment Projections (OEP) publishes the *Occupational Outlook Handbook, Career Guide to Industries,* and *Occupational Projections and Training Data*. In addition, OEP publishes the *Occupational Outlook Quarterly* (www.bls.gov/soc/socguide.htm).

Census of the Population

Perhaps the most well-known source of economic data has been the U.S. Census, which collects data every 10 years. The census obtains from every

household a small amount of data, such as age, race or ethnicity, gender, family, and a few housing items. Historically, about 1 in 20 households filled out a longer form that supplemented the personal data with an extensive bank of questions about many topics of interest to economic developers. The longer form reported on types of industry and occupation, income, education level, disabilities, and many other factors. The sample data were extrapolated to the entire population, but in areas with small populations, answers were aggregated to protect the confidentiality of respondents. Information from the long form guides the administration of federal programs and the distribution of federal dollars.

A new survey, the ACS, has been implemented to replace the decennial long form. Because long-form data collection occurs only once every 10 years, they soon become out of date. Planners and other data users are reluctant to rely on them for decisions that are expensive and affect the quality of life of thousands of people. The ACS is intended to provide the data communities need every year instead of once in 10 years. The ACS includes around 3 million households and makes estimates of demographic, housing, social, and economic characteristics for every county in the United States. Smaller areas are also covered in the ACS, but it will take several years to accumulate sufficient data.

Census data have many advantages. First, the census has had a fairly standard set of questions and categories as well as a consistent methodology over many decades, which allows good long-term perspectives, often valid for 50 or more years. Although the analyst must be attentive to changes in industry and occupational classifications, census data are still the best source for long-term trend analysis. Second, census data reflect a hierarchy of geography, with smaller areas accumulated into larger areas. The nation, states, regions, counties, cities, towns, places, census tracts, and census blocks are some of the most important categories. In addition, data are provided for metropolitan areas, divisions, and other intermediary urban geographical sectors. Third, the widespread electronic availability of census data is permitting additional formats and estimated patterns. Thus, the census allows the widest geographical perspective.

However, the use of census data has certain limitations. First, census reports are based on where people live, not where they work. Although the census does ask about commuting, these data are not directly comparable to data on place of employment, especially if a large number of people work outside the area under study. Second, the census is collected only once every 10 years and is thus often out of date. Furthermore, it usually takes 2 years from the time the census is taken until data are available on items of interest to economic developers. Third, economic data from the census are from a

sample, and confidentiality limits the availability of important data in small geographical areas. Finally, and most important, census data are less complete in poor neighborhoods, among ethnically diverse communities, and where the population is in flux. Many challenges have been made to the census counts in central cities, in small rural communities, and in places where there are many undocumented immigrants. Homeless people, for example, are substantially undercounted. In spite of the fact that census data are the best we have, it is important to recognize potential gaps in coverage.

The census also makes periodic specialized censuses of importance to economic developers. Every 5 years, the census surveys manufacturing businesses, agriculture, and governments. These specialized reports provide detailed information within their topic. Even though this special census shows where manufacturing businesses are located, it does not include data on individual employees in each firm.

Employer Reports

Employers provide accurate, inclusive, and recurring reports as they get licenses and pay fees and taxes as part of their overall activities. These reports turn into data, which are collected by government agencies. Economic development planners are especially interested in two reports that all employers must make: quarterly payments for unemployment insurance to their state and social security deductions to the federal government. Thus, in the payment of these taxes, employers provide current and accurate data that can track the economy by specific industry SIC code in local areas.

As part of their unemployment insurance tax payments, all firms must report employment, payroll, and location, and their NAICS code is regularly checked. These detailed data are the backbone of the employment and earnings reports produced by each state's employment security agency. These firm-level sources are reported not by where employees live but by where they work. Such data are excellent for coverage and are often available promptly to allow analysis of quarterly trends. In addition, many states are able to generate special reports based on particular geographical information (such as zip code) or showing detailed industrial categories (such as the fourth-digit level of the NAICS).

County Business Patterns data are collected from employer surveys as well as being obtained through administrative records on employers from the Social Security Administration, the Internal Revenue Service, and the U.S. Department of Labor. Like employment and earnings reports, they are based on where people work, not where they live. As the name implies,

County Business Patterns data provide data for the county level. More recently, however, these annually collected data have started to be published at the zip code level.

Government data series also rely on other specialized sources. For example, most states publish a report based on *sales tax collections*, which gives the dollars spent on taxable sales in counties or even cities by specific types of establishment. Depending on tax laws, taxable sales data may not include large parts of the retail sector (e.g., food or services that are not taxed, and most sales to businesses), but much retail analysis can rely on these data.

State income tax records are often analyzed both for business taxes and for individual income tax payments to provide information on earnings. *Agricultural data* are derived from crops planted, sales, and other information collected through marketing boards and reporting as part of inspections. Traffic monitoring leads to highway data on commuting and trucking. The purpose here is not to identify all the sources of data for economic development but to encourage planners to look for the data they need by identifying who might collect it for another purpose and then finding it.

Private Data

There has been a significant increase in private data sets that economic development analysts find useful. In some cases, these data sets are from public sources but are repackaged by private firms in a manner that makes them more useful for analysis. An example is the Business & Company Resource Center produced by the Gale Group. This is a subscription database that can usually be accessed at larger public and academic libraries. In other cases, a private data provider may be collecting data from businesses that it then processes and sells to customers. For example, Dun & Bradstreet provides privately generated data that are compiled and updated as part of its ongoing need to supply business credit information, such as the number of employees, sales, and the location of the firm. It provides data on privately held as well as small companies, unlike many other databases.

Private data have several advantages. First, confidentiality is less an issue with privately gathered data than with state or federal information. Several companies sell detailed data files on selected firms. Second, detailed geographical locations are available—even street addresses if needed. Third, special reports can be generated from the extensive data bank collected for sale to analysts and marketing firms who can pay the fee.

The limitations to private data sources are that the coverage is neither uniform nor exhaustive. For example, the only way a firm is listed in Dun & Bradstreet is if it requires a rating for credit. How serious a problem this is

has been debated in the literature. Another limitation is that updates do not occur simultaneously. Dun & Bradstreet tries to make sure that every firm is updated every 3 years, but otherwise a firm's data are updated only when a new credit report is needed. And while publicly held firms that must report to the U.S. Securities and Exchange Commission can legally be liable for misrepresentation, there is no penalty for those that report to Dun & Bradstreet.

There are other types of private data that can be useful for local economic development analysis, such as data on commercial or industrial real estate markets or trade association data that can help the analyst discern what kinds of challenges a locality's key businesses may be encountering or what potential exists for fostering greater clustering of a key industry.

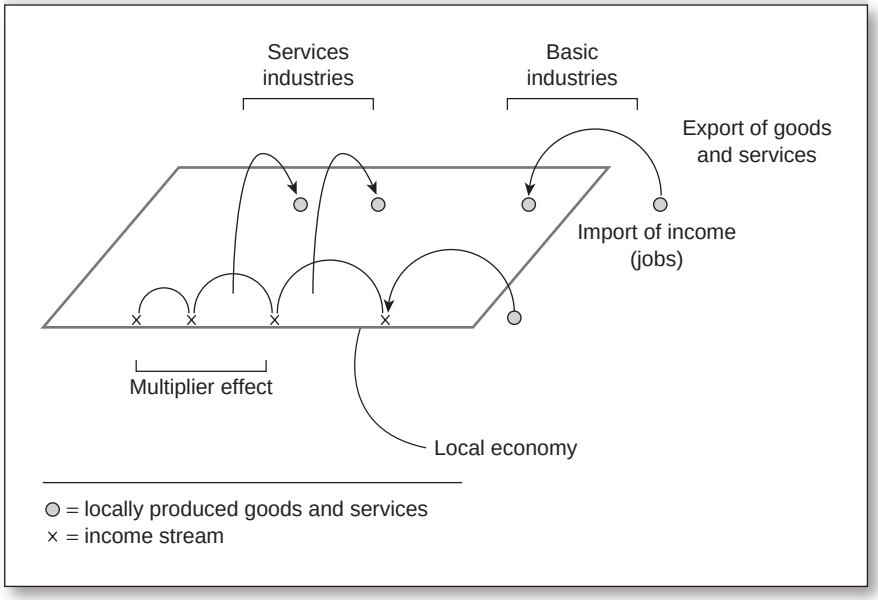
Examining Analytical Techniques

There are at least five areas of analysis that the local economic development planner needs to understand:

1. What parts of the local economy are most valued by local residents and political leaders? How do the citizens see themselves compared with other communities?
2. What parts of the economy form the local economic base, accounting for the most substantial number of jobs and growth in wealth?
3. What parts of the local economy are growing most rapidly, forming jobs and generating opportunity? What can local leaders do about other parts that are declining?
4. How do changes multiply through the local economy? How does growth or decline in one part of the economy alter the other parts to which it sells or from which it buys?
5. What are the parts of the local economy that are most important because they are embedded in a strong and growing interdependent cluster of firms and related industries?

The answers to Questions 2 through 5 provide substantial insight into the economic system associated with every community. A version of this economic system is depicted in Figure 6.1. Healthy economies, as shown in the figure, export jobs, retain substantial income, and build internal linkages. Determining the size and performance of these economic relationships, as well as the community's ability to alter its relationship to other areas in the region, is the focus of the analytical techniques discussed in this chapter (Landis, 1985; Rochin, 1986).

Figure 6.1 Model of Local Economy



Source: Adapted from Agajanian (1987).

The answers to Question 1 must come from primary data collection such as surveys, interviews, and focus groups. From our descriptive analyses using secondary data, we can gain insight into Questions 2 and 3. Further insight into Question 3, as well as into Questions 4 and 5, can be gained through additional analytical techniques. The remainder of this chapter will focus on the most commonly employed techniques.

Economic Base Analysis as a Foundation for Economic Development Planning

Solid economic development planning hinges on an understanding of the factors that affect the level and growth of the local economy. These factors include how local firms meet the needs of people in their community and how these firms are shaped by external forces, such as markets for the export of local goods, imports, tourism, and even major changes in international trade (e.g., the rise or fall of the dollar relative to foreign currency). Every firm is part of an industry sector, and a local economy's industrial structure is the most fundamental factor that affects its growth.[1]

McLean and Voytek (1992) have observed the following:

> The industries that are most crucial to local economic growth are those that produce goods and services sold outside the local economy, generating an inflow of income. These industries are known as an area's "economic base" or "export base." They generate the income that sustains the "local-serving" or "non-basic" sector of the economy—firms such as restaurants, grocery stores, automobile repair shops, laundries, and so on.
>
> In addition to exporting, local economies import goods and services that are demanded by local consumers and businesses but produced elsewhere. The extent and nature of a local economy's imports are also of interest for the analysis, since there may be opportunities to substitute locally produced goods and services for those being purchased from outside the area. (p. 60)

A simple economic base model can be depicted as follows:

Basic employment + Nonbasic employment = Total employment

The principle of traditional economic base theory is that businesses that generate wealth should be targeted for attraction and nurtured with a higher priority than other firms. As Malizia and Feser (1999) have observed, the most common economic development strategy—industrial recruitment—is justified by economic base theory since the attraction of outside firms, which today can be manufacturing or service firms that export, will lead to increased demand for local firms. The interconnections between local serving and exporting firms of an economy and just how much export-based growth stimulates local-serving growth is most robustly analyzed via input–output analysis, a technique that is included in economic development methods courses and that we briefly discuss in this chapter. It is from input–output analysis that the most accurate estimates of multipliers are created. The concept of the multiplier is a much-focused-upon indicator in local economic development that is used to estimate how much change (for example, income, taxes, or jobs) will occur in the total local economy from an exogenous change in activity in the basic industries.

While economic base analysis has traditionally focused on industries as its unit of analysis, there has been something of a turn in local economic development analysis to focus on occupations as a driver of the economic base. This is particularly the case for occupations that are perceived to generate new forms of economic activity or fuel entrepreneurship. The creative class concept is one example of an occupation-centered economic base analysis.

In the next section, we discuss a simple-to-perform technique for analyzing the economic base that can be used to examine industrial or occupational structure. For simplicity of presentation, we use industry to describe the technique.

Location Quotients for Base Analysis

The location quotient (LQ) is a technique used to identify the concentration of an industry sector in a local economy relative to a larger reference economy. Stated simply, an industry's share of the local economy is compared with the same share that industry has in the reference economy. The LQ—sometimes called the concentration factor—is a static measure, picturing the economy at only one point in time. It does not say anything about whether an industry is growing or declining in importance relative to the local economy.

The LQ is shown as a ratio between the percentage of employment in an industry locally to the percentage of employment in the same industry found in the state or nation being used as a reference. If the ratio of the local to the reference economy is greater than 1, it means that the industry has a greater representation in the local area compared with the reference economy. If the ratio is less than 1, however, the industry has a smaller representation. An LQ of 1.0 means that the local area and the reference economy have the same percentage of that industry in their respective economies. In economic base analysis, an LQ of 1 is interpreted as the local economy just meeting its needs for the products of that industry. An LQ less than 1 means the economy does not meet its needs internally. It is therefore considered local serving, and the locality may need to import the industry's products or services to fully meet its needs. On the other hand, an industry with a LQ greater than 1 produces more than is needed locally, and the portion of the employment that leads to the LQ being greater than 1 is assigned to the locality's economic base that supports the economy as a whole. McLean and Voytek (1992) suggested that the analyst focus on industries with LQs greater than 1.25 or less than 0.75. Those with LQs of 1.25 or more are most clearly the export base industries whose further growth will stimulate the overall economy. Those with LQs less than 0.75 could also warrant focusing on because they offer opportunities for import substitution development strategies.

The standardized formula for depicting the LQ is as follows:

$$\text{LQ} = \left(\frac{e_i}{e}\right) \div \left(\frac{E_i}{E}\right)$$

where

e_i = local employment in industry i

e = total local employment

E_i = national employment in industry i

E = total national employment

In essence, the LQ is an index of specialization. For example, if a rural locality has 10% of its local employment in the dairy industry and the state (the reference economy) has only 5% of its employment in dairy, the LQ is the ratio of the first to the second, or 2.0 (i.e., divide the local percentage (10) by the reference percentage (5), to get the answer of a LQ of 2.0). But if an urban area has only 1% of its employment in dairy, the LQ will be 0.2 (i.e., divide 1 by 5 to get 0.2). In the first case, the LQ of 2.0 indicates that the dairy industry constituted twice its expected share of the local economy, whereas in the second the LQ of 0.2 indicates that the local share was only 20% of what would be expected if the local area was like the reference economy.

Analysts typically calculate LQs for detailed industry classifications at the two-digit or greater levels. The danger in using one-digit industry data, such as for agriculture, is that either all or none of a sector's employment could be erroneously assigned to the economic base.

In Table 6.3, LQs are presented for three metropolitan areas in the United States: Atlanta, Indianapolis, and Seattle. We will look for industry sectors with LQs greater than 1.5 to get a sense of what are the greatest industry specializations in these three metro areas. Beginning with Atlanta, we can see that its greatest specialization is in Air Transportation (NAICS 481), with a very large LQ of 4.94. This correlates with the fact that the region's Hartsfield–Jackson Airport is a major hub for both passenger and cargo transport. However, Atlanta also ranks high in what can more generally be called the information economy. It has LQs of 2.37 in NAICS 517—Telecommunications. Additionally, it has a large LQ for NAICS 515—Broadcasting, except Internet. While Atlanta is the well-known home of CNN, if that were its only firm in this NAICS sector, we would not be able to calculate an LQ due to data disclosure rules. However, there are also a number of other broadcast firms in the metro area.

Three different areas of specialization are revealed in the Indianapolis metropolitan area. First, its economy is more specialized in what is often called traditional industry, with large LQs for Chemical Manufacturing (NAICS 325) and Transportation Equipment Manufacturing (NAICS 336),

Table 6.3 Total Employment and Location Quotients for Two-Digit and Select Three-Digit NAICS Sectors, 2010 Quarterly Census of Employment and Earnings

Industry by Two-Digit and Select Three-Digit NAICS	U.S. Total	Atlanta–Sandy Springs–Marietta, GA MSA		Indianapolis–Carmel, IN MSA		Seattle–Tacoma–Bellevue, WA MSA	
Total, all industries	106,201,232	1,816,730		708,417		1,363,645	
		Jobs	LQ	Jobs	LQ	Jobs	LQ
NAICS 11 Agriculture, Forestry, Fishing and Hunting	1,146,962	1,778	0.09	1,786	0.23	4,570	0.31
NAICS 114 Fishing, Hunting and Trapping	8,205	17	0.12	ND	ND	1,122	10.65
NAICS 21 Mining, Quarrying, and Oil and Gas Extraction	651,631	1,020	0.09	697	0.16	702	0.08
NAICS 22 Utilities	551,287	10,524	1.12	3,995	1.09	1,962	0.28
NAICS 221 Utilities	551,287	10,524	1.12	3,995	1.09	1,962	0.28
NAICS 23 Construction	5,489,499	87,263	0.93	36,654	1.00	77,687	1.10
NAICS 236 Construction of Buildings	1,226,917	18,086	0.86	8,621	1.05	18,068	1.15
NAICS 238 Specialty Trade Contractors	3,451,459	56,299	0.95	23,461	1.02	50,312	1.14
NAICS 31–33 Manufacturing	11,487,496	140,959	0.72	82,271	1.07	165,556	1.12
NAICS 312 Beverage and Tobacco Product Manufacturing	183,414	1,706	0.54	1,931	1.58	1,931	0.82
NAICS 313 Textile Mills	119,385	2,045	1.00	ND	ND	51	0.03

(Continued)

Table 6.3 (Continued)

Industry by Two-Digit and Select Three-Digit NAICS	U.S. Total	Atlanta–Sandy Springs–Marietta, GA MSA		Indianapolis–Carmel, IN MSA		Seattle–Tacoma–Bellevue, WA MSA	
NAICS 314 Textile Product Mills	119,145	4,267	2.09	541	0.68	1,305	0.85
NAICS 322 Paper Manufacturing	392,853	6,773	1.01	2,242	0.86	2,365	0.47
NAICS 323 Printing and Related Support Activities	485,523	9,582	1.15	5,604	1.73	5,604	0.90
NAICS 325 Chemical Manufacturing	785,283	9,297	0.69	14,730	2.81	14,730	1.46
NAICS 326 Plastics and Rubber Products Manufacturing	623,259	11,826	1.11	2,600	0.63	4,015	0.50
NAICS 327 Nonmetallic Mineral Product Manufacturing	368,097	7,036	1.12	2,738	1.12	4,756	1.01
NAICS 332 Fabricated Metal Product Manufacturing	1,276,933	10,048	0.46	10,257	1.20	9,633	0.59
NAICS 333 Machinery Manufacturing	991,039	7,249	0.43	6,763	1.02	6,763	0.53
NAICS 336 Transportation Equipment Manufacturing	1,327,169	13,451	0.59	13,187	1.49	83,253	4.89
NAICS 339 Miscellaneous Manufacturing	566,479	6,696	0.69	6,499	1.72	6,956	0.96
NAICS 42 Wholesale Trade	5,466,463	127,674	1.37	39,183	1.07	75,991	1.08
NAICS 423 Merchant Wholesalers, Durable Goods	2,718,043	70,174	1.51	25,401	1.40	38,827	1.11
NAICS 424 Merchant Wholesalers, Nondurable Goods	1,935,875	37,010	1.12	10,899	0.84	24,690	0.99

NAICS 425 Electronic Markets and Agents and Brokers	812,545	20,490	1.47	2,884	0.53	12,475	1.20
NAICS 44–45 Retail Trade	14,481,324	242,687	0.98	88,245	0.91	165,664	0.89
NAICS 441 Motor Vehicle and Parts Dealers	1,630,802	28,995	1.04	10,637	0.98	18,060	0.86
NAICS 442 Furniture and Home Furnishings Stores	436,314	8,111	1.09	2,886	0.99	5,795	1.03
NAICS 443 Electronics and Appliance Stores	502,036	8,996	1.05	3,339	1.00	5,381	0.83
NAICS 448 Clothing and Clothing Accessories Stores	1,379,749	25,902	1.10	7,700	0.84	15,312	0.86
NAICS 451 Sporting Goods, Hobby, Book and Music Stores	604,441	10,761	1.04	3,301	0.82	9,200	1.19
NAICS 452 General Merchandise Stores	2,988,606	51,232	1.00	20,376	1.02	32,650	0.85
NAICS 453 Miscellaneous Store Retailers	772,389	12,774	0.97	5,756	1.12	10,712	1.08
NAICS 454 Nonstore Retailers	414,244	4,640	0.65	3,513	1.27	10,010	1.88
NAICS 48–49 Transportation and Warehousing	3,943,659	105,891	1.57	43,987	1.67	53,143	1.05
NAICS 481 Air Transportation	448,145	37,895	4.94	3,874	1.30	9,495	1.65
NAICS 483 Water Transportation	62,401	152	0.14	ND	ND	2,913	3.64
NAICS 484 Truck Transportation	1,249,934	24,782	1.16	15,231	1.83	15,230	0.95
NAICS 487 Scenic and Sightseeing Transportation	26,399	ND	ND	42	0.24	454	1.34
NAICS 488 Support Activities for Transportation	540,988	10,190	1.10	3,176	0.88	12,838	1.85
NAICS 491 Postal Service	4,424	69	0.91	ND	ND	117	2.06

(Continued)

Table 6.3 (Continued)

Industry by Two-Digit and Select Three-Digit NAICS	U.S. Total	Atlanta–Sandy Springs–Marietta, GA MSA		Indianapolis–Carmel, IN MSA		Seattle–Tacoma–Bellevue, WA MSA	
NAICS 492 Couriers and Messengers	519,434	14,369	1.62	9,643	2.78	9,643	1.45
NAICS 493 Warehousing and Storage	629,934	15,234	1.41	11,206	2.67	11,206	1.39
NAICS 51 Information	2,703,886	75,531	1.63	14,506	0.80	87,250	2.51
NAICS 511 Publishing Industries, Except Internet	754,903	18,782	1.45	5,155	1.02	53,831	5.55
NAICS 515 Broadcasting, Except Internet	293,533	9,954	1.98	1,485	0.76	2,300	0.61
NAICS 517 Telecommunications	902,691	36,546	2.37	5,693	0.95	19,478	1.68
NAICS 518 Data Processing, Hosting and Related Services	242,412	4,600	1.11	909	0.56	3,273	1.05
NAICS 519 Other Information Services	141,462	1,990	0.82	222	0.24	5,253	2.89
NAICS 52 Finance and Insurance	5,486,241	94,491	1.01	40,220	1.10	57,052	0.81
NAICS 524 Insurance Carriers and Related Activities	2,041,869	39,386	1.13	22,072	1.62	24,476	0.93
NAICS 53 Real Estate and Rental and Leasing	1,915,571	38,456	1.17	13,934	1.09	29,743	1.21
NAICS 531 Real Estate	1,382,794	26,948	1.14	9,460	1.03	23,380	1.32
NAICS 532 Rental and Leasing Services	507,470	10,626	1.22	4,203	1.24	5,385	0.83
NAICS 533 Lessors of Nonfinancial Intangible Assets	25,307	880	2.03	161	0.95	170	0.52

NAICS 54 Professional and Technical Services	7,457,913	154,316	1.21	42,480	0.85	109,547	1.14
NAICS 541 Professional and Technical Services	7,457,913	154,316	1.21	42,480	0.85	109,547	1.14
NAICS 55 Management of Companies and Enterprises	1,854,778	38,746	1.22	10,687	0.86	24,620	1.03
NAICS 551 Management of Companies and Enterprises	1,854,778	38,746	1.22	10,687	0.86	24,620	1.03
NAICS 56 Administrative and Waste Services	7,399,320	160,668	1.27	60,157	1.22	83,301	0.88
NAICS 561 Administrative and Support Services	7,043,417	157,658	1.31	57,007	1.21	78,550	0.87
NAICS 562 Waste Management and Remediation Services	355,903	4,066	0.67	2,491	1.05	4,751	1.04
NAICS 61 Educational Services	2,460,150	42,699	1.01	13,177	0.80	22,485	0.71
NAICS 611 Educational Services	2,460,150	42,699	1.01	13,177	0.80	22,485	0.71
NAICS 62 Health Care and Social Assistance	16,196,009	213,258	0.77	104,322	0.97	175,405	0.84
NAICS 622 Hospitals	4,639,079	70,736	0.89	36,372	1.18	37,211	0.62
NAICS 624 Social Assistance	2,467,934	35,336	0.84	11,747	0.71	35,707	1.13
NAICS 71 Arts, Entertainment, and Recreation	1,903,739	25,747	0.79	11,463	0.90	28,676	1.17
NAICS 711 Performing Arts and Spectator Sports	394,835	5,744	0.85	4,479	1.70	6,750	1.33
NAICS 712 Museums, Historical Sites, Zoos, and Parks	127,527	1,057	0.48	991	1.16	1,881	1.15
NAICS 713 Amusements, Gambling, and Recreation	1,381,377	18,661	0.79	6,985	0.76	20,046	1.13

(Continued)

Table 6.3 (Continued)

Industry by Two-Digit and Select Three-Digit NAICS	U.S. Total	Atlanta–Sandy Springs–Marietta, GA MSA		Indianapolis–Carmel, IN MSA		Seattle–Tacoma–Bellevue, WA MSA	
NAICS 72 Accommodation and Food Services	11,103,075	192,467	1.01	70,953	0.96	124,814	0.88
NAICS 722 Food Services and Drinking Places	9,355,821	170,944	1.07	65,026	1.04	109,735	0.91
NAICS 81 Other Services, Except Public Administration	4,349,563	55,065	0.74	26,221	0.90	75,485	1.35
NAICS 812 Personal and Laundry Services	1,266,794	21,626	1.00	8,201	0.97	18,231	1.12
NAICS 813 Membership Associations and Organizations	1,313,677	12,876	0.57	9,701	1.11	12,491	0.74
NAICS 814 Private Households	633,973	2,400	0.22	1,033	0.24	18,352	2.25
NAICS 99 Unclassified	152,667	4,954	1.90	14	0.01	ND	ND
NAICS 999 Unclassified	152,667	4,954	1.90	14	0.01	ND	ND

Source: BLS (2003 and 2010); *Quarterly Census of Employment and Earnings*, http://www.bls.gov/cew/data.htm.

Note: ND = not disclosable. In order to provide the best possible disclosable data, for each NAICS the published data is the better available of either the metropolitan area figure, as reported by BLS, or the sum of the counties in the metropolitan area, as reported at the county level by BLS. Some NAICS may still be underestimates due to nondisclosure. The metropolitan area definitions are based on the metropolitan and micropolitan statistical areas, and metropolitan divisions, defined by the Office of Management and Budget, December 2009.

Location Quotient: Ratio of analysis-industry employment in the analysis area to base-industry employment in the analysis area divided by the ratio of analysis-industry employment in the base area to base-industry employment in the base area.

along with Printing and Related Support Activities (NAICS 323). Indianapolis is also specialized in three sectors that suggest it is a significant distribution hub: NAICS 484—Truck Transportation; NAICS 492—Couriers and Messengers; and NAICS 493—Warehousing and Storage. Finally, a LQ analysis for Indianapolis reveals it specializes in Arts and Entertainment (NAICS 711—Performing Arts and Spectator Sports).

Analysis of Seattle reveals it is narrowly specialized in three industry areas relative to the nation that are representative of three key phases of industrialization. First, it has a very high LQ of almost 11 for NAICS 114—Fishing, Hunting and Trapping. Next, its LQ for NAICS 336—Transportation Equipment Manufacturing—is more than 3 times that of Indianapolis, largely driven by the fact that Boeing has a major facility in the area. Third, the Seattle metropolitan area has high LQs for NAICS 511—Publishing Industries, Except Internet, and NAICS 519—Other Information Services. The first includes software—and, of course, the Seattle metro region is the home of Microsoft. Finally, Seattle has a high LQ for one of the lowest-paying industry sectors, NAICS 814—Private Households.

It is important to understand that the LQ analysis is an index of specialization relative to a reference economy. It does not necessarily indicate that an industry sector with a large LQ has a large number of employees in the local economy. For example, in the case of Seattle, while the LQ for the Private Household industry sector was 2.91, this sector's number of employees represents only 1.3% of all employment (19,106 employees of 1,407,193 total). What this high LQ may suggest is that household help is more affordable in the Seattle metro area, or a greater proportion of higher-income households can afford to hire private domestic workers. Further, the LQ of 12.56 for the Fishing, Hunting and Trapping sector represents less than one thousandth of total employment for the metro area. It is high because of Seattle's location on the Pacific coast, where a lot more of this activity naturally takes place.

Beyond indicating how specialized a local economy is relative to the larger economy of which it is a part, the LQ is essential to determining the economic base of a local economy.

Data Requirements for Location Quotients

The basic data needed for calculating LQs can come from any reliable statistical series for which the same categories of data are available for the local area and for the reference economy. The usual data series are employment by industry from the employment and earnings reports or

from County Business Patterns. Many analysts compare their local area to national data, while others choose to compare their local area to their state or multistate region. To some extent, the decision about which reference area to use depends on the size of the state and its applicability as a good reference. For example, because they are large, California, New York, and Texas are good references for calculating LQs for the cities and counties in those states, whereas Vermont is not large enough to be a reference economy for its townships and counties. Vermont analysts may want to develop a New England (multistate) reference to facilitate their analysis.

While the LQ is most often used with employment data, the same type of ratios can be calculated if the analyst has data on the industry sales, payroll, or any other related data series from which the industry share of the whole economy can be calculated. Indeed, only using employment as a base can send the wrong signal. For example, as efficiency and capital investment work through an industry, often employment falls. In some industries, falling employment may be one of the first signs not of weakness but of strength. Thus, in industries such as construction or farming in which efficiencies in employment are dramatic, a case can be made that analysts should use sales or other economic measures instead of employment.

The Growing Parts of a Local Economy: Understanding Where Jobs Will Be in the Future

Just as it is important to know the current base of a local economy, the analyst must also assess (a) where the economy is going and (b) where the jobs will be. The process of making assessments of the projected future of local economies is very difficult—and extremely risky for the analyst, who could well be wrong. Local economic development agencies often contract with consultants for these analyses since the consultants have more experience and skills. However, to be a competent consumer of the projections of the consultants, every economic developer needs to understand the core issues.

In this section, we will help planners understand two components of the complex nature of assessing a changing local economy. First, we will describe the concepts and tools to go beyond the LQ. This involves a *dynamic analysis* that shows what is growing and what is declining at more than one point in time. Then we will summarize *economic projections* and some of the principles of taking a trajectory of change into the future.

Rationale for a Dynamic Analysis

Analysts will want to know what is changing in the economy for several reasons. First, they will be able to invest public resources wisely and to allocate public infrastructure for appropriate industrial needs. In addition, knowing which industries are likely to grow most rapidly will allow economic developers to understand which jobs and skills are likely to increase, requiring allocation of job training efforts. The latter objective is central to the strategies of the national Workforce Investment Act (WIA) administered by the U.S. Department of Labor (see http://www.doleta.gov/usworkforce/wia/). Under the WIA, state and local areas are mandated to project future job needs.

The data needed for a dynamic analysis of the changes in the local economy are the same as for a static analysis, but they need to be collected at two or more points in time. When choosing the two points in time, ideally the analyst will consider where they fall in the business cycle. For example, the analyst should avoid creating a distorted picture by comparing economic conditions of an economy at its peak or highest output level to the trough or lowest level of the business cycle. Some industries (appliance manufacturing is an historic example) will suffer temporary economic declines in a trough from which they subsequently fully recover. The changes the analyst would record from observing the data at the trough would inaccurately suggest a structural change had occurred in the economy.

A major tool for the analysis of the dynamic changes in a local economy is a set of tools that has been called *shift-share analysis*. Although few analysts actually use the entire shift-share approach, parts of it are essential to helping us understand answers to the key question: How is our area changing, and is it becoming more competitive?

Analysis Tool: Shift-Share Analysis

Shift-share analysis is a powerful technique for analyzing changes in the structure of the local economy in reference to the state or nation. Unlike the LQ, shift-share deals with the changing economy, not just the way it is at one period of time. As with LQs, the community under study can be as small as an incorporated town or as large as a metropolitan region. At the same time, the reference economy can be as small as a county or as large as the nation. As the reader might anticipate, this type of analytical technique is not useful at the neighborhood level.

The purpose of shift-share analysis is to disaggregate the growth of a local economy's industry structure. Again, shift-share analysis can be calculated with employment or other economic data, but employment is usually used. According to the shift-share approach, economic growth or decline in a local area is a combination of three interrelated but distinct components:[2]

1. Economic growth in a local community benefits from or suffers from the changes in the overall national, state, or regional economy. Regardless of what industry it is, the overall growth or decline has an impact on the locality, and part of the change in employment (or sales, etc.) of a local industry has to do with what is happening in the broader economy. During economic expansion or recession, all industries are affected to some degree, and the overall direction of the economy is a context for all local firms and industries. The key here is the notion that the "rising or falling tide raises or lowers all boats." This is called the *national growth effect*. It is calculated as follows:

   Growth: (employment in 2010 – employment in 2000)/
   employment in 2000.

2. The second factor is the relative change of an industry to the total of all industries. In shift-share language, this is called the *proportional shift* or *industry mix effect*, which measures the relative advantage or disadvantage that an industry has relative to the overall economic growth. If communications and health care, for example, are growing faster than the overall economy, they are proportionally more likely to contribute to the growth of the local area. On the other hand, if an industry is declining, such as forestry or agriculture employment, the local area will be shaped by these changes regardless of whether the economy is in expansion or recession. Thus, the second factor shaping the fate of a local community is how well the mix of industries in its area is doing relative to the overall mix of industries in the larger economy. The proportional shift allows one to identify industries that are contributing to growth and decline.

   Industry mix effect = local industry employment ×
   (national industry growth rate – national average growth rate)

3. The differential shift is what most economic development analysts focus on when they use shift-share. The differential shift, also called

the *local share effect*, provides an indication of the competitive advantage of the local economy. It is the difference in the rate of growth or decline in a local industry relative to the rate of growth or decline in that same industry in the larger reference economy. Thus, in industries where the industry mix effect is flat (i.e., the industry as a whole is growing or declining at the same rate as the overall economy), local growth or decline shows that the local industry is doing better or worse than would be expected if the local area were just like the region. However, if the industry in the state or nation is rapidly growing, the differential shift is positive only if the local area is growing faster than the industry in the larger economy. Similarly, if an industry such as agriculture is losing employment overall in the economy, but the local area is losing employment at a lower rate, then it is advantaged. In short, local areas can be advantaged if they are declining less rapidly in declining industries, but they must be growing faster than expected in growing industries to have a positive differential shift. When the differential shift of a particular industry is positive, then it is assumed to be more competitive than the reference economy in this industry.

Local share effect = local industry employment in base year ×
(local industry growth rate – national industry growth rate)

The change in employment for each industry (and for the local economy overall) is equal to the sum of the national growth effect, industry mix effect, and local share effect. Shift-share analysis provides helpful insights into the local economy, but, as Shields (2003) noted, it has limitations: It minimizes business cycle impacts; while it shows where a comparative advantage may be, it cannot identify the cause; and its results are sensitive to the time period as well as level of industry aggregation chosen for calculating employment change.

A shift-share analysis for Cincinnati is presented in Table 6.4. Data are shown for both 2003 and 2010. Note that the first calculation (Column G) is the rate of change of each industry, not the share of the total as in LQs. Two calculations of the rate of growth are required for each industry—one for the metro area county (Column H) and one for the nation (Column I). Some will be found to be positive and some negative. More industries will show positive growth if employment is growing, and most may be negative if employment is declining. It is expected that there will be differences in growth between the local area and the nation, because no local area's economic structure is identical to the nation's. Further, it is precisely the local economy's performance relative to the larger reference economy that shift-share analysis is designed to detect.

Table 6.4 Calculation of Shift Share, Cincinnati, Ohio, Metropolitan Area

		Cincinnati MSA			United States			Shift-Share		
		A 2000 Employment	B 2006 Employment	C Percentage Change[a]	D 2000 Employment	E 2006 Employment	F Percentage Change[a]	G Shift (Overall Growth)	H Proportional Shift[b]	I Differential Shift[c]
11	Agriculture, Forestry, Fishing and Hunting	319	423	32.6%	1,201,637	1,167,004	–2.9%	3.3%	–6.2%	35.5%
21	Mining	488	496	1.6%	511,418	617,048	20.7%	3.3%	17.4%	–19.0%
22	Utilities	6,068	2,951	–51.4%	847,075	803,859	–5.1%	3.3%	–8.4%	–46.3%
23	Construction	47,905	48,792	1.9%	6,848,386	7,793,430	13.8%	3.3%	10.5%	–11.9%
31–33	Manufacturing	145,757	120,576	–17.3%	17,363,496	14,153,115	–18.5%	3.3%	–21.8%	1.2%
42	Wholesale Trade	51,773	55,630	7.4%	5,741,228	5,885,436	2.5%	3.3%	–0.8%	4.9%
44–45	Retail Trade	114,649	108,981	–4.9%	15,344,490	15,435,110	0.6%	3.3%	–2.7%	–5.5%
48–49	Transportation and Warehousing	45,342	40,139	–11.5%	5,386,807	5,302,583	–1.6%	3.3%	–4.9%	–9.9%
51	Information	20,314	16,247	–20.0%	3,757,053	3,185,907	–15.2%	3.3%	–18.5%	–4.8%
52	Finance and Insurance	44,623	49,369	10.6%	5,578,028	6,037,467	8.2%	3.3%	4.9%	2.4%
53	Real Estate, Rental and Leasing	15,086	13,465	–10.7%	2,074,629	2,203,542	6.2%	3.3%	2.9%	–17.0%

54	Professional, Scientific, and Technical Services	50,303	52,427	4.2%	6,919,298	7,502,331	8.4%	3.3%	5.1%	–4.2%
55	Management of Companies and Enterprises	29,653	32,430	9.4%	1,783,807	1,785,257	0.1%	3.3%	–3.2%	9.3%
56	Administrative, Support, and Waste Management and Remediation Services	61,058	67,195	10.1%	8,125,498	8,376,060	3.1%	3.3%	–0.2%	7.0%
61	Educational Services	43,467	46,914	7.9%	10,554,237	11,734,366	11.2%	3.3%	7.9%	–3.3%
62	Health Care and Social Assistance	108,102	125,095	15.7%	14,233,766	16,480,734	15.8%	3.3%	12.5%	–0.1%
71	Arts, Entertainment, and Recreation	19,649	19,638	–0.1%	2,071,818	2,286,930	10.4%	3.3%	7.1%	–10.4%
72	Accommodation and Food Services	75,761	86,515	14.2%	10,055,329	11,189,512	11.3%	3.3%	8.0%	2.9%
81	Other Services	33,027	30,587	–7.4%	4,200,336	4,420,427	5.2%	3.3%	1.9%	–12.6%

(Continued)

Table 6.4 (Continued)

		Cincinnati MSA			United States			Shift-Share		
		A 2000 Employment	B 2006 Employment	C Percentage Change[a]	D 2000 Employment	E 2006 Employment	F Percentage Change[a]	G Shift (Overall Growth)	H Proportional Shift[b]	I Differential Shift[c]
92	Public Administration	30,975	34,214	10.5%	6,961,574	7,228,408	.8%	3.3%	0.5%	6.6%
99	Unclassified	n/a	617	n/a	n/a	245,310	n/a	3.3%	n/a	n/a
	Total	944,319	952,701	0.9%	129,559,910	133,833,836	3.3%	3.3%	0.0%	–2.4%

Source: BLS (2003 and 2010); *Quarterly Census of Employment and Earnings*, http://www.bls.gov/cew/data.htm.

a. Rate of growth or decline for each industry is 2006 employment divided by 2000 employment, minus 1 (B/A–1, or [B–A]/A).

b. Proportional shift is calculated by subtracting the total (all industry) rate of growth for the county from the industry-by-industry growth or decline (F–G). This shows which industries exceeded or lagged what would be expected if everything grew at the same rate as the nation.

c. Differential shift is calculated by subtracting the rate of growth of each industry at the national level from the rate of growth of the same industry at the local level (F–C).

Shift-share can be useful to identify the industries in which a local area has a competitive advantage and that are growing faster than would be expected if they were performing just like the national economy. Shift-share analysis can also reveal a local economy's weaknesses. In the case of Cincinnati, we see that the metropolitan area did not grow between 2003 and 2010, while the nation grew slightly (–3.9% versus .02%). The proportional shift shows which national industries' employment exceeded or lagged what would have occurred if they had experienced the same rate as the national overall average. The differential shift reflects the difference between the growth rate of a particular industry in Cincinnati and its national growth rate. In interpreting the analysis in Table 6.4, it is important to note the actual employment numbers that are generating the shifts. Many of Cincinnati's industries grew less or declined more sharply than their national counterparts. The larger the industry, the greater the concern this should generate. At the same time, those industries with larger employment levels in 2003 that also grew at a higher rate than the national industry warrant attention, as they suggest a competitive advantage for Cincinnati. There was really one significant industry in this category: Management of Companies and Enterprises (15.3%). While there is a very large differential shift of 57.5% for Agriculture, Forestry, Fishing and Hunting, employment in this area was too small to make this noteworthy (622 out of 946,500 in 2010).

Principles of Economic Projections

In an effort to plan for future changes in the local economy, economic development analysts make projections into the future based on changes that can be determined from present conditions. These can require sophisticated econometric and other analytical strategies for which local economic development planners often rely on outside consultants. However, the key to many economic projections is that they build on trajectories from the recent past. To start, economic developers can examine what would happen if the trends observed in the economy over the past decade were to continue into the future. Since the future is never exactly like the past, the recent past is best used as a starting point for analyzing the types of forces likely to change the direction things will take in the future. For example, in an area coming through a downturn in military spending and base closure, it would not be expected that the problems of military cutbacks will be as difficult for this community in the future as they were just after the base was closed. Similarly, communities that benefited from the dot-com boom and bust of the early 2000s knew that these changes were unlikely to repeat themselves in the next decade. On the other hand, communities seeing a steady growth in

their tourism or medical industry may well expect that these trends will continue to dominate the future. Looking at previous trends and then examining the extent to which they will not continue into the future is a good reality check for all economic development analysis.

Economic development analysts also can make use of national or larger area projections to plan for changes in the economy. For example, the BLS publishes 5-year projections of which occupations and which industries will grow or decline. The analyst can use this to examine the local economy and determine where there may be a need for new training programs and economic adjustment assistance.

Another aspect of economic projections is to consider how a change in the present or near future can be expected to have longer-term effects. This will be addressed in the next section.

How Do Changes Multiply Through the Economy?

The Concept of Cumulative Change

The dynamic quality of the local economy is not demonstrated by a lot of independent industries acting in isolation from each other. Instead, it is a highly interconnected network of economic exchanges of which consumption or export is only the last step. When one buys a computer, for example, the company that produces it purchases parts from many other companies. The supply companies may not be in the same state or even nation as the company making the computer, but when the computer maker increases sales, so do the supply companies.

For instance, computer makers often buy memory chips from companies specializing in memory, and these companies in turn buy the many things they need to make the chips from yet other companies—silicon, metal contacts, chemicals, plastics, fabricating machinery, energy, packaging, and so forth.

Hard disk drive suppliers also supply computer manufacturers, and an increase in purchases of hard disks will also lead to an increase in purchases from a different set of suppliers. Thus, with an increase in computer purchases, all these suppliers and the suppliers of the suppliers will see an increase in their business as well. And, of course, a decline in computer purchases will lead to a decline in the sales of the suppliers.

Referring back to page 180, the fourth question local economic developers needs to ask, then, is how any particular changes in this interconnected economy will affect the entire economic base. For this, they use the concept

of a *multiplier* to summarize the cumulative change or sum of all economic activity that results when any one part of the economy either grows or declines. The sum of the economic activity will be made up of direct and indirect effects. For example, the local multiplier for a computer industry that has obtained an order for an additional $1,000 of computers is as follows: a direct effect of $1,000, plus an indirect effect from the sales made by local serving firms due to the additional $1,000 coming into the local economy. These sales may be made to the computer industry for supplies to create the additional product, or they could come from employees of the firm making increased local purchases with additional income, or some combination thereof. If the sales made by local serving firms are $600, then the total increase in sales is $1,600, for a multiplier of 1.6. Multipliers can be computed for employment changes or income changes as well. In general, local multipliers are highest in areas where a large proportion of inputs are made locally and in industries in which there are many economic transactions along the way. For example, if the computer manufacturer is located in an area where no parts are made and all parts are purchased from another region, then the additional $1,000 in sales will have little additional impact locally. On the other hand, if the computer manufacturer is in Silicon Valley, the local multiplier will be high. As another example, labor-intensive businesses such as dry cleaners have few outside purchases when their business increases—they may need a bit more cleaning fluid (which is reused by the newest machines) and energy, but most of their cost is labor. Their multiplier will be small regardless of where their suppliers are located.

Economic developers need to understand how changes will multiply through the local economy, and the multiplier can help them to prepare for the total impacts if an existing industry grows, a new industry locates, or an industry leaves the local economy. The multiplier can also be used to consider whether public incentives provided to an industry are justified based on the total growth that may be expected from the added employment or sales that the industry is expected to create in the local economy.

Analysis Tool: Input–Output Analysis

The 1973 Nobel Prize in Economics was awarded to Wassily Leontief for developing input–output analysis. His first major treatise on the topic in *The Structure of American Economy 1919–1939* was published in 1941. Leontief viewed the economy as a large system that had industries trading with each other. Given widespread computer and programming availability, a number of software programs are able to calculate local input–output analyses. IMPLAN is one of the best-known programs, and it runs on a

personal computer. Although it is complicated and this text does not pretend to explain it, the program is in widespread use by economic development consultants and large economic development agencies.

The *framework* for an input–output analysis lists the industries in a region along both the horizontal and vertical axes of a table. The industries on the vertical plane are suppliers, and the industries on the horizontal plane are buyers. To develop a national input–output table, many firms were interviewed to determine what was needed to produce a dollar's worth of product. Because a typical firm buys from a limited number of industries, these were all identified. A firm also buys labor, which was estimated. Similarly, firms sell to a relatively limited number of buyers, which are other industries, and these were identified. Producers also sell to people who are consumers—what is called final demand. The national tables also estimate on average what people will buy when they receive additional income. Adding imports and exports, the tables were balanced to represent the total dollar transactions for the entire economy. Then the inputs and outputs were standardized as ratios between 0 and 1, which can be summarized to provide multipliers.

Input–output analysis starts with a national model and can be adapted to fit local areas. A number of alternative strategies can fit the national data to a local area, but they all work in roughly the same way. Taking the national coefficients, for example, IMPLAN adjusts production levels to fit states and counties based on what is known about the total output by industry in each state and county. IMPLAN balances local economic activity with other areas to total state and national totals, tracing the flow of goods as production increases or decreases. This provides a local area an idea of purchases and sales characteristic of its particular industrial mix.

Input–output analysis generates three types of multipliers that are of great interest to economic development professionals. The first type of multiplier includes just the first-order transactions of what an industry must buy to increase production by $1.00. For example, a pen manufacturer will need to buy certain amounts of plastic, metal, ink, and other materials to make a pen and will also buy some energy, buildings, and machinery. The firm will also hire a certain amount of labor, lawyers, and other business services. The first-order multiplier traces these direct expenditures by the pen manufacturer, and it is the smallest of the types of multiplier.

The second type of multiplier looks at the input–output consequences of these direct purchases. The firms that sell to the pen manufacturer will themselves have to buy more things unique to their industry in order to manufacture the goods or services they sell to the pen manufacturer.

Thus, metal producers will need to buy ore, machinery, energy, and other things. The ink producer will have to buy the graphite, oil, and other chemicals that go into ink. The cascade of purchases goes on in that the ore producers, ink chemical makers, machinery manufacturers, and so on will also have to buy steel, energy, and other items. In fact, this cycle is nearly infinite, though the indirect purchases quickly become trivial. From a local perspective, this second-order multiplier is reduced to the extent that purchases are made by firms outside the region and to the extent that outside firms do not buy things made locally.

There is also a third-level multiplier that takes into account another layer of impact. That is, at each step, the dollar increase in sales of pens goes to some part of a dollar in wages to employees, who earn wages with which to buy products and services. When they are purchased, they increase sales as well—of housing, cars, clothing, food, electronics gadgets, and so forth. (An average market basket of consumer items purchased by workers in each industry has been developed.) And each of these products or services a worker buys has its own cascade of production inputs.

The construction of the input–output tables did not entail tracking of the dollars spent by all these people who had indirect impacts on the economy due to the increase in sales of pens. Once the input–output table determines how much is spent in each transaction, mathematical models calculate all the millions of subsequent transactions. The result produces estimates based on the average expenditure for each industry and individual.

Using Input–Output Analysis in Local Economic Development

While input–output analysis has many uses in economic development, it can be misinterpreted and lead to unreasonable claims such as overpredicting the final impact of a subsidy to a specific industry. In interpreting results, the analyst should consider the following:

- Input–output analyses and the multipliers derived from them are based on national models and not on local information. If a local area has unique industries, this may not be picked up by the national averages used in input–output analysis. For example, a local area specializing in making custom-designed furniture for wealthy clients will not have the same coefficients as the overall furniture industry, which largely mass produces items. This difference is not reflected in local tables.
- Multipliers at the local level are usually quite low. For example, many advocates for local industry claim that if a business comes to the local

area, it will have a multiplier of three times or more. Therefore, they argue, offering local incentives to attract the firm will result in three times as much local economic activity as is now generated. In fact, rarely are multipliers for a local area above 2.0, and usually these are in the 1.5 to 1.75 range.

- Multipliers in rural areas are lower than in large metropolitan areas. In rural areas, few of the inputs that are needed by most other producers are available in the same county or region, so they must be imported from outside, "leaking" dollars out of the local economy. This large amount of leakage means that the multiplier will be very low. In some agricultural areas with seed, fertilizer, and processing facilities in the county, the multiplier for agriculture can be high, but the suppliers usually serve many other rural counties where the multipliers will thus be low. In large metropolitan areas such as Los Angeles, in contrast, a diversity of suppliers will be able to meet most local needs and the multipliers will be closer to 2.0 in many industries.
- Input–output analysis is available only on a subset of industries, depending on the source and the size of the local area being examined. The smaller set of industries does not necessarily have the level of detail that a full three- or four-digit analysis would provide, leaving much of the interesting detail unable to be studied.
- Input–output analysis and multipliers are simply starting points for an economic development analysis, and they need to be supported by interviews and extensive additional analysis.

Overall, the complex portrait provided by an input–output analysis of the local economy can enhance the economic development professional's understanding of the consequences of different development scenarios.

Identifying Industrial Clusters: The Most Important Parts of the Local Economy

Local Networks of Buying and Selling

The final analytical strategy for economic development we discuss in this chapter addresses the question of what are the most important parts of the local economy in terms of growth and strength. The typical local economy has a number of highly concentrated industries—several of which may be growing. In addition, many of these may be linked together into a strong local network of buying and selling. Local economic developers have recognized that not all businesses are the same in terms of their contribution to

the growth of the local economy and their potential to create jobs and improve local well-being.

Economic developers have adopted the concept of industrial clusters to help them explain and nurture growing economies. A *cluster* is more than just the largest firms in a local area—it is the network of interrelated firms that buy and sell from the same suppliers, share markets, and are supported by a common specialized infrastructure.

The prototypical cluster is the electronics industry in Silicon Valley. There, a network of electronics firms has a global advantage because its members have a critical mass of firms in related fields, they are in proximity to firms and labs developing new technologies so they can learn about and adopt those advances before they become available elsewhere, they benefit from social infrastructure (e.g., universities, research centers, venture capital, and industry associations located nearby), and they have direct access to advantageous marketing channels (Bradshaw, 2000).

Other areas also have strong industrial clusters, but not all clusters are high technology. For example, California's Napa and Sonoma valleys are centers for the wine cluster; agricultural technology is located in the central valley; the apparel cluster is in Los Angeles around the Fashion Mart; and Sacramento is host to an expanding information technology (IT) cluster. Autos are clustered in Detroit; finance is in New York; and plastics and rubber are in Akron. Many cities and regions have well-identified and highly visible clusters, but the promise of cluster analysis is to help identify clusters in places where they are not so visible and to help any place become aware of potential sets of industries that can be nurtured as a cluster. The proximity of multiple industries (or what economists call *agglomeration*) means that they gain benefit from their common location in addition to whatever each firm might be able to do by itself (Bradshaw, King, and Wahlstrom, 1999).

Analysis Tool: Cluster Analysis

Economic developers need to (a) understand the clusters in their region and (b) adapt programs to support the diverse needs of the firms in the cluster. To do these two things, clusters need to be identified. For purposes of analysis, industrial clusters can be defined as firms in related industries that are as follows:

- Geographically *concentrated* in a particular region
- Gain a *competitive advantage* because of their proximity to each other in the region
- Share specialized *supplier and buyer (marketing) advantages* because of their location

- Supported by *advantageous infrastructure* in the region, such as physical resources (e.g., a port or access to minerals), educational and research advantages (e.g., universities), financial institutions (e.g., venture capital), or labor advantages (e.g., training programs)

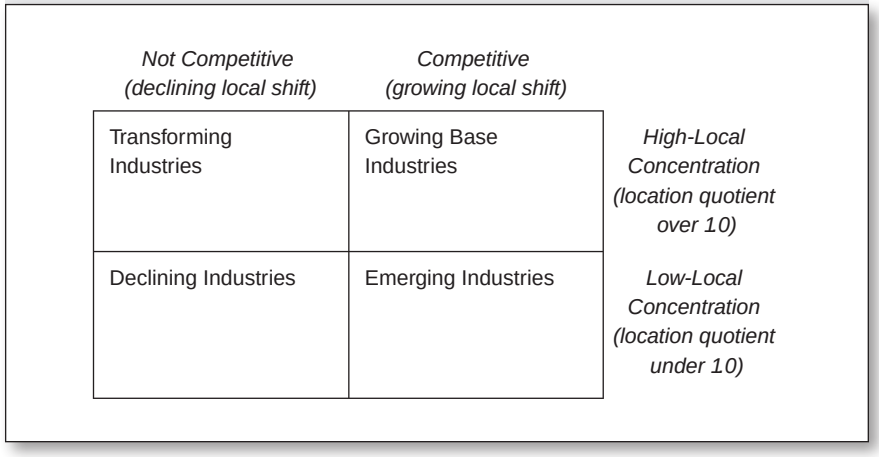
These four criteria are common to most definitions of clusters, though there is no agreed-upon methodology or formula for defining a cluster. Indeed, there are some economic developers who favor identification of local clusters by consensus of business and community leaders, not through a statistical analysis. On the other hand, some cluster identification techniques involve complex data analysis and statistical techniques that obfuscate the relationships that seem central to the concept.

The objective of a cluster analysis is to identify a set of interrelated industries composed of firms that have competitive advantages because they are colocated in a geographic area. The set of firms that has a competitive advantage may include firms in just a single two- or three-digit industry, or in several industries with similar NAICS codes, or in a wide assortment of industries that cut across many different parts of the NAICS code. Cluster analysis is also used in local economic development to identify emerging clusters of firms that may not yet have enough size to show up strongly in a quantitative analysis using standardized data. For example, if locally available data show that firms form a competitive cluster but these firms are buried in NAICS codes that do not fully describe their output, the case still can be made for thinking of them as a cluster. To illustrate, locally based arts and crafts production is often classified with individual firms in jewelry, art, tableware, furniture, and so forth, and would consequently be buried in a standard cluster analysis. On the other hand, artisan crafts may go hand in hand with a tourism industry and be a major economic force in a community. In the end, cluster analysis techniques are limited by the data available, and the analyst must think creatively about the network of firms in the local area if the results are to be useful.

Four steps can guide a first-cut cluster analysis:

Step 1. Highly concentrated and competitive industries are the building blocks of a cluster. To construct a preliminary cluster analysis, LQs and the local differential from shift-share should be calculated for all industries in the local area at the two- and three-digit levels, if possible. As shown previously, industries with an *LQ greater than 1* are concentrated in the local area and probably export their production to the wider area. Also, we showed

Figure 6.2 Four-Quadrant Table



above that industries with a *local differential greater than 0* had a competitive advantage of growing more rapidly. These two descriptions of industries, which show strength in the local economy, can be combined to form a four-quadrant table (see Figure 6.2), which collectively illustrates the findings of a LQ and shift-share analysis.

Step 2. From candidate industries found in the upper-right quadrant of the fourfold table, clusters can initially be located. It is important at this point to note that concentrated and competitive industries are not necessarily also clusters and that all parts of a cluster are not necessarily in the upper quadrant. The best strategy is to construct the four-quadrant table for both two- and three-digit industries. The key to cluster analysis is to start with industries that are both concentrated and competitive in the local area and then to refine this categorization—for example:

A. Local industries that are concentrated but known not to export should be eliminated. The typical concentrated industry that should be eliminated for this reason is construction, which may be concentrated and growing only in response to local population or economic growth. In growing areas, construction may generate a lot of jobs, but it sells nothing for use outside the local area.
B. Industries like transportation and utilities that are supportive of all industries are usually not parts of a cluster but constitute specialized infrastructure that benefits a wide array of firms.

C. Single firms that dominate an industry are often insulated from other businesses and do not constitute a cluster of firms in related industry. This is most common in rural areas.

   ○ After removing obviously inappropriate industries from the top-right category, the analyst should look for related industries that can be combined. Usually by the end of Step 2, a number of candidate clusters will have been identified. These need to be refined further and the top candidates selected. The issue in cluster analysis is not that a set of firms either is a cluster or is not a cluster. Clearly, there are different degrees to which a set of firms gains competitive advantage because of its common location. The economic developer is interested in strengthening these competitive advantages.

Step 3. After the analyst has narrowed the list of concentrated and competitive industries, the next step is to determine whether the candidate clusters do the following: (1) share advantages of having local supplier and marketing chains and (2) have an advantage of specialized infrastructure in the local area. The presence of local supplier linkages can be determined from the input–output table. First, the analyst will determine which suppliers are strongest for a given industry—both locally and in relation to whether local suppliers are more important than external suppliers. These data can be obtained from input–output tables. Identification of suppliers and markets can be understood as an hourglass-shaped set of linkages, with the core of the cluster (identified by Step 2) at the narrow middle point. The linkage of suppliers needs to be supplemented by an understanding of marketing channels for the products. Marketing drives the concentration of some industries. For example, Scott (1988) showed that the Fashion Mart in Los Angeles was such a major outlet for designer dresses that designers needed to be nearby as well as sewing shops for top-line fashion. In addition, fabric suppliers, accessory suppliers, and other companies found it to their advantage to be near the top design shops. This specialization continued to stimulate even mass-production fashion firms, which needed to be near the designers. Thus, the market gave the local area its advantage. Specialized marketing firms and outlets in other industries play similar marketing roles.

Step 4. Finally, to complete the cluster analysis, one must examine the nature and presence of specialized local infrastructure that can assist in the development of the main cluster industries and their suppliers. The nature and strength of these relationships is unlikely to be determined by quantitative measures; rather, they will be ascertained by examining the type of industry and its business patterns. Around the country, different local

infrastructure advantages help shape clusters. Military markets drove the advantages that defense and aerospace companies had in Los Angeles and that shipbuilding companies had around Virginia. Proximity to minerals shapes the location of iron-producing regions, as national parks influence tourism. Transportation routes also are important for some industries, including ports and airports, favoring cities on either the Pacific or Atlantic coast. As well, telecommunications lines (e.g., fiber optic cable and access to main hubs of the Internet) give certain areas advantages over places without this infrastructure. It is possible, but less common, for a cluster to develop without an identifiable specialized infrastructure.

Clusters are important because they form the core of regional economies, and they define the jobs that will be created as the economy grows and changes. Clusters in an area include firms that account for a disproportionate part of their industry in the state; thus, these are a core part of the existing economic base in a region. Furthermore, firms in a cluster have more rapid growth than other firms in their industry because they are competitive, and they are inherently networked, which helps identify related firms that are likely to grow along with the core.

In 2004, the Cincinnati USA Partnership, the economic development arm of the Cincinnati USA Regional Chamber, worked with the University of Cincinnati's Economics Center for Education and Research to develop an industry cluster identification report. The May 2004 *Identification of Industry Clusters for Guiding Economic Development Efforts in Cincinnati USA* report used available data, new analysis, and the findings of six prior studies to determine the clusters on which the Cincinnati USA Partnership should focus its future economic development work.

The PLED Problem Solving 6.1 box summarizes the primary analytical techniques the Economics Center used to identify clusters in the Cincinnati region.

Cincinnati USA Partnership Cluster Work 8 Years Later

Cluster identification is only the first stage in the process of pursuing a target-based approach to economic development. Since the Economics Center report's release in 2004, the Cincinnati USA Partnership has been working on using its findings to foster economic growth in the region. Primarily, progress has been made in the areas of Aerospace, Motor Vehicle Manufacturing, and Chemicals and Plastics.

During its economic development work, the Cincinnati USA Partnership has found that the region's clusters are more specialized and defined than the 2004 cluster definitions would suggest. For example, in Aerospace,

PLED PROBLEM SOLVING 6.1
Cluster Case Study: Cincinnati, Ohio, Metropolitan Area

Part 1. The analysis began with a calculation of regional LQs for each two-digit level NAICS business sector code. These data were used to determine in which sectors the Cincinnati region has an apparent specialization, as measured by those with an LQ over 1.0.

The analysis found that the region no longer had its historic economic dependence on manufacturing, with management of companies and enterprises, transportation and warehousing, and wholesale trade each having a higher LQ than manufacturing. A brief county-by-county analysis of jobs distribution was also conducted to garner a better sense of subregional economic patterns.

Part 2. The next step was an analysis of occupational LQs in 22 classification groups. The occupational analysis is beneficial because it is the best means of assessing the skills base of the current workforce, which impacts the types of jobs that can be attracted or grown, at least in the short term.

The initial occupational analysis found that the Cincinnati region had proportionately more jobs in production and transportation and material-moving occupations.

Further analysis was done of 34 more specific occupational groupings in which the region was found to have a high occupational LQ. This analysis also divided occupations by average wages to focus on jobs with higher earnings potential.

This additional occupational analysis found the region had a high number of jobs in management, marketing, promotions, advertising, and sales professions. Less specialized but also found to be noteworthy were occupations in the fields of finance, insurance, computer programming and science, architecture, engineering, and health care.

Part 3. The next phase of the analysis was to measure job growth rates by sector compared with national trends (from 1990 to 2000). The BLS national projected job growth rates (from 2002 to 2012) were also analyzed to determine what areas of the national economy appeared to be healthier than others. The primary finding was that service-based sectors were generally healthier than production-based sectors.

In a similar historic and projected growth analysis of occupations, the report found that the Cincinnati region had enjoyed strong growth in service, executive, professional, and technical occupations. Nationally, future growth was expected to be strongest in management, business, financial, professional, and service jobs. The report highlighted the fact that a number of these required at least a 4-year degree for employment.

Part 4. The next phase of the analysis looked at more qualitative factors in its consideration of how sectors related to each other in terms of supply chain or competitive relationships. The research used the U.S. Department of Commerce Bureau of Economic Analysis's 1997 report, *Input-Output Transactions Between NAICS Sectors*, and its own factor analysis to identify 29 national clusters.

Those 29 clusters were analyzed using six measures that the Economics Center determined were a good basis for evaluating the health of a national cluster within the Cincinnati region (based on 2001 data):

- Average wage higher than $35,000
- Representative of at least 1% of total jobs in the region
- Exporter (primary customer base extends beyond the region)
- LQ analysis (comparatively high percentage of total)
- Healthy sector nationally, measured by job growth rate
- Shift-share analysis (local growth outpaces national growth)

Based on that analysis, the report identified the following clusters for the Cincinnati region:

- Advanced Design Services
- Advanced Manufacturing (metalworking, industrial machinery, and primary nonferrous metals)
- Aerospace
- Biotechnology
- Business Management
- Chemicals and Plastics
- Digital Equipment and Telecommunications
- Financial Services
- Motor Vehicle Manufacturing
- Software and Data Processing

The identified targets were analyzed within the context of occupational groupings to determine whether the existing labor force could support them. The measure of analysis used was the number of "critical occupations," or those that were most difficult to fill because they either required a high skill level or represented a large proportion of the industry's total jobs. The Advanced Design Services cluster definition was refined somewhat based on these findings, but otherwise this analysis did not impact the identified clusters.

Part 5. To validate and further refine the cluster definitions, the list of identified clusters was compared with the findings of six previous studies conducted between 1999 and 2003. The scope of these ranged from Cincinnati's home county of Hamilton to the states of Ohio and Kentucky. The Economics Center's analysis determined that all but one of the clusters it identified (Advanced Design Services) were included in at least two of the previous studies.

The Hamilton County analysis—the April 2004 Hamilton County Regional Planning Commission report, *Hamilton County's Comparative and Competitive Advantages* (Hamilton County Regional Planning Commission Community Compass, 2004)—used the four-quadrant concept to illustrate the findings of its LQ and shift-share analysis (see Figure 6.3).

(Continued)

(Continued)

Figure 6.3 Hamilton County Four-Quadrant Table

Not Competitive (declining local shift)	*Competitive (growing local shift)*	
Transforming Industries—"Emerging" • Arts, Entertainment, and Recreation • Information Technology	**Growing Base Industries—"Stars"** • Advanced Business and Financial Services • Advanced Manufacturing • Chemicals • Food Processing and Technology	*High-Local Concentration (location quotient over 10)*
Declining Industries—"Declining" • Transportation, Logistics, and Distribution • Advanced Materials	**Emerging Industries—"Transforming"** • Biomedical/ Biochemical • Information, Communications, and e-media	*Low-Local Concentration (location quotient under 10)*

Source: Hamilton County Regional Planning Commission Community Compass (2004).

Cincinnati's primary opportunities are in the power and propulsion-equipment side of the industry. In the area of Chemicals, Cincinnati's existing strength in food product flavoring is a promising subsector from which to leverage further growth.

Based on this experience, the Cincinnati USA Partnership has continued to examine the region's economy to determine more specific cluster definitions and monitor potential new clusters. It has now identified four emerging industry clusters that include advanced energy, consumer products and creative services, IT, and life sciences. In the last cluster, the Cincinnati USA Partnership has identified more than 220 businesses engaged in research, testing, and production of pharmaceutical, medical, and agricultural products.

Cincinnati's experience is evidence of the reality that local regional cluster identification remains a moving target as local knowledge expands or new

local or national economic realities take hold. While some consistency must be maintained for local target development activities to be effective, local economic development professionals must also be aware of the constant change that is inherent in a regional economic climate.

Using Clusters in Local Economic Analysis

The term *clusters* has become a common buzzword in economic development analysis and, as such, tends to be overused. Taking this fact into account, the economic developer can use the concept of clusters in several ways:

- *Specialized infrastructure strategies.* In this first strategy, the policy issue is to build the infrastructure that supports the core firms, their suppliers, and marketing. Many economic development programs focus on infrastructure, which looks at transportation, ports, telecommunications, industrial parks, redevelopment, natural resource extraction and availability, and other "hard" resources needed by industry. In addition, finance, legal specialization, regulatory environments, and other "soft" infrastructure may be needed. The most often noted and perhaps the largest contributors to many leading clusters are education and research facilities, such as university labs, technology transfer programs, and higher education degree programs. Specialized research, such as the University of California, Davis's research on wine, is often credited with being the core around which leading clusters build. Likewise, research programs at the University of California, Berkeley and at Stanford are often credited with supporting the electronics and biotechnology clusters in California, though others suggest the university role is overstated.
- *Missing link strategies.* The second way policymakers can expand the strength of a cluster or rescue a threatened one is to identify gaps in supply and marketing linkages. If a cluster is not achieving its potential national or global advantage because a key supplier or buyer is missing, steps may be taken to fill the gap. Because it is not the public's role to establish a firm to fill the open slot, economic development programs often target certain industries using cluster analysis to identify challenges and solutions. In the New Economy, economic developers see their role as one of generating the information so that businesses fitting into the supplier or buyer linkages of a cluster are made aware of the advantage of locating in the local area.
- *Human resource strategies.* A third way to expand clusters is to increase the skill and training available to workers. By having a competent workforce, clusters have what they often consider the core resource for being more competitive. Communities can take

advantage, for example, of the WIA and school–higher education programs, as well as lifelong learning and retraining programs. In addition, human resource skills can be focused on likely growth industries that make every firm more successful. Occupations associated with these growth industries are good targets for training programs.

- *Marketing strategies*. Clusters are most successful when they are well known. If a cluster does not have market identification, it is most unlikely that it will grow and expand. The public role is to find ways to help identify and promote clusters. Public policies, from government procurement policy to public equivalents of marketing boards, can strongly influence the market for products. Public assistance in marketing ranges from proclamations of leadership (e.g., "artichoke capital of the world") to establishing convention centers, visitor centers, museums, and other facilities that assist marketing. Location of industry associations is also strongly associated with effective industrial marketing.

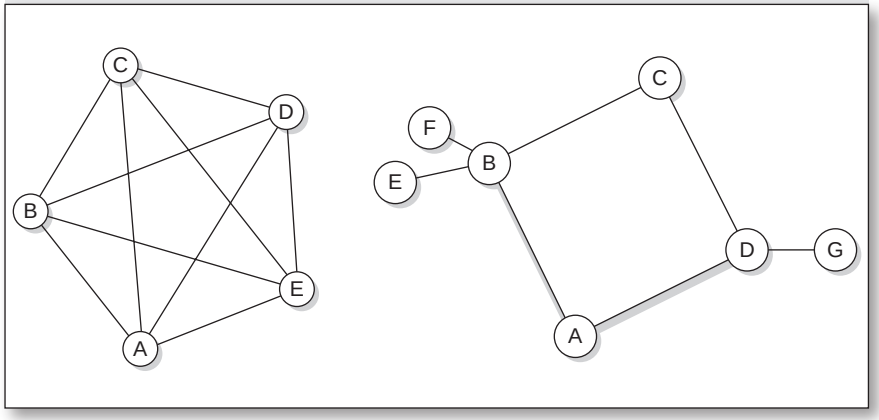
These four significant policy arenas cut across all types of clusters and provide strategies to address policy opportunities and needs that must be met.

Social Network Analysis

We have focused in this chapter on four key quantitative methods used by economic development analysts to understand and plan for their local economies, and the first three methods—LQ, shift-share, and input–output analysis—can all be useful to help identify the fourth, cluster analysis. As we described earlier, cluster analysis identifies a set of interrelated industries composed of firms that have competitive advantages because they are colocated in a geographic area. The identification of the cluster is made through quantitative analysis.

Economic developers seeking to promote policies to strengthen clusters can benefit from a better understanding of the interorganizational network of their local economy's industry cluster. Social network analysis (SNA) is a relatively new tool that uses specialized software to identify the network of a cluster. (For a review of international practices, see Giuliani and Pietrobelli, 2011.) It can be used as a descriptive or policy tool. The types of interactions between members of the cluster network are derived from qualitative data such as surveys of cluster members that ask about who they buy and sell to, have on corporate boards, have technology or research collaborations with, and other possible interactions. When combined with geographic information system (GIS) analysis, links between network members and nodes (areas of spatial concentration of network members) can be

Figures 6.4a and 6.4b Cluster Development Networks



identified and help to inform efforts to strengthen the collaborations and connections of the network. This, in turn, can increase positive economic development outcomes.

The two figures that follow are highly simplistic representations of two different cluster development networks. In Figure 6.4a, the firms in the network are all connected to each other, which suggests high levels of mutually beneficial interactions occur that can lead to strong economic outcomes. In Figure 6.4b, there is a dense core of well-connected firms along with less-connected peripheral firms. The less-connected firms may not experience as great a benefit from the network. For example, firm G may be a supplier to firm D and would benefit by also selling to firm C. However, neither firm G or C is aware of the other, and thus firm C buys the input that could be provided by firm G from a firm outside of the network and the local economy. A policy to strengthen the interactions between firms in the network represented in Figure 6.4b could lead to greater sales for firm G and less leakage of income from the local economy, as G is no longer buying the needed input from the outside.

Conclusion

As we noted at the outset of this chapter, successful economic development is based on a solid analytical framework that accurately describes the local economic context, including the identification of groups that have special needs; the local resources available to address these needs; and the place of

the community in the larger regional, state, national, and global context. However, analytical techniques alone can neither fully identify development problems nor help to select the means of solving them. Every local problem presents unique dimensions requiring insight and innovative strategies. The standard techniques presented here can prove useful to planners in suggesting both the point of intervention and ideal steps to be taken. Standard measuring systems help us assess the degree to which the community needs to improve with respect to its goals. After implementing new strategies, we ideally will perform economic development evaluations to determine the effectiveness of the strategies.

Putting It All Together: Creating a Local Economic Development Strategy (Part 2)

PLED PROBLEM SOLVING 6.2
Case Study, Part 2

Now that you have more knowledge about strategies used by development analysts, you may be able to refine your suggestions for West Central Georgia's economic development plans (see the case study at the end of Chapter 5). First, study Tables 6.5 and 6.6 to get updated job data for different sectors in West Central Georgia compared with the nation, and then answer the following questions:

1. What are the existing sectors in West Central Georgia that are highly concentrated? To what extent are these sectors an outgrowth of the special history and character of the place?
2. Which of these sectors, if any, would West Central Georgia want to protect in an economic development plan? Explain.
3. What sectors in West Central Georgia might be the basis for a cluster? Construct a four-quadrant table.
4. Which West Central Georgia industries are competitive (positive differential shift)? To what extent are those sectors impacted by local and regional economic trends?
5. Which industries are neither concentrated nor competitive?
6. What would you need to know to complete a cluster analysis for West Central Georgia? How would you use the information, assuming that you could identify a set of clusters?

Table 6.5 Jobs by Employment Sector in West Central Georgia and the United States in 1998 and 2006

		West Central Georgia				United States			
		1998	2006	Change	Percentage Change	1998	2006	Change	Percentage Change
		A	B	C	D	E	F	G	H
11	Agriculture, Forestry, Fishing and Hunting	226	155	–71	–31.4	1,206,059	1,167,004	–39,055	–3.2
21	Mining	*	*	*	*	568,640	617,048	48,408	8.5
22	Utilities	*	218	*	*	852,038	803,859	–48,179	–5.7
23	Construction	5,551	8,153	2,602	46.9	6,216,946	7,793,430	1,576,484	25.4
31–33	Manufacturing	32,966	29,535	–3,431	–10.4	17,668,078	14,153,115	–3,514,963	–19.9
42	Wholesale Trade	2,190	4,489	2,299	105.0	5,527,955	5,885,436	357,481	6.5
44–45	Retail Trade	16,856	19,643	2,787	16.5	14,694,552	15,435,110	740,558	5.0
48–49	Transportation and Warehousing	2,044	1,769	–275	–13.5	5,148,374	5,302,583	154,209	3.0
51	Information	2,166	2,970	804	37.1	3,359,021	3,185,907	–173,114	–5.2
52	Finance and Insurance	2,986	4,108	1,122	37.6	5,412,813	6,037,467	624,654	11.5

(Continued)

Table 6.5 (Continued)

		West Central Georgia				United States			
		1998	2006	Change	Percentage Change	1998	2006	Change	Percentage Change
		A	B	C	D	E	F	G	H
53	Real Estate, Rental and Leasing	1,092	1,263	171	15.7	1,982,356	2,203,542	221,186	11.2
54	Professional, Scientific, and Technical Services	1,616	2,226	610	37.7	6,218,214	7,502,331	1,284,117	20.7
55	Management of Companies and Enterprises	975	864	–111	–11.4	1,730,435	1,785,257	54,822	3.2
56	Administrative, Support, and Waste Management and Remediation Services	5,946	8,460	2,514	42.3	7,337,847	8,376,060	1,038,213	14.1
61	Educational Services	6,178	12,162	5,984	96.9	9,964,361	11,734,366	1,770,005	17.8

62	Health Care and Social Assistance	9,222	14,215	4,993	54.1	13,793,525	16,480,734	2,687,209	19.5
71	Arts, Entertainment, and Recreation	956	1,161	205	21.4	1,932,221	2,286,930	354,709	18.4
72	Accommodation and Food Services	8,481	12,420	3,939	46.4	9,605,117	11,189,512	1,584,395	16.5
81	Other Services	3,015	2,786	–229	–7.6	4,046,965	4,420,427	373,462	9.2
92	Public Administration	3,089	6,913	3,824	123.8	6,669,838	7,228,408	558,570	8.4
99	Unclassified	*	98	*	*	*	245,310	245,310	*
Total		105,555	133,608	28,053	26.6	123,935,355	133,833,836	9,898,481	8.0

Source: BLS. Data organized based on the NAICS system of classifying job data by business sector. (The 1998 data are from the BLS series, which reports 1998 SIC data reclassified into the new NAICS classification codes.)

Note: A = Total jobs in 1998 in West Central Georgia (reported by BLS); B = Total jobs in 2006 in West Central Georgia (reported by BLS); C =Change in jobs from 1998 to 2006 in West Central Georgia (B–A); D = Percentage change in jobs from 1998 to 2006 in West Central Georgia (C/A); E = Total jobs in 1998 in the United States (reported by BLS); F = Total jobs in 2006 in the United States (reported by BLS); G = Change in jobs from 1998 to 2006 in the United States (F–E); H = Percentage change in jobs from 1998 to 2006 in West Central Georgia (G/E)

*Data not disclosed by BLS in accordance with employer privacy protection policy.

Table 6.6 Proportional and Differential Share in West Central Georgia in 2006

		Location Quotient Analysis			Shift-Share Analysis			
		Percentage of Total Region	Percentage of Total United States	Location Quotient	Percentage of Share	Percentage of Proportional Shift	Percentage of Differential Shift	Total
		I	J	K	L	M	N	O
11	Agriculture, Forestry, Fishing and Hunting	0.1	0.9	0.13	8.0	–11.2	–28.2	–31.4
21	Mining	*	0.5	*	8.0	0.5	*	*
22	Utilities	0.2	0.6	0.27	8.0	–13.6	*	*
23	Construction	6.1	5.8	1.05	8.0	17.4	21.5	46.9
31–33	Manufacturing	22.1	10.6	2.09	8.0	–27.9	9.5	–10.4
42	Wholesale Trade	3.4	4.4	0.76	8.0	–1.5	98.5	105.0
44–45	Retail Trade	14.7	11.5	1.27	8.0	–2.9	11.5	16.5
48–49	Transportation and Warehousing	1.3	4.0	0.33	8.0	–5.0	–16.4	–13.5
51	Information	2.2	2.4	0.93	8.0	–13.1	42.3	37.1
52	Finance and Insurance	3.1	4.5	0.68	8.0	3.6	26.0	37.6

53	Real Estate, Rental and Leasing	0.9	1.6	0.57	8.0	3.2	4.5	15.7
54	Professional, Scientific, and Technical Services	1.7	5.6	0.30	8.0	12.7	17.1	37.7
55	Management of Companies and Enterprises	0.6	1.3	0.48	8.0	–4.8	–14.6	–11.4
56	Administrative, Support, and Waste Management and Remediation Services	6.3	6.3	1.01	8.0	6.2	28.1	42.3
61	Educational Services	9.1	8.8	1.04	8.0	9.8	79.1	96.9
62	Health Care and Social Assistance	10.6	12.3	0.86	8.0	11.5	34.7	54.1
71	Arts, Entertainment, and Recreation	0.9	1.7	0.51	8.0	10.4	3.1	21.4
72	Accommodation and Food Services	9.3	8.4	1.11	8.0	8.5	29.9	46.4

(Continued)

Table 6.6 (Continued)

		Location Quotient Analysis			Shift-Share Analysis			
		Percentage of Total Region	Percentage of Total United States	Location Quotient	Percentage of Share	Percentage of Proportional Shift	Percentage of Differential Shift	Total
		I	J	K	L	M	N	O
81	Other Services	2.1	3.3	0.63	8.0	1.2	–16.8	–7.6
92	Public Administration	5.2	5.4	0.96	8.0	0.4	115.4	123.8
99	Unclassified	0.1	0.2	*	8.0	*	*	*
Total		100.0	100.0	1.00	8.0	0.0	18.6	26.6

Source: BLS. Data organized based on the NAICS system of classifying job data by business sector. (The 1998 data are from the BLS series, which reports 1998 SIC data reclassified into the new NAICS classification codes.)

Note: I = Percentage of jobs in sector represents of total jobs in West Central Georgia (respective row of B/total of B); J = Percentage of jobs in sector represents of total jobs in United States (respective row of F/total of F); K = LQ (I/J); L = Share, percentage growth of total jobs in United States (total of H from Table 6.5); M = Industry shift, percentage growth of sector in United States, minus percentage growth of total jobs in United States (H–L); N = Local shift, percentage growth of sector in West Central Georgia, minus percentage growth of sector in United States (D–H); O = Total of shift-share, to confirm sum equals percentage growth of sector in West Central Georgia (L + M + N)

*Data not disclosed by BLS in accordance with employer privacy protection policy.

Notes

1. Some firms may be engaged in activities that fall into more than one industry sector, particularly if they are large businesses. In such cases, the industry sector in which the largest portion of the firm's business is conducted is the one the firm falls into for economic survey purposes (BLS, 2012a).

2. Shift-share analysis is broken down into three components, though these components are not always given the same labels. In this revised sixth edition of the book, the labels for the three components of shift-share analysis have been changed to reflect those more commonly used; see Bendavid-Val (1991) or Shields (2003).

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7

Local Economic Development Strategy

Strategic planning is now an accepted approach to determining direction for firms, institutions, and regional economies. Selecting a strategy and announcing it publicly has occupied much of the attention of planning agencies in many of the nation's cities. Globalization has given increased emphasis to the notions of strategic planning for cities and regions. An entirely new vocabulary has arisen to support the notions of strategic city or regional choices in a competitive global economy. Saskia Sassen (2006) has been a leading proponent of the notion that the strategic global region is the new fulcrum for international commerce. City-states are employing a range of strategic templates to reposition their economies. Beyond the oft-cited creative class strategy (Florida, 2002), U.S. city-regions are positioning themselves as key centers of finance (Charlotte, North Carolina), international logistics (Atlanta, Georgia), information technology (Seattle, Washington, and San Jose, California), pharmaceuticals (San Diego, California, and Raleigh, North Carolina), biotechnology (Boston, Massachusetts, and San Francisco, California), and energy production (Houston, Texas), among others. Regional innovation strategies are increasingly the focus of economic development planning. Innovation strategist AnnaLee Saxenian (2006) suggested that innovation springs from intelligent strategies that spread innovation through networks of organizations and institutions across a well-defined regional space.

Economic development practitioners increasingly understand the value of strategic approaches to rekindle distressed communities, both rural and urban. Strategic economic development has a well-documented lineage. The long economic boom of the 1990s coincided with one of the largest immigrant population waves since the end of the 19th century. As the United States has gained population and the economy expanded, some places have benefited while others have been left behind. But the influx of people and new money created new techniques using computer-based information systems to spread the opportunities to revitalize inner-city urban areas and made some declining rural areas attractive for spawning new technology-based firms with a backdrop of recreation, retirement, and leisure. Most of the communities that have been successful point to some form of strategic choice—for example, the Branson, Missouri, choice to build a new economy based on country music; or the Indianapolis, Indiana, strategy of becoming the collegiate sport capital of the United States; or the Pittsburgh, Pennsylvania, strategic choice to develop a new base in manufacturing and engineering technologies when its steel industry went into steep decline.

Interestingly, at the end of the 19th century, a similar phenomenon occurred. The Great Chicago Exhibition of 1893 focused on building the technology for the coming 20th century, such as the telephone, electricity, and new forms of power. This exhibition placed planning for a modern America at its core.

In the first two decades of the 21st century, planning for the nation's infrastructure must again be a national priority. The Bush administration tried to tackle both social and physical planning in the areas of social security and health care for the elderly. Earlier, the Clinton administration of the 1990s embarked on a large-scale search for national consensus on economic revitalization of the inner cities of the nation. In 2015, President Obama signed a bipartisan infrastructure bill authorizing $305 billion to improve highways, roads, public transit, railways, and bridges, and to reform federal transportation programs. The five-year Fixing America's Surface Transportation (FAST) Act is the first federal law passed in over 10 years providing long-term appropriations for surface transportation planning (U.S. Department of Transportation, Federal Highway Administration, 2016). It will allocate funding to states, local municipalities, and metropolitan planning organizations (MPOs) to carry out critical infrastructure projects (see https://www.fhwa.dot.gov/fastact/). Over the years, however, state and local governments have been far more ambitious and astute than the national government in forging the future. States and localities have led the way in trying to reduce the settlement sprawl and develop smarter growth approaches for dealing with the consequences of post–World War II settlement patterns based on the highway and the automobile.

This local consensus recognizes several interrelated features. First, compact cities represent a storehouse of infrastructure that can be revitalized at less expense than that involved in continuing sprawling development on the periphery of metropolitan areas. Second, transportation alternatives that reduce travel times must be found. This includes more mass transit and more condensed development closer to work and shopping locations. Urban sprawl has more than physical form consequences; it has social and economic impacts as well. Over the past three decades, urban areas have increased by more than 50% of their former geographic size, but their populations have increased by less than 5%. This expanding urban geography has been accompanied by increasing race and class separation.

No urban area has been exempt from increasing suburbanization. Old core cities like Chicago, St. Louis, and Detroit have seen dramatic declines in their populations. Urban core areas have not only lost population but also have lost the vital middle class in the suburbanization process. Not only have the suburbs reduced the city population size, but they have also severely restricted central-city tax bases. Traditional industries have closed in the city, and central-city retail districts have became ghost towns in most mid-sized and even some large cities. As a result of this collapse, cities became holders of "stranded assets"—that is, underused capacity in infrastructure, schools, and industrial sectors and the population left behind. Physical assets were allowed to deteriorate, and no investments were made in the education and social services needed to fully develop the center cities' human capital.

Just how vulnerable a city can become in this unfortunate set of trends was made very clear when Hurricane Katrina hit New Orleans, Louisiana. Exposed to the world was an urban tragedy decades in the making, due to class and race separation and inadequate attention to critical urban infrastructure and natural resources. Hurricane Katrina demonstrated how severe the toll could be for suburban encroachment on the environment.

Nationwide, millions of acres of open space and critical watershed area have been lost, covered by new housing developments, strip development, and low-rise commercial centers. Environmentalists, city mayors, and other advocates are now united in decrying the consequences of urban sprawl. The Urban Land Institute (1999) has "recognized that conventional planning and development approaches are not effectively addressing growing traffic congestion and greater loss of open space" (p. 1).

Not only is the physical environment in peril, but so is the nation's social fabric. As the suburbs grow, so does economic and racial disparity (Ewing and Rusk, 1995; Orfield, 1996). In an examination of four metropolitan areas—Atlanta, Georgia; Cleveland, Ohio; Philadelphia, Pennsylvania; and Portland, Oregon—Lee and Leigh (2007) found that, despite exhibiting different growth patterns and policies, the four metro regions all experienced

increased intrametropolitan spatial differentiation as well as inner-ring suburban decline between 1970 and 2000. Thus, inner-ring suburban decline—which is a spillover of problems from inner cities as well as the result of new immigrant populations increasingly occupying their aging housing stock—will require specifically targeted revitalization policies. Furthermore, as this negative trend was evident in metropolitan areas experiencing both high and low growth, we cannot expect it to be ameliorated by stronger overall metropolitan growth. Instead, it will require "smart growth" and antisprawl policies.

In contrast to the inner-ring suburbs, the downtown and inner-city subareas exhibited a gradual recovery from their decades-long patterns of distress. However, this recovery pattern has not been as strong in the two slow-growing metropolitan regions (Cleveland and Philadelphia). Their inner cities were still the most distressed subareas of the metropolitan area, while the outer-ring suburbs continued to thrive, drawing most of the new population and housing development.

Local development allies, together with older, inner-ring suburbs, have joined in supporting smart growth measures designed to increase urban densities, improve urban livability in all aspects (e.g., schools, mass transit), and boost inner-city retailing. The measures have ranged from proposals for urban growth boundaries (in Oregon and, in modified versions, in Maryland, Florida, New Jersey, and Vermont) to state- and local-supported inner-ring developments (in Georgia and Washington). However, Lee and Leigh (2007) found that, in spite of its urban growth boundary, the level of distress in the Portland, Oregon, inner-ring suburbs has actually increased over time. Thus, regional growth controls alone are inadequate for addressing inner-suburban decline. Instead, strategic neighborhood-level economic development planning is required.

Inner-city areas have recently become the net beneficiaries of an influx of development activity, such as higher-density apartment buildings in the urban cores of San Diego and Dallas as well as increased investment in downtown malls and sports and entertainment complexes. Old downtowns (e.g., Santa Monica, Pasadena, and San Jose, California; Boston, Massachusetts; Baltimore, Maryland; Chattanooga, Tennessee; and even Washington, D.C.) have undergone remarkable transformations. For example, Harlem is now the office location for former president Bill Clinton. It is one of the best retail addresses in the United States and the latest target for middle-class gentrification. Continued inner-city revitalization, however, is heavily dependent on continuing national prosperity, low crime rates, and some migration from both rural areas and new waves of urban pioneers from overseas to America's inner cities.

This chapter discusses how economic development planning is linked to an overall strategy for a community (urban or rural) to engage its human, physical, and economic resources.

Strategies, in this context, are planned actions for specific development goals of a community derived from the available opportunities—economic as well as social. While concern over sprawl and the toll on the environment and the economy initiated the Smart Growth movement in the 1990s, growing concerns in the first decades of the third millennium over climate change and inequality are now shaping sustainable approaches to local economic development planning and reframing some of the basic approaches discussed next.

Projects emerge from specific courses of action undertaken within a given strategy. The distinction between strategies and projects is necessary because in too many instances a single project or group of projects with no particular focus is described as a local economic strategy. In most instances, these ad hoc efforts are reactions to current circumstances. The most common rationale for the majority of these uncoordinated efforts is that "something had to be done."

Strategies, however, constitute an overarching set of principles that form concepts to guide general to specific actions (i.e., from goals to strategies to projects). Strategies are valuable in forcing clarity of thought and generating consensus during the local economic development process. It is, therefore, important to examine alternative strategies along with a set of specific projects or proposals as the basic building blocks of an economic development plan (Kemp, 1992).

The Goals of Local Economic Development

A key goal for any economic development strategy is to *provide quality jobs for the current population.* The thrust of workforce planning is to create employment for and with the resident population of the community. This is preferable to relying on approaches that attract new employers, who may require a different set of skills than those possessed by or that can be developed with the resident labor pool. Labor pools in many communities have changed dramatically over the past decade. Even though more immigrants with physical skills are arriving on our shores, many of them lack a good education and fundamental English-language skills. As a result of the fast pace of job creation, the labor pool does not always match the location or quality of the jobs created. Increasingly, small and large communities have the most individuals without the skills or capacities to enter good jobs in the

New Economy. It is important, then, to rethink job generation by starting with the supply side of the question—that is, who is in our population base? What skills do they bring, and what kind of jobs might best fit them? This will require careful population data analysis along with intense focus groups and community surveys to determine where to apply economic development strategies.

Achieve Local Economic Stability

Economic development will be successful only if the community has a specific approach to meet all the needs of business (i.e., land, finance, labor, infrastructure, and technical assistance, in addition to labor). Many cities don't even know the locations of available industrial sites or how a firm can identify requisite financing. If a community wants to obtain and retain jobs, it must have all its economic resources and socioeconomic data available in an organized form. In the New Economy, communities also have to be able to match human resource capacities with telecommunication as resources. In other words, land and location mean far less than they once did. As a result, community economic development strategists have to design alternative mixes of resources to entice new technology firms or to retain existing firms as they expand or seek expanded international markets.

Build a Diverse Economic and Employment Base

No community with a single employer or set of employers is safe from fluctuating employment. Regardless of whether the community is high or low tech, it must have a broad base to provide continuing employment opportunities for residents. As firms become global, it is important for every community to develop regional strategies to create a web of economic and social infrastructure that will act as hubs for global firms. The dispersal of the Boeing headquarters from Seattle after 81 years to a three-city headquarter hub is one of the signals for any city that firms will move to human resources and capital and are not locked into any place because of tax rates or even raw materials.

Promote Local Sustainability

The three primary goals (achieve local economic stability, build a diverse economic and employment base, and promote local sustainability) can all be employed in an approach that either does or does not also have the goal of promoting sustainable economic development. To incorporate sustainability into the process, the economic development strategy must explicitly consider

the impacts of industries on the environment. It may specifically seek out innovative industries that are creating environmentally benign or remediating products and services. It may seek employers that adopt green practices and choose green buildings for their industrial, office, or commercial activities.

Prerequisites for Successful Strategy Formulation

The essential starting points for designing appropriate development strategies are the socioeconomic base analysis and development capacity analysis described in Chapter 6. At the conclusion of these analyses, a community can identify its opportunities and challenges and the resources available to meet them. A community should also, at this point, state explicitly its economic development goals. These goals should specify those sectors and groups that economic development is to serve.

When determining target sectors, industries, and social groups, one should keep several important points in mind. The best job creation strategy is one that stresses increasing "basic" employment. Basic employment entails business activities that provide services primarily outside the local area via the sale of goods and services but whose revenue is directed to the local area in the form of wages, payments to local suppliers, and capital expenditures. Examples of business activities that could represent basic employment include resource-based manufacturing, transportation, and wholesale industrial sectors. When an office industry represents a headquarters for services, the result also is an increase in basic employment. "Nonbasic" employment, however, is associated with services and business activity that primarily serve the local area; revenue sources, therefore, are from the community. As a result, an analysis of the economic base should consider the following:

- Determining which sectors play a dominant role in the local economy in terms of jobs, sales, taxes paid, and linkages to other local industries—for example, agriculture, forestry, some types of manufacturing, commerce, services, and government
- Identifying important linkages between the local economy and the external economy to gauge the extent to which local sectors and infrastructure (e.g., international airports, world telecommunications links, and quality schools) respond to changes in the regional, national, and international economy
- Assessing the local potential for economic growth, stability, and decline and identifying contingencies for economic development

(e.g., major tourism or other resources) that can be used as a buffer for changes in other components of the local and regional economy and complement each trend
- Exploring contingencies important to the local population or political leadership that could have major impacts on jobs, sales, incomes, public revenues and expenditures, economic productivity, job quality, and local quality of life

With target economic sectors and social groups as firm points of reference, the process of identifying and assessing alternative development strategies will be a clear but difficult task. The identified economic development opportunities probably will not provide all of the employment for the disadvantaged groups of the community. Thus, more than one economic development strategy will be required to meet local needs.

Selecting Strategic Options

It is well known that localities with severe economic problems face a morass of complex, interrelated issues. Such local situations result from a mixture of people needing jobs, firms closing or leaving, and factors that attract or produce more jobs. No single facet of the economic or employment problem is easily resolved. Too frequently, however, a single dimension or aspect of the problem is highlighted without full comprehension of its interaction with other components. To provide a better perspective of the situation faced by local governments and community groups, the strategic model created here portrays options as the components of an overall local development strategy. Each of the options listed presents an alternative approach to meeting one or more aspects of a community's needs.

City and neighborhood leaders must decide how each of these components should be combined in order to create a unique strategy that will secure the types of jobs and requisite job balance for the community, given the resources available and local development objectives.

There are four strategic approaches. These are strategies that emphasize (1) locality or physical development strategy, (2) business development, (3) human resources development, and (4) community-based development. In most instances, a strategic plan will incorporate different elements of these approaches, depending on local needs and circumstances.

Each of these major components is part of the mixture of approaches the community develops to create a local economic development strategy. That is, strategies—like problems—are unique in their development and in their application.

The Locality Development Strategy Option (the Built Environment Dimension)

As major developers of parks, roads, drainage, parking lots, and in some cases water and electricity supplies, local governments influence the establishment and operating costs of businesses. By developing a program to upgrade a locality designated for industrial and/or commercial uses, local government may have a positive influence on local business development. Quality and affordable housing, as well as safe neighborhoods and good schools, are central to achieving a quality living environment. Places like Redman, Washington, just outside Seattle, and Rochester, Minnesota, home of the Mayo Clinic, are consistently rated among the best places in the United States to live and work because these communities have low crime rates and little racial segregation. Large cities can attain similar reputations. Places like Seattle, Washington; Portland, Oregon; and even San Jose and San Diego, California, have low crime rates and high employment levels. There are a number of natural and community assets a community can decide to upgrade (for example, parks and theaters) to attract executives, entrepreneurs, and creative professionals, who seek places with high and visible quality-of-life attributes to raise their families.

The tools for accomplishing locality development goals are numerous and include the following:

- *Planning and development controls.* Positive use of these controls improves the image of councils with business and has a positive influence on the investment climate.
- *Economic and enterprise zones.* These are designed to revitalize aging and underused inner-city and rural retail areas.
- *Transportation and major infrastructure.* These developments increase the use of major civic assets (e.g., riverfronts, city core areas, parks, and the like).
- *Landscaping and streetscaping.* Economic upturn in town commercial centers can be achieved by making improvements to the street (e.g., planting shade trees) and to local business premises (e.g., improving window displays and the physical standards of commercial buildings).
- *Household services and housing.* A well-housed and well-serviced labor force is an inducement to businesses; in addition, activities in this sector also have the potential to generate employment.

The full array of locality development tools available is discussed in Chapter 8.

The Business Development Strategy Option (the Demand Side)

In most places, there are not enough jobs within existing firms to meet local population needs. Therefore, new ways have to be found to encourage new businesses, to attract existing businesses to relocate in the area, and to sustain and expand existing local firms. This should result in a net increase in total jobs. Several mechanisms can be employed, including the following:

- *Small business and innovation assistance centers* to provide accessible management training, counseling, consulting, and research services for small firms or inventors as a means of improving their economic performance and possibly helping them to expand their workforce
- *Technology and business parks* to provide the specific infrastructure requirements of sought-after industries
- *Venture financing companies* to provide venture capital to selected firms unable to obtain financing from other traditional lending institutions
- *One-stop business information centers* to expedite the information needs of existing and potential new businesses
- *Micro-enterprise programs* that provide seed capital in a group lending approach that builds both collective social capital in the group and increases emphasis on local ownership and capital formation
- *Business retention and expansion programs* that focus on helping existing local businesses be successful, surveying local businesses to determine strengths and weaknesses, and developing supportive programs

The methods used to improve local business development are discussed in greater detail in Chapter 9.

The Human Resource Development Option (the Supply Side)

This strategic option forges close connections between the employment needs of certain segments of the local population and the job formation process. The goal is to alter the human resource system in ways that increase opportunities for good jobs for the unemployed and underemployed in the community. The new emphasis on creative human capacity emphasizes people as the wealth-generating resource in the 21st century. Furthermore, due to the abolition of permanent welfare recipients in the reforms to welfare legislation, there is a greater need to create jobs than ever before. Finally, a new emphasis on women in the workforce and seniors as expanded intellectual and human capital increases the need for communities to identify

the resources required to develop human resource banks as a central goal for economic development. The methods include the following:

- *Customized training*, providing the employer with specific training based on the firm's requirements
- *Innovation development*, through the organization of space and programs that provide for inventors and others to expand their talents and invent new products and services in space provided by local government
- *Targeted placement*, ensuring that employers who receive government assistance are obliged to hire qualified local personnel as the first source of employees
- *Welfare to work*, which is required under Temporary Assistance to Needy Families (TANF). Under this legislation, welfare recipients are required to seek employment with some local assistance. Local employment institutions have been designed to serve this end
- *School-to-work programs*, aimed at improving the prospects of young people, particularly from disadvantaged communities, to find employment while at school and/or to link the educational process directly to employers' needs
- *Local employment programs*, developing employment offices in the community that run training and personal skills development programs to help especially disadvantaged social groups gain employment or acquire increased skills

These approaches are coupled with several related tools that can be used to develop local human resources, as discussed in Chapter 10.

Economic Development Plans Within the Context of Comprehensive Plans

Comprehensive land-use plan development is a widely utilized local planning practice primarily intended to reserve underdeveloped land for a future "highest and best use." Increasingly, communities are recognizing the value of pursuing an economic development strategy in conjunction with a comprehensive planning process. Land-use planning decisions can be of higher value when they are determined based on the agreed-upon priorities of the community's economic development goals.

As a final option for pursuing an economic development strategy, the comprehensive approach can be of most value if it embodies not only the interests of the traditional land-use plan but also those of the locality,

business, human resource, and community-based strategy options. The most promising economic development programs are those that recognize that success depends not on any one initiative but on a multipronged approach that addresses all the factors that impact a community's economic health.

The Community-Based Employment Development Strategy Option (the Neighborhood Dimension)

This option is designed to promote economic development at the neighborhood or small community level and create employment opportunities for persons who are long-term unemployed, new entrants to the labor force, or groups seeking to play unconventional roles in the economic system. In this approach, activities are intended to function as intermediaries between the social welfare system and the local economy. They are aimed at providing alternative employment opportunities for individuals who require new skills or skill upgrading. In addition, these alternative socioeconomic structures may serve those who wish to contribute to society through enterprise firms that promote economic democracy. Community-based organizations can represent the intersection between the social sectors by acting as the institutions that provide the opportunity to bring individuals and groups in the lowest and immigrant ranks or with blemished social histories, such as brushes with the law, back into society. Finally, community-based organizations are the major provider of low-cost and affordable housing for the nation's workforce. Basic activities include the following:

- *Community-based development organizations*, nonprofit organizations that own and/or operate entrepreneurial activities and also provide a wide range of community services (the purpose of providing both business and services in the same organization is to facilitate, without stress, the movement of usually difficult-to-employ individuals through the progressive stages of employment)
- *Cooperatives*, worker-owned and worker-managed businesses in which the group shares the responsibility and liability for generating wealth and/or employment using jointly held resources
- *Community capital institution*s, a new set of community-based capital institutions that are emerging across the nation. Some of these are engaged in microcredit, trying to develop small loans and collective borrowing strategies in low-income neighborhoods, while others are fully fledged banking institutions ranging from credit unions to community development finance institutions that finance community-based housing and similar enterprises

- *Affordable housing corporations*, which provide housing for workers, low- and moderate-income groups, and special-needs populations, at the same time creating new employment and business opportunities
- *Land trust and similar community ownership instruments*, which create vehicles for local control and ownership of economic activity in the community

Clearly, these alternative approaches to local economic development can and will be mixed to meet the requirements of a given situation. Different strategy options will suit different socioeconomic circumstances. Each of the following three basic types of socioeconomies—(1) growing, (2) unstable, and (3) those that are restructuring, including distressed mature economies and declining or chronically depressed economies—requires a different strategy or approach.

Common Traps in Strategy Formulation

When selecting economic development strategies, community leaders will face several traps. These pitfalls are usually derived from civic leaders' anxiety to move quickly and get results. In their haste, however, they frequently overlook important fundamentals, such as the following:

1. *Leading with grants without a strategic program and clear goals.* Local development practitioners often accept foundation and government programs as their strategies with no assessment as to whether they fit their locale or population. Public officials and community organizations usually attempt to make local needs fit national government programs rather than basing approaches on local need. All too often, such attempts overlook employment or economic problems and divert attention from the real assets of the community and/or its economic development limitations. Moreover, when the government or foundation program goes away, often the local economic strategy also disappears. The new approach is for government and foundations to provide financing and not funding. This means any organization needs to find ways to develop long-term stability by generating income for services or diversifying its funding base from a wide variety of public and private sources.
2. *Letting the tool(s) determine the strategy.* Civic leaders often confuse a particular development tool with a comprehensive strategy plan. Instruments such as industrial parks, enterprise zones, small business assistance, one-stop business information offices, tax relief, or even more sophisticated public–private financial schemes are ingredients of an economic strategy, not the plan itself.
3. *Starting at the wrong end of the problem.* Although employment creation is the usual goal of most communities, human resources are

seldom the focus of local economic planning. Usually, local planning groups attempt to attract any firm in the anticipation that the local workforce will obtain most of the jobs. This desired economic result seldom occurs because too little attention has been paid to the actual skill levels, training requirements, or abilities of the local population. Because human resources are more important than natural resources or even location, initial planning must focus on current as well as projected labor force skills. An unskilled or even technically but unsuitably trained workforce can rarely meet the labor market conditions of new firms.

4. *Following the fad.* High technology, small business, tourism, and convention centers dominate current municipal economic strategies. Communities adopt these trendy approaches on scant economic evidence and without any particular ability to provide the necessary infrastructure for these firms. A substantial body of recent research indicates that there is little support for most communities' aspirations for a high-tech, tourism, or convention scenario. In fact, unless a community has unique attributes, with the necessary reinforcing institutions (such as a university's relationship to high technology), prospects for such development are dismal no matter how many artificial stimulants or inducements are provided.
5. *Overlooking development capacity.* Too often, local governments or neighborhood groups have adopted development strategies and proceeded without assessing the overall development capacities described earlier. Groups should undertake serious examination of the capacity to develop and manage any project to avoid this pitfall. In many instances, planning efforts have failed. Development strategies and projects must be designed to fit not only the area's or region's resources but also its competencies. Indeed, the success of a local development strategy depends on a long-term commitment by a sustained coalition of local public officials and corporate and labor leaders to carry out the program or activities.

Assembling the Elements of a Strategy

A strategy is a collection of actions and activities that help achieve a predetermined goal. The methods used to assemble the strategy are critical in building one that is long term in nature. The following factors form the base for assembling such a strategy.

Target Characteristics

Target characteristics include such items as the strategy's scope. Is it multijurisdictional, single city, or neighborhood? The strategy may also focus on

a specific sector for revitalization and emphasize certain types of enterprises, such as small businesses or large export firms. In addition, the strategy can address the direction of economic growth by selecting new firms versus existing enterprises, or it may single out some elements of both. Finally, a strategy must address the critical environmental constraints that may impede its successful implementation.

Methods of Development

A good strategy uses appropriate methods to accomplish intended objectives. These methods might include direct assistance to firms, such as financial incentives, land assembly, and other tools. Alternatively, the strategy may emphasize improving the procedures or processes available within the local environment for firms to establish or expand into new markets. The means to accomplish these objectives range from improving the existing permit procedures to business education and marketing assistance.

Forms of Local Organization

In many instances, the form of the economic development organization is selected before a strategy is designed. As a result, the institutional form is not compatible with the strategy. For example, local governments are not very good vehicles for taking ownership of declining enterprises or for starting new businesses.

The organizational form needs to be well thought out before economic development strategies are selected. Voluntary organizations, nonprofit community development corporations (CDCs), local development corporations, business associations, and neighborhood organizations all have strengths and many limitations when it comes to local economic development.

Time Frame

A local economic development strategy must include both short-term, visible objectives and long-term, process objectives. It is important that the local decision makers consider clearly how to incorporate both shorter-term as well as longer-term goals in any economic development strategy.

Projects From Strategies

Having formed a development strategy, the next step is to build an action plan for each of its viable projects. Action plans are documents describing the components of a proposed project that match the economic development

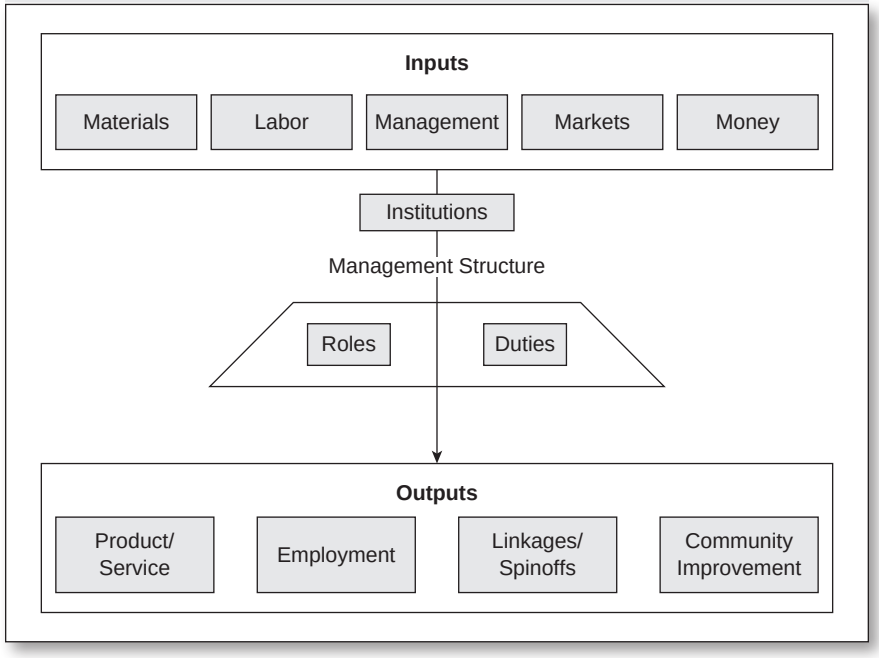
strategy. The principal purpose of the project action plan is to provide sufficient information to test the project's viability—that is, to determine whether the necessary economic, technical, management, and other support systems will indeed be adequate to support the proposed project. Taken as a whole, all the projects with detailed action plans constitute the community's overall development program.

The components of an action plan are shown in Figure 7.1. They include a statement of project inputs, a management structure and institutional plan, and a statement of project outputs. Each of these components is discussed next.

Describing Project Outcomes

Planning cannot commence without an examination of project outputs, because one cannot specify exactly either project inputs or a project management and institutional plan without knowing what the project is to produce.

Figure 7.1 Components of an Action Plan



The first task in building an action plan should be that of *specifying the goods and/or services* that the proposed project will produce and/or sell. All of the other factors in the action plan will relate to this definition. Other project outputs that should also be described at this time include employment impacts, linkages and spin-offs, and community improvements.

Employment Impacts

Job creation generally is important, but it is more important to create the right jobs for those in need in the community. As mentioned earlier, it is far easier to create jobs for the existing human resources than it is to move people to new jobs or to attempt to retrain them for other forms of employment. It is therefore important to ascertain the types of jobs created in relationship to the existing employment requirements of the community. Although this will necessarily be a rough estimate, it will provide a framework for ensuring a better fit of jobs to people.

A statement of employment impacts should include answers to at least the following questions:

- How many new jobs will be directly associated with the proposed project?
- In which occupational category and wage range will the new jobs fall?
- Will the new jobs provide better-paying jobs, better working conditions, or better career advancement possibilities compared with existing employment opportunities?
- How many of the new jobs are likely to be filled by local residents? How many by newcomers?
- How many of the new jobs for local residents are likely to be filled by unemployed people, women, or minorities? Would job training be required to accomplish this? If so, what kind?
- Will the new project result in the elimination of jobs, directly or indirectly, in other local businesses?

Linkages and Spin-Offs

The extent to which new projects fit into the existing business and industrial base is an important consideration. If new businesses drive out existing firms, little is gained from the development planning process. On the other hand, some projects expand or improve the existing business base or even create new industry bases.

The attraction, expansion, or start-up of businesses or services that have linkages with existing economic activities in the region will have a more beneficial socioeconomic impact than industries with no local linkages. Socioeconomic linkages can include the following:

- Use of local raw materials
- Use of locally produced goods or services as inputs
- Employment of local personnel (particularly if they have been locally trained)
- Sale of the goods or services produced to the local market
- Attraction of new investment to the area
- Attraction of ancillary employers to the area

Projects that strengthen socioeconomic linkages are usually also projects with a competitive advantage.

Community Improvement

Development planning is not merely (or solely) a business development activity. Culture, recreation, community appearance, and related factors are integral to development planning. As a result, each project should be measured for its contributions in these areas in addition to the areas of direct employment and economic development. For example, projects that build the self-esteem and identity of youth can significantly alter a community's social and economic climate. These aspects of a project, which enhance the total livability of an area, should be documented under the heading *community improvement*. To reiterate, the specification of outputs for proposed projects forms the definition and guide for the entire development process. One cannot determine other project requirements without discussing with knowledgeable people the full potential for success and failure. Similarly, platitudes about job creation or improving the overall economy are meaningless. The real focus for economic development comes from trying to work through specific activities that improve actual situations using known or attainable resources.

Specifying Strategic Resources

Economic growth and development can be seen as analogous to a living plant's growth and development: The key elements of heat, light, water, and other nutrients must be present in proper amounts for a plant to grow. If one key element is missing, growth will not occur—even if other elements are present in abundance. Similarly, five key elements must be present for

Table 7.1 Five Fundamental Resources for Economic Development

Materials
Land
Buildings
Location
Infrastructure/natural resources
Labor Force
Skilled personnel
Available workforce
Education and training capacity
Markets
Markets analysis
Competition
Penetration
Marketing strategy
Management
Organizational structure
Managers/operators
Research and development (R&D)
Marketing and sales
Legal
Money
Equity/ownership capital
Debt/borrowed funds
Capitalizing institutions
Subsidy and substitutes for direct capital

economic development to occur. These elements are (1) materials, (2) labor force, (3) markets, (4) management, and (5) money. Each one must be considered by communities when developing an economic development plan. This section defines these elements (see Table 7.1) and discusses their importance to economic development programs.

1. *Materials* may be thought of as all existing physical resources, including both natural resources and human-made facilities or infrastructures, such as roads, ports, electric power distribution systems, and buildings. Natural resources, of course, encompass all useful, naturally existing materials and conditions in such forms as soil, terrain, minerals, climate, water sources, plant and animal life, and geographic locations. A community should understand that although these resources may be limited in quantity and availability, they might be combined in any number of ways to produce a wide variety of products and services. Because absence of materials can restrict the types of goods that may be produced in an area, however, the existence of these resources should be investigated before attention is given to potential products and their production in the effort to provide jobs.
2. *Labor force* represents the population used to create a product or service for sale. For example, labor includes the person operating a machine, repairing a machine, supervising the process, or delivering the final goods or services produced. Specific skills may be needed for different stages of a process, and those skills may be acquired through experience or training. These skills amount to an investment that has a clear "payoff" in the form of improved productivity. A trained and experienced person will be more disciplined, make fewer mistakes, and be more innovative. The skilled person is therefore an asset and can be thought of as human capital within the economic development process.
    - The labor (or human resources) available for work in an area depends on the proportion of the population that is of working age as well as willing and able to work. Willingness to work can depend on social and cultural characteristics of the population, the type of work available, and the prevailing wage rates. Ability to work depends not just on having the right skill sets and education levels for jobs available but also access to essential infrastructure and supports such as transportation, child or elder care, and disability accommodations.
3. *Markets* are the places where there is demand for certain products or services. Demand size depends on the number of people or organizations desiring the product; the qualities of the product; the price at which it is offered; and the ability to inform possible consumers of the product's quality, price, and availability. The market area for a product is not fixed. A change in population characteristics, the local or international economy, or general social values and

attitudes may create potential customers. Similarly, new methods of communicating price and product characteristics create the potential for new demands. New markets may be created through better product pricing, superior transportation, better production techniques, and/or penetration of more local or overseas markets. The point is that markets are normally very flexible and can be expanded through imagination and hard work. Identifying potential consumers, knowing what kind of product they want and at what price, and being able to inform them of the product's availability are examples of using a market area to maximum effect.

4. *Management* is a special type of human capital. A good manager is the person able to combine materials, money, and personnel to produce and market a product or service successfully. Without the catalyst of effective management, economic development cannot occur. The most effective managers also tend to be visionaries, risk takers, and innovators, as well as motivators and coordinators.
    - Economic development is a multifaceted process, and for it to be successful, there must be effective coordination between government and industry as well as between various agencies and levels of government. Most important, the local community must provide support and involvement. Successful links among these diverse groups require top management talent in both the public and the private sectors of the economy. Local government or other initiators of economic development programs designed to stimulate employment may have to be especially creative in finding ways to contribute to the availability and use of effective management talent.
5. *Money* is the financing directly involved in establishing and operating a proposed project. Money is required to initiate an economic development project in order to provide necessary facilities, to hire and train staff, to pay for materials if a product is to be manufactured, to transport the product, and to market the product or service.
    - When there is a need to provide missing elements or components for a successful project, money must be found to purchase, hire, organize, or in some other way make these elements available. For example, funds may have to be found to acquire the use of buildings, hire accountants or management consultants, train workers in specific skills, or extend sewer lines and roads. Funds for the necessary project components may come from private or public sources, and the components themselves may be provided by public or private agencies. In the next section, we will describe a variety of alternative approaches to finance.

Plan Financing and Implementation

Money, the last of the five key elements of economic development, causes the greatest problem for most local governments or development organizations because it is too often thought of as "funding" rather than "financing." In the public sector, *funding* refers to obtaining all of the fiscal resources to develop and manage a project or program. In essence, government agencies usually think of a continuing commitment of tax dollars to support a public activity, regardless of any income generated from it. However, *financing* refers to identifying sources of capital (often private) to provide the initial financial resources. It is further anticipated, based on careful analysis, that the project will generate sufficient income to pay for itself. For a detailed discussion of project finance, see Giles and Blakely (2001).

No matter how it is constructed, an economic development strategy is only as successful as its implementation allows. Critical to the process is assembling the personnel and resources necessary to develop, oversee, and update (as needed) the approaches identified in the strategy.

The right personnel include both the leadership and staff-level support necessary for the new initiatives to achieve positive results. The most successful initiatives are often those that are able to develop a leadership structure that provides program "ownership" to key stakeholders in the public and private sectors. From strategy conception to full-scale implementation, buy-in from the community's primary political, institutional, and business entities is vital. For example, those entities may include city and county governments, universities, community and technical colleges, chambers of commerce, business associations, nonprofit foundations, or other community organizations.

Sufficient financing is key to successful implementation, as it ensures that the most-qualified staff, most-needed resources, and other key programmatic elements are secured. To achieve both financing and much-needed support from the public and private sectors, many economic development programs are structured as 501(c)(3) entities. By using this designation, the programs are able to garner donations, annual allocations, and grant monies from public, private, and nonprofit sources.

To help finance a 501(c)(3) or alternatively structured economic development entity, a community would be remiss to overlook the numerous grant opportunities available from local, regional, and national nonprofit foundations, their state government, and the federal government. The most widely recognized grants for financing general program activities are Community Development Block Grants (CDBGs), which are the U.S. Department of Housing and Urban Development (HUD)–funded grants

allocated by the states to eligible applicant communities. There are numerous additional grant opportunities to help finance economic development from the general to the very specific initiative. For example, in September 2007, AT&T announced a $1.5 million competitive grant program to help local educational programs fund wireless Internet service and infrastructure (AT&T Foundation Competitive Grant Program, 2008).

For locality- or community-based strategies, there are also specific tax-related and other measures that can be used to help fund economic development. Some widely used examples are as follows:

Business improvement districts (BIDs). An organized effort to use public and private monies to maintain and restore a commercial neighborhood

Empowerment Zones (EZs). Businesses in these designated areas of need that are eligible for special incentives to open or expand operations

Tax increment financing (TIF). A typically district-based designation that allows projected future tax gains to be used to finance today's infrastructure improvements

Project financing requires the flexible use of existing assets combined with solid project planning. For example, city-owned land may form the basic fiscal resource for financing a local agency's building project. Similarly, local governments have become adept at selling development rights for the construction of needed office space above parking structures or other community facilities. Some cities have used civic assets (e.g., museums, city halls) as their contribution to commercial and retail developments in which the city government is a major investor. Many cities have used a lease agreement for the major portion of a commercial structure, thus encouraging a private developer to build a new multistory administrative building and civic library. In other words, project financing requires imagination more than actual money. A well-documented economic demand for a service or the use of city government space, development rights, or other factors can assist the community in achieving its objectives without using local taxes. Project identification follows the assembly of the appropriate local fiscal resources to meet the community's goals. Good project ideas are the key to development.

In a typical situation, identifying economic development projects will require compromises and trade-offs. There may be projects that improve people's well-being, increase productivity and economic viability, or enhance the quality of life and work, but there may be no markets available for such products. An economist would say that wants and needs are

greater than effective demand (that is, the ability to pay). In the typical situation, there would have to be trade-offs between meeting local development needs and making money. Thus, the most general guideline for identifying projects is to look for those that enhance local economic development and generate acceptable profits, simultaneously, at reasonable levels of risk. An obvious but important implication of this guideline is that local communities should avoid at all costs projects with high risk and/or no profit. If an acceptable cash flow cannot be anticipated from a potential project, the project should be discarded. With the criteria of economic development potential, profitability, and risk in mind, these guidelines form the minimum mean test for a community's participation.

The general implementation guidelines discussed in this section can make the difference between a strategy that results in sustainable economic vitality and a strategic document that sits on a shelf. By carefully fostering the relationships and securing the financing necessary to make implementation a public–private partnership, local economic development practitioners can significantly improve their chance of measurable success.

Conclusion

Strategy development and program design form the basis of local economic development planning. The planning system or orientation taken by any community will shape the goals of the process and the resources used.

The collective experience of many hundreds of local areas working to develop their economies will shape new strategic models. Unavoidably, perspectives favoring corporate and local needs will exist side by side in the same locality. Similarly, nearly every area contains some growing industrial sectors and others that are declining. Thus, these areas will exhibit simultaneously two or three requirements for economic development. Communities cannot remain complacent or indifferent to questions of economic development, as they have in the past. The careful economic development planner will sort through the economic development models outlined. Strategies emerge from the circumstances. None will conform to ideal types depicted here. In the following chapters, these strategies are explored in greater detail and combined with case studies that illustrate how they are integrated into a community environment.

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8

Locality Development

Locality development has traditionally focused on the ownership, regulation, and management of land and the buildings placed upon it. These are the sites on which economic activity occurs. Locality development highlights how transportation planning and urban design are essential contributors to quality local economic development and overall quality of life. Good transportation systems are required for the efficient movement of goods and people within the local economy. Increasingly, the transportation focus is being expanded to incorporate the notion of accessibility. Thus, the key issue is not the physical distance between economic and community activities but rather the ease and time required to access them. Urban design also addresses these issues by creating the vehicular and pedestrian networks of the locality as well as providing attractive ways to combine a mixture of land uses (residential, business, community) that enhances functionality and property values. Urban design helps to create the locality's image through the application of design standards, as well as to establish the fundamental framework on which evolving economic and community activity occurs.

Locality development needs to focus on minimizing environmental impacts of land development and building construction to respond to growing concerns about climate change and desires to create greater sustainability. That is, we should expect a "greening" of locality development that is only beginning to be seen in current practice.

Land is one of the most important resources in local economic development, so it must be managed carefully. Without control of land, local

development is essentially impossible. Thus, land management and land deals should form an important component of any economic development program. A local or community development plan will be thwarted if suitable sites and buildings for selected projects cannot be furnished. Moreover, this management must aim to improve existing land-use practices and the appearance of the community, paying special heed to design standards associated with urban space. The newest concept in locality development is called smart growth or new urbanism. Both terms refer to strategies that are antisprawl and call for the reuse of existing urban space at higher densities and with more mixed uses to increase neighborhood walkability and community social contacts.

Livability is another extremely important component of smart growth and new urbanism as the catalyst for economic development. Because both residents and nonresidents tend to spend their time and money in the most pleasant of the available environments, tree-lined streets, covered walkways, and clean, well-managed retail areas can help build local business. An attractive entrance to and exit from a city tell the visitor a great deal about the pride and community spirit of its residents. Indeed, for tourism, there are few factors more important than community appearance. Visitors do "judge the book by its cover."

In fact, judging cities by their appearance and their social or economic climate has become a major assessment tool of economic development professionals. For example, the Rand McNally quality-of-life survey is viewed by some economic development practitioners as a legitimate locational preference index for corporate real estate managers. In addition, *Fortune*, *Money*, *Financial World*, and other leading business periodicals present annual assessments of civic performance on the basis of the local capacity to do business with the private sector along with the physical and social appeal of the community to its indigenous population and visitors. One result of these polls is the transformation of the desirability of communities like these over the past few decades: Chattanooga, Tennessee; Charleston, South Carolina; Pittsburgh, Pennsylvania; Seattle, Washington; Sioux Falls, South Dakota; Baltimore, Maryland; and Oakland, California. In particular, communities with the right physical attributes, such as Old Town Pasadena in California, LoDo in Denver, and 18th & Vine in Kansas City, Missouri, have created living environments that are nationally attractive. The cityscape and the total natural environment are essential attributes of the quality of life economic developers seek to highlight. Good environmental management, which includes developing open space and preserving valuable habitat in the community

and the surrounding region, is an important corollary to good economic development.

Local officials find it increasingly important to do "image management" in the face of global competition for corporate location. As a result, they must carefully develop their land, building assets, and "presentation features." The motivation behind developing land management and control systems should not be to prevent the worst things from happening but rather to get the right things to happen. This requires land-use planning that goes beyond coloring maps and issuing regulations. It calls for the development of a visual theme that (1) creates a sense of identity, (2) improves the amenity base or livability of the community, (3) preserves and protects sensitive land areas and recognizes environmental equity in the community (e.g., adequate parks and open space within the urban areas and across the region), and (4) improves the attractiveness of the civic center with smart growth and related strategies to mix residential and commercial spaces in an effort to improve local business and quality of life. Table 8.1 reviews the most commonly used locality development tools to achieve these ends. Each of these tools is described in the next section.

Table 8.1 Location Development Tools and Criteria

Tool	Objective		
	Image Building	Amenity Improvement	Business Improvement
Urban Design Landbanking	X	X X	X X
Infrastructure provision		X	X
Speculative buildings			X
Incentive zoning		X	X
Regulation improvement	X		X
Tourism planning	X	X	X
Townscaping	X	X	X
Shopsteading	X		X
Housing and neighborhood improvement	X	X	
Community services	X	X	X

The Link Between Economic Development and Urban Design

While not typically considered in economic development texts, urban design is a fundamental component of locality development. Urban design focuses on subdivision of land, open space (parks, greenways, etc.), sidewalks, streets, and spaces between buildings. It is essential to recognize that land subdivision patterns are the most permanent aspect of a city and its neighborhoods. That is, buildings and land uses are temporary when compared to the durability of the subdivision of land into streets, blocks, and lots. Many types of buildings are converted to different uses—factories and offices to residential, industrial to commercial (stores, hotels, restaurants), and old schools to lofts, just to name a few examples. But the blocks and streets on which these uses are located stay the same, and it is on these blocks and streets that private and public businesses and the employees they hire are located.

Growth management and urban design strategies for strong and weak economies are more effective when the locality is structured as small blocks and streets instead of superblocks, cul-de-sacs, and the gated enclaves of housing, offices, or industry that have characterized much of postwar suburban development. Good urban design enables strong and self-renewing local economies, while poor urban design significantly inhibits revitalization efforts. To be effective, both urban design and economic development must reflect the idea that the use of a building or parcel of land is always temporary. Change is inevitable, and the pace of change has accelerated in our global economy. U.S. cities have also experienced significant change from business cycles and recessions, with the most recent recession creating some of the most profound change. Throughout the United States, cities and towns have higher levels of business closures and abandoned housing and subdivision projects as a result of the financial crisis, all requiring new strategies and users to restore the neighborhoods in which they are located.

Effective local economic development is enabled by urban design principles of incremental development, organization of territory, layering of infrastructure, definition of boundaries, and creation of public space, which are described briefly in the following paragraphs.*

*This section consists of excerpts from Bacon, Dagenhart, Leigh, and Skach (2008).

The first principle of incremental development maintains that design should reflect the uncertainty of the future. More fundamentally, urban development is understood as an ongoing process that has no determinant end form and requires a strategic framework that allows the city and its neighborhoods to continually reinvent and reconstruct themselves while providing an organizing structure for growth. Instead of attempting to control a master planned outcome, urban design should remain flexible, adaptable, and indeterminate such that a wide range of future development scenarios, foreseen or unforeseen, can be accommodated.

While incremental development establishes a critical strategy for urban design, the second principle—organization of territory—directly informs the staging of incremental development. How a site is organized internally influences how and where development occurs. Thus, territory should be organized in a way that specific uses and programs are allowed to change without altering the underlying ordering strategy. The traditional lot, street, and block arrangements found in cities across the world are organizations of territory that have proven to accommodate change over centuries. Large single-use parcels, whether large industrial brownfield sites or suburban superblocks, do not have the capacity to easily change. Instead of letting market analysis, which by definition is always short term, determine how territory is organized, the territory should be thought of as a part of a city and organized into patterns of lot, street, and block structures that are empirically proven to work. In great cities, land and economic use adapts to urban form and structure, not vice versa, enabling the continuing changes and processes of economic development.

How a territory is internally organized brings into discussion the third principle: layering of infrastructure. The traditional street grid has provided efficient organization of territory, accessibility, and mobility. However, widespread acceptance and use of a hierarchal street system—arterials, collectors, and distributors—has shifted the focus more toward mobility, almost to the point where any other design element has disappeared. Historically, streets have not only provided for vehicular movement but also shaped public space, encouraged economic development, incorporated the needs of transit and pedestrians, and connected to other urban infrastructure systems like water management and power distribution (Jacobs, 1993; Mossop, 2006).

The permanent nature of infrastructure necessitates that it reclaim its traditional ability to function as a critical organizing element, serving as the skeleton for a given site or larger territory. This is particularly important since one of the main forms of economic development incentives is to fund

infrastructure improvements. Infrastructure outlasts land uses and should be designed as such.

Definition of boundaries, the fourth principle, underlies both the principles of organization and infrastructure and focuses on how development sites are physically connected or bound to their surrounding context. One aspect of binding a site to its context is physical connections—extending streets to connect in as many places as possible with the surroundings. But it is also about economic connections—the economic processes on one site are bound to others.

The last principle, creation of public space, deals with physical design and the redevelopment process itself. As design, the principle of creating public space serves as an extension of the boundary, infrastructure, and organization conditions by designating locations for key public parks and programs. However, as process, creation of public space implicates public involvement in making spatial choices beyond the standard practice of reviewing and approving completed plans for redevelopment. True creation of public space validates surrounding communities, attracts users, and catalyzes development (Frenchman, 2004). Of course, it also strengthens economic development processes. In other words, public space "fertilizes" the economy.

If a locality follows the urban design principles described here, its use of many of the tools discussed subsequently will be more successful.

Landbanking and Community Land Trusts

Landbanking is the practice of acquiring and improving contiguous parcels of land. Local development organizations can use landbanking to put together good development sites for business or industry. Landbanking does not necessarily mean vacant site acquisition. In fact, local governments accomplish some of the most creative landbanking. A number of cities have rented or leased land or buildings acquired through tax sales or eminent domain to assist in starting up new businesses or developing new markets. For example, some cities have leased land, acquired through street widening or located under freeways, to new environmental enterprises. In other instances, cities have reused vacant warehouses as community ice-skating or roller-skating rinks prior to razing the facility for another use. In each of these cases, the community has used an underutilized asset to establish a new enterprise that can be relocated when the land or buildings are converted. Vacant land and derelict buildings are unsightly and can discourage reinvestment.

Landbanking is a powerful locational incentive, done primarily in older communities where little land is available for development or where there is significant vacant land that the community seeks to strategically position for an economic development strategy. It is also used in newer communities to reserve good sites for future development. Landbank sites often include land that is city-owned surplus, former stockyards, or former military installations as well as donated, acquired through condemnation, purchased from private sources, or considered a forest or watershed. To develop a landbank, a locality should set up a real estate division to search continuously for underutilized or underdeveloped properties, catalogue these properties by size and location, and computerize the information for rapid updating and quick reference.

At the neighborhood or community level, a *community land trust* (CLT) offers a unique means to maintain control over physical assets. CLTs are local groups that establish themselves as nonprofit land trusts. The trust board and leadership are generally composed of local neighborhood activists, businesspersons, and relevant professionals (e.g., planners, architects, and finance and real estate brokers). The initiating group can call on technical assistance from the Institute for Community Economics in Springfield, Massachusetts.

The most common community trust usually acquires vacant homes through a loan, gift, or city reconveyance in blighted neighborhoods or in areas undergoing significant disinvestments. The trust identifies low- or moderate-income families and assists them in rehabilitating the property. The families' "sweat equity" may be used as a down payment for the house. The trust sells the home but maintains a land lease on the ground that requires owner occupancy and limits the resale price on the property. In some instances, state housing financing agencies offer the mortgage loans, and in others, banks or bank intermediaries fulfill their Community Reinvestment Act (CRA) quota through such loans.

CLTs have expanded to include the purchase of farmland from hard-pressed farmers, releasing the land to the farmer under the condition that he or she maintains the land in agriculture.

Landbanks or community trusts require substantial capital. Potential sources of funds for land acquisition and preparation include national, state, or local capital programs, CRA funds, program-related investments of foundations and intermediary institutions, such as the Local Initiatives Support Corporation (LISC) of the Ford Foundation, and industrial development bonds. If money for land acquisition cannot be found, however, an alternative approach is to gain control of suitable parcels of land by purchasing an option on them and later selling the option and land to a suitable developer.

Brownfield Redevelopment: A Priority of Locality Development

As noted in Chapter 2, the problems of brownfields—or previously developed properties with known or perceived contamination—have been a major focus of federal economic development efforts over the past two decades. The U.S. Environmental Protection Agency (EPA) responded to communities' concerns raised about how environmental cleanup legislation (Comprehensive Environmental Response, Compensation, and Liability Act, or CERCLA) created a strong disincentive for redeveloping contaminated properties, thereby affecting prospects for economic revitalization in general and economic development efforts in low-income communities especially. Further, brownfields are often major visual blights for a community and detract from the attractiveness of the locality.

While predominantly associated with older cities and towns, brownfields can also be located in rural areas or anywhere economic activity has left behind hazardous waste. Further, brownfield creation is not just an artifact of the past: New brownfields are still being created, primarily due to illegal activities. For example, a new source comes from "methfields," or brownfields created by clandestine drug labs. These have rapidly multiplied throughout urban and rural areas. The dumping of their waste—estimated at five pounds for every one pound of methamphetamine produced—is contaminating drain fields, soils, and surface waters. It is likely that this new source of brownfields will be disproportionately located in disadvantaged neighborhoods and areas.

The proactive stance of the EPA to overcoming the problems of brownfields was significantly enhanced with the 2002 enactment of the Small Business Liability Relief and Brownfields Revitalization Act. This act furthered the establishment of a brownfields marketplace by authorizing funding for site assessment and cleanup, clarifying legal liability, and allowing states to sign off on completed brownfield remediations in their voluntary cleanup programs.

EPA legislation and programs have also been a critical catalyst for the creation of a sophisticated brownfield industry that includes specializations in environmental consulting, finance and investment, law, insurance, real estate, engineering and remediation, and research and development (R&D) of new remediation technologies. Localities seeking to redevelop their brownfields can and should draw on this expertise.

Throughout the country, cities have begun to proactively address the problem of vacant land. This is distinct from greenfields that have never been developed and instead is land that has been developed and is no longer

in productive use. Brownfields are a key contributor to the problem because many owners of contaminated sites find the remediation costs that must be incurred to sell the property cannot be recouped. The strategy of landbanking introduced previously is being tested as a means of resolving this problem. The city of Cleveland established an Industrial Commercial Land Bank in 2005 to attempt to create market-ready properties for firms seeking to locate or expand in Cleveland. The lessons they have learned so far are that it is much easier and less costly to acquire land that does not have buildings that must be demolished. Further, it is far more cost effective to process larger properties than smaller ones (Furio and Hoelzel, 2007).

Brownfields and other kinds of vacant land act as a drag on overall prospects for neighborhood and community revitalization. Research by Leigh and Coffin (2005) has found that the presence of brownfield properties stigmatizes and devalues surrounding nonbrownfield properties, acting as a barrier to neighborhood revitalization. By lowering the property values of surrounding properties, brownfields reduce overall neighborhood property taxes with which to pay for schools, infrastructure, and other essential economic development services. In turn, these neighborhoods are left further behind from those in which brownfields are being revitalized, which tend to be the larger and best-located properties, or the "low-hanging fruit." The rationale for the public sector focus has been to maximize return on public investment, while the private sector logically and appropriately is seeking to maximize profits. But this rationale does not take into account the potential for widening inequality between neighborhoods within a community.

An important component of locality development is to develop a picture of the extent of the community's brownfield problem through inventories and mapping and to develop a proactive strategy to revitalize brownfields. This strategy should balance the desire and need for maximizing returns on public investment, which considers only immediate costs, with the need to prioritize revitalization of the community's poorest neighborhoods to reduce spatial and human inequalities.

Physical Infrastructure Development on Industrial and Commercial Land

Industrial and commercial land and buildings are often more attractive to potential businesses and industries if they have already been improved. The advantages to a company buying or leasing improved land are twofold: The time between acquisition and operation can be greatly reduced, and the expense and bother of site improvement are avoided. Thus, many towns and

industrial development corporations have the requisite building inventory and physical infrastructure already in place to attract new companies and retain existing, expanding companies. Some have been successful; others have not. When considering this tool, be sure it is used only in relation to businesses truly suited to an area.

Adaptive reuse is another alternative for community infrastructure revitalization. A number of cities have developed policies to reclaim old, underused industrial property for other uses. Factory space has been transformed into housing, live–work space, offices, art studios, restaurants, and shopping malls. The city usually uses its resources to reconfigure the streets, build parking structures, and reinforce the building to meet the basic requirements of the new users. Federal and state rehabilitation tax credits allow the developers to receive tax breaks for a period of 5 or more years for the conversion investments.

There is a variety of additional ways in which a community can improve land and buildings to create incentives. Most common is the provision of water and sewerage lines, street lighting, access roads, and sidewalks. Lowell, Massachusetts, converted 11 major textile mills into office and demonstration space for a national urban park with the city providing offsite improvements and parking. North Adams, Massachusetts, converted an old abandoned factory into a museum of contemporary art that draws more than 100,000 visitors a year. Older industrial and port cities, such as Charleston, South Carolina, have provided landscaping for privately financed historic preservation efforts of industrial, commercial, and housing estates. The Tennessee Valley Authority (TVA) provided technical assistance to small rural communities for the transformation of old city motels into residential space called "hometels" (Homets, 1992).

Speculative Buildings

Speculative buildings are "shell" buildings. Their interiors are left largely unfinished until a tenant is found. They are a marketing tool for attracting firms to an area and for retaining existing companies that are expanding. They provide work space—a key factor in a firm's decision making on site location. By providing the space, a city or neighborhood can significantly reduce a firm's start-up or expansion time.

Speculative buildings are best used by localities that suffer from a shortage of industrial space but have an adequate labor force; a transportation system; and a sufficient supply of public services, including utilities, police, and fire services.

One inventive and low-risk approach to speculative building is for a locality to build fully serviced storage units with water and power. These units, if properly designed, can be turned into small factoryette spaces, repair shops, and business incubators. A number of communities in the Northwest have either assisted in such space development or converted their own underutilized corporate yards to this type of incubator space. Perhaps the best example of this type of investment in the United States is the very successful biotechnology incubator space provided in Emeryville, California, which is adjacent to the University of California, Berkeley, and Silicon Alley in New York City's Greenwich Village.

Zoning Regulations

Zoning policy can promote economic and commercial development by setting aside a sufficient amount of land for industrial and commercial use and by allowing flexible zones and rules in the local zoning code. A number of techniques have been developed that overcome deficiencies of single-use, strict limit designations of height and density—thus making land use more flexible. Such zoning tools include incentive zoning, overlay zoning, and special districts. Because the local government controls these regulations, only local planning and zoning officials can use these tools.

Incentive zoning is often used to overcome strict site regulations of height and/or bulk. It provides a developer with flexibility and encourages certain land uses and project features. These incentives may be applied in a variety of ways, but they are generally used to obtain public benefits in exchange for design concessions to a developer. The most prevalent type of incentive zoning is bonus zoning, in which additional densities or increased floor areas, beyond those specified in the zoning codes, are awarded in exchange for public benefits (access to mass transit facilities, open space, etc.).

Overlay (or floating) zoning is a regulatory tool used when local government's general zoning and development standards do not address a subarea's unique issues and conditions (Fitzgerald and Leigh, 2002). The overlay zone is a special zoning district that is placed over the existing zoning base, thereby superseding, modifying, or supplementing its requirements. The overlay can add special provisions for land uses, design standards, or preservation of unique features, as in the case of historic preservation zoning overlays. For economic development purposes, the overlay zone can be used to create specialized commercial or industrial districts. In addition, overlay zones can be used as a device to market development rights by selling to

developers the right to increase plot ratios in a specific area while maintaining the same overall citywide density limits.

Another excellent example of the use of overlay zoning is the historic corridor district developed in Gastonia, North Carolina. Gastonia's overlay zone is a supplemental zoning area bordering its historic residential district. The overlay zone protects the underlying historic district residential character and design, and the overlay provides a development corridor in the area that allows professional offices, banks, specialty shops, and small restaurants in keeping with the overall historic theme. As a result, commercial development and residential character have both been enhanced.

In essence, overlay zoning merely allows the shifting of densities and zoning applications around the city within prescribed limits. It also allows the market to work more effectively and efficiently. Developers can place facilities where demand exists rather than where planners think they ought to be. Finally, in growing areas, this tool is a tremendous fund-raising device, allowing the local government to acquire capital for other civic improvements without going back to the taxpayers. At times, this practice alone generates sufficient income to finance the community's economic development office and/or program.

Business Improvement Districts

There is little doubt that business improvement districts (BIDs) have restored New York City's retail areas. Basically, an improvement district is like a special-purpose zoning or taxing area, but it is organized by the businesses and gains legal form through a majority of the businesses voting for its existence. They are also agreeing to assess or tax themselves to raise the funds needed to pursue improvements to the district. These funds can be augmented by securing public grants and can be used for a variety of locality-improving purposes such as cleanup, enhanced pedestrian and transportation projects, policing, marketing programs, building facade improvements, and so on. The most well-known BIDs—New York City's Grand Central Station (see Figure 8.1) and Times Square—have been responsible for the restoration of these important areas by providing added police services, local hourly cleanups, and joint merchant services.

Businesses and sometimes apartment or condominium owners agree to form an organization to provide basic community services (e.g., street sweeping, supplementary police services, area-wide advertising) that promote the location and bring it new retailing and residential occupants. A local board of business and community leaders, including local schools, is established

Figure 8.1 Grand Central Station, New York, Community Business District Team

and—with city permission and usually encouragement—the district is established and allowed to tax local businesses a small amount for services.

BIDs have been set up in many major cities—with impressive results. Crime and vandalism have declined markedly, and patronage of local merchants has far outweighed the small monthly assessments of the districts. In many of these districts, the district leadership has formed a compact with the local schools and community service organizations to promote after-school programs that support both in-school and out-of-school sports and recreation as well as engage local volunteers for school programs. The BIDs also host speakers programs and other activities, such as holiday celebrations, that pull the community together.

Not all communities or businesses favor BIDs. Many merchants view this as no more than a new tax with few benefits. Moreover, the BID is another level of government, creating a new excuse for local government not to provide the tax-mandated services. Furthermore, it is argued that the BIDs create a new establishment in some communities that makes its own rules with little real accountability to the entire community. In spite of these arguments, BIDs are increasingly popular in both large and medium-sized cities because of the results they bring in terms of improved physical appearance and a feeling of security to residents and patrons in the area.

Regulatory Improvement Through Simplification

An excellent method of evaluating a community's regulatory system is to place a local public official in the developer's role and have him or her walk through a typical permit or code enforcement routine. This will provide the local official with insight, from a developer's point of view, into any flaws and problems associated with the development approval process, such as conflicting regulations, time-consuming delays, or a negative or adversarial view of development. If this procedure indicates procedural and regulatory shortcomings, the community should alter its regulations and simplify the approval process. The Loma Prieta earthquake in San Francisco in 1989; the Oakland, California, firestorm in 1991; Hurricane Andrew primarily in Florida and Louisiana in 1992; New York's terrorism attacks on lower Manhattan in 2001; as well as the Hurricane Katrina experience in New Orleans in 2005 forced local government officials to undertake intense and expensive reviews of their existing zoning procedures. The aftermath of each of these events provided local officials with a better understanding of how their planning and building systems were ill equipped to respond to the development process.

Recently, many communities have established local interdepartmental panels, one-stop permit offices, or committees to review development impacts and overcome the aggravation and uncertainty involved in the process.

Townscaping

Many small towns believe tourism is the antidote to the collapse of their town centers. Although tourist dollars are important, local trade is important as well. Tourism is both cyclical and fickle. Commercial centers must ultimately survive on local traffic. Communities must therefore do everything they can to make shopping in their civic center attractive and worthwhile for local residents as well as for outsiders. One of the best ways to make the downtown area attractive is to embark on programs that give it character or restore some character to it.

Townscaping—a physical, attitudinal, and management process—is one means of achieving these objectives. The physical component basically entails the development of a visual theme for the central town area by local merchants, city planners, and citizen groups. The theme may be based on the area's history or be a more contemporary expression of the community's identity. A typical manifestation of this idea is the Main Street program in

which the town theme is incorporated into plans for building or rebuilding the existing landscape and built environment. For example, small communities in the Midwest have developed modest but well-designed approaches to townscaping that make them exceptionally visually appealing. Many small communities have experienced increased local business traffic and tourism as a result of improving their visual image while preserving their rural or small-town character.

The attitudinal component of townscaping relates to the actions local businesses take with regard to their town center. Some communities have resurrected or formed new local chambers of commerce to provide business with a forum in which to discuss common problems such as improving the skill level of shop assistants and increasing the type and range of advertising on television or radio as a group advertising effort.

One of the most clever townscaping programs in the nation is the restoration of downtown Pasadena, California (see Figure 8.2). For all of its native beauty, sunshine, and national attention via the Rose Parade, Pasadena was an economic disaster in the 1970s. However, with the assistance of a group of planners and architects, the core of Colorado Boulevard was restored on its art deco base. Along with well-appointed alley shops, tree-lined streets, and exceptionally well-hidden but accessible parking, Pasadena is now one of Southern California's major tourist destinations.

Figure 8.2 Shopping Area, Pasadena, California: Interior Buildingscape

The management aspects of townscaping include such measures as hiring consultants or even civic center managers to help analyze methods for increasing sales, improving product offerings, maintaining cleanliness and attractiveness, and advocating civic improvements that will improve retail opportunities.

Shopsteading

Shopsteading is a relatively new approach to community or inner-city neighborhood revitalization. It is a tool that can be used to address the problem of vacant commercial property. It involves the sale of abandoned shop facilities to businesspeople willing to renovate them and then operate their business there. The success of shopsteading hinges on two main factors, the first of which is the availability of vacant properties in areas that have considerable potential for economic revitalization. This means that there must be an identifiable market for goods and services in the shopstead area.

The second necessary component is the availability of individuals able to satisfy shopsteading requirements. Before settling on the property, shopsteaders are usually required to provide evidence of equity capital and to submit detailed specifications for rehabilitating the property. They also must have estimated all capital requirements for reconstruction and obtained commitments for the necessary financing. Shortly after settlement, the shopsteaders must begin improving the property. Within a few months, the building must comply with the local building code, and within a year, the shopsteaders must have completed the renovations. If not, the property reverts to the city. Within a year, the shopsteaders must also begin operating the business and continue in operation for at least 2 years before it may be sold.

Shopsteading is designed to promote both business retention and business attraction activities. For businesspeople, the most important benefit is low-cost—sometimes even rent-free—property; the shopsteaders have the immediate advantage of purchasing property at a cost considerably below the market value. Owning the building where his or her business is located gives the small businessperson an incentive to improve it. Shopsteading probably provides one of the best opportunities for people who wish to open retail and specialty shops, service-oriented firms, and other small businesses.

For the city or town, shopsteading has the potential for improving land-use patterns in marginal commercial areas and providing incentives for other private investors to renovate the remaining buildings on the block. Before deciding to initiate this program, however, local governments and

community groups must study the opportunity costs of shopsteading (i.e., how the available resources might be used for another project).

Housing and Neighborhood Improvement

Housing is one of the most obvious community resources, yet it is rarely considered by most cities when it comes to economic development. There are two aspects of the housing–economic development nexus. One is the need to provide diverse housing types to provide homes for all groups in the community. The other is the need to provide households with services ranging from child care to community facilities, such as swimming pools. The traditional approach taken to these opportunity areas has been merely to wait for the state or someone else to act. City councils, however, are becoming increasingly aware of how the availability of housing and household services influences the local economic development climate. As a result, some cities are becoming aggressive housing developers through the use of their land. For example, BRIDGE Housing Corporation in San Francisco is the largest nonprofit housing producer in the nation. BRIDGE produces more than 1,000 units of housing annually for both sale and rental. BRIDGE developments are almost entirely based on local land contributions to support the project.

There are more than 1,000 nonprofit housing development corporations in the country that pursue similar strategies. Chicago devised a very ambitious plan to revitalize its entire public housing stock, replacing it with a mixture of moderate- and low-income housing and including both rental and homeowner units in the same development. Another example is Oakland, California. Its downtown and its entire city have been revitalized by Mayor Jerry Brown's aggressive housing program that has restored or developed more than 10,000 mixed-income housing units at the heart of the city (see Figure 8.3).

Housing development need not be a prohibitively expensive process if a community is prudent about land acquisition. By purchasing or trading land, community groups or city governments can put themselves in the position of inviting in quality developers to build diverse housing. However, land cost is a critical determinant of whether good affordable housing can be provided. New Orleans is undertaking a very aggressive strategy to reduce blighted housing that predated the hurricanes. The city of New Orleans, with a combination of foundation and city resources, is purchasing and condemning properties that have been abandoned or have taxes in arrears in distressed neighborhoods to create new affordable and market-rate housing.

Figure 8.3 Neighborhood Housing, Oakland, California

Household Services

Household services represent another area in which there are new opportunities for enterprising local governments. Some local councils have built new recreation and sport facilities under lease agreements with private operators rather than providing and maintaining these facilities themselves. In addition, community-based organizations can provide household and community services on a contract basis for neighborhood development and job generation.

Community Services

Local government provides a wide range of services, from household to commercial (see Figure 8.4). Communities are also becoming involved in providing services, such as running trailer parks, operating summer youth

Figure 8.4 Street Closure for Farmers' Market, Berkeley, California

projects, writing local histories, and maintaining museums and art galleries. In other instances, councils are beginning to operate motion picture theaters and similar labor-intensive services. These services are frequently a drain on city resources. However, there are ways for communities to reduce these costs and in some instances turn them into moneymaking propositions.

Local government and community-based organizations have used a number of techniques to make community services pay for themselves. Local governments have sublet their visitor centers to entrepreneurs who run them as combination gift shops and information centers. In addition, as communities embark on tourism as an economic activity, they discover that tourist services must pay for themselves directly. Visitor bureaus and similar activities are expensive. There are ways to finance these services, however. For example, some visitor centers publish tourism newsletters with advertising for local merchants. This helps defray some of the cost of the center.

The approaches communities use to provide services while reducing costs and creating jobs is limited only by the imagination. The traditional fiscal municipal management philosophy of "we won't do it unless we've got the money" is no longer acceptable. For example, communities in Florida and Maine aim at attracting tourists willing to pay more to "sustain" the natural environment. Local officials have the responsibility of finding a way to do it rather than a reason for not doing it. Recognizing this, a local government should develop alternative mixes of public and private resources, combined with incentives, to achieve its objectives. Similarly, community groups cannot take "no" for an answer. They must also develop a strong blend of existing and new resources to meet their goals. The examples in Economic Developments 8.1 represent means by which a community can use its civic assets.

ECONOMIC DEVELOPMENTS 8.1
University-Led Revitalization Strategies*

The 135-year-old Le Droit neighborhood is in the northeast section of Washington, D.C., on the major arterial traffic route that connects the capital with Maryland. It is an area with a rich history and remarkable physical attributes. Due to Le Droit's strategic location, more than 60,000 vehicles pass through the area per day. In addition to the location, the neighborhood is home to the McMillan Park Reservoir Historic District, designed by Frederick Law Olmsted Jr., which includes a community park of several hundred acres. The community also possesses some of the most significant post–Civil War historic architecture in the nation. Le Droit's most important institutional and economic asset is Howard University, the largest historically Black university in the country, with 11,000 students and almost 6,000 staff. The university includes 13 schools and colleges and a major teaching hospital complex.

As in many cities, after the urban riots of the 1960s, both White and Black middle-class residents abandoned the Le Droit neighborhood. In the 1970s, drug dealers moved in, saddling Le Droit with a reputation for crime, drug dealing, and prostitution. In response, Howard University took a defensive strategy by closing off its campus and beginning a campaign of landbanking for expansion purposes. In so doing, dozens of homes and vacant lots were purchased, boarded up, and left to deteriorate (French, 2004). Consequently, despite its numerous positive assets, the negative public perceptions of the Le Droit neighborhood, in concert with Howard University's defensive rather than proactive response, contributed to community disinvestment.

Le Droit's fortunes began to change in the mid-1990s when a new president came to Howard University. French (2004) wrote, "On a tour of the neighborhood, [H. Patrick Swygert] was appalled by the degree of deterioration that had taken place since his days as a student in the 1960s" (p. 110). The first step the university took to turn around the Le Droit neighborhood was to move a number of university entities into vacant buildings on the main commercial street near the campus, Georgia Avenue. These included the university technology center, bookstore, Howard Community Association, and a new visitor center (French, 2004).

This action became the first phase of what has become a four-phase redevelopment initiative. Along the way, the university has developed significant partnerships to realize its goals, including those with the district government, community groups, and Fannie Mae, which developed and offered low-interest home and business loans. In Phase 2, project collaborators created homeownership opportunities out of 29 boarded-up properties and 17 vacant lots. By the end of Phase 3, a total of 45 homes had been constructed or rehabilitated, which were purchased by Howard University employees, public school teachers, municipal firefighters and police, and other community members. Also in Phase 3 were significant infrastructure improvements, including "street resurfacing, installation of new street lighting, bricking of sidewalks, tree planting and traffic calming measures, all undertaken by the City with $5 million in federal grants awarded to the University" (Swygert, 2008, p. 2).

Phase 4 of the Le Droit Park Initiative is the "Howard Town Center," a mixed-use project proposal for more than 445 market-rate rental residential units with parking, and 70,000 square feet of retail space, including a 35,000-square-foot grocery store. In late 2012, Washington, D.C., approved an $11 million dollar tax break for the redevelopment, including a 10-year, 100% property tax abatement (Weiner, 2012). Soon after, however, the project was postponed indefinitely due to a $100 million lawsuit filed in 2013 by Howard Town Center Developer LLC alleging Howard University wrongly terminated the developer's 99-year ground lease for the property site. The university contends that the developer broke their contract by failing to pay rent for the property by the required deadline. In the meantime, Howard University is working with a different developer to create another mixed-use project nearby that will include 319 residential units and 11,000 square feet of retail (Neibauer, 2015).

Prior to these recent challenges, Howard University's Le Droit Revitalization Initiative ("Le Droit Neighborhood, Washington, D.C.," 2000) won national recognition for its successful redevelopment, including 11 national awards (French, 2004). This long-term and multiphased project is one of many university-led local economic development strategies around the country implemented to benefit both schools and their surrounding neighborhoods.

*Research assistance provided by Ashley Bozarth

PLED PROBLEM SOLVING 8.1
Community Building Through Ownership

Chesterfield has had an impressive recent record of innovation in urban revitalization. It was one of the first cities to respond to the need for rehabilitated housing and to recognize the opportunity of abandoned, vacant city-owned houses by developing the urban homesteading program. City residents willing to rehabilitate and live in the buildings could buy them for just $1. Chesterfield has become a city that planners, urban government officials, and private developers use as an example of a city willing and able to develop innovative programs to meet the needs of all its residents.

Part of the reason for Chesterfield's success has been the city's ability to build on the strength of its neighborhoods. That process has involved a willingness to listen to neighborhood concerns and to adapt city policies and programs to meet those concerns. Keeping the neighborhood shopping areas alive and healthy has been an important part of that effort.

One of the problems with many city programs is that they attack only one facet of a problem. Cities focus on putting in street improvements or a mall and then hope for the storeowners to do their part. They expect homeowners and apartment owners to improve their properties. The city of Chesterfield recognized that public improvements would not, by themselves, have any long-term effect unless there was a total approach to the needs of the shopping areas and homeowners.

The city's staff worked closely with a locally developed city economic development task force to identify the commercial and housing needs of an area and then organize programs of activities to meet those needs. The program included four major components: public improvements, housing and storefront improvements, management, and financing.

The city's task force recommended a program in which commercial buildings, multiple-unit dwellings, and a few single-family units used as "crackpads" were seized for payment of delinquent taxes or fines. These buildings are being recycled for community use. In the program, as designed by the task force, the city pays for mutually agreed upon public improvements such as public housing, police protection, parking, landscaping, benches, and other street furniture in a designated neighborhood. The citizens of the selected area must work for a nonprofit community-based community land trust (CLT). The CLT purchases distressed properties from the city at cost. CLT properties are then placed in one of three programs: the lease–purchase program, the Homeward Bound program, or the multifamily program. Under the CLT lease–purchase program, qualified low-income working families who cannot raise the down payment but can make lease payments of $200 to $300 per month can lease a home or apartment with an option to purchase. Families must put at least $2,000 in sweat equity into the

home via repairs before they can move into the unit. The low-income prospective owner must present a plan to rehabilitate the property at his or her expense. During the lease period, the family must keep up the property or face lease termination.

The Homeward Bound program is aimed at young people who have moved away from their neighborhoods. It is similar to the lease–purchase program but aimed at higher-income families who still cannot afford a down payment. These families take on mortgage payments of $1,000 to $1,400 per month. Families purchase the property with a low down payment and a second mortgage. They can refinance the project in as little as three years and take on the full first mortgage themselves. CLT maintains a ground lease on these properties that specifies owner occupancy and sets a formula for a sales price. If the property is sold for a price higher than the agreed-upon formula, the land lease is terminated, and the back land rent is due and payable in full.

Finally, the multifamily program provides for the rehabilitation of multifamily units by CLT for rental. CLT has a separate housing management company to service the nearly 400 units of apartment units it currently operates.

A fourth critical area of the Chesterfield program is management assistance. The city has the staff and expertise to do all of the things needed to manage property. The city's program provides that expertise to building owners too small to afford it on their own. The city offers a neighborhood development manager in each district who will carry out an analysis of retail demand in the neighborhood so merchants can offer the goods and services their customers want. It also helps merchants plan and carry out promotional events such as street fairs, tours, and market days as well as assists with advertising campaigns.

The city is contemplating moving beyond this program to revitalize neighborhood areas. The new approach would be to establish a local community development bank to help finance community- or neighborhood-based projects. The development bank would be formed as a community development bank trust with a local board composed of both neighborhood and business representatives. The city economic development staff, which proposed the idea, are suggesting that the city council place a portion of the city employee pension fund assets in this bank and the income stream from downtown redevelopment projects as well as the $1 million private sector commitment into the bank. The proposal has generated heated debate in the city council and the community. The *Chesterfield Tribune* has editorialized that such a use of city pension and investment funds in this manner would be "totally irresponsible." What are the pros and cons of this type of investment approach? Should the city risk its pension funds and city redevelopment income on such projects?

PLED PROBLEM SOLVING 8.2
Revitalizing the Center

The key to a city downtown revitalization strategy is a dynamic public–private partnership. During the late 1960s, Centerville began to decline economically. As in many other moderate-sized, industrial American cities, Centerville's retail sector moved to the suburbs and its industrial base shrank. The 1990 census showed a continuing decline in the city population from 690,000 in 1960 to 499,000 three decades later. Meanwhile, the metropolitan area's population increased from 792,000 to 1,570,000. In the late 1960s and early 1970s, Centerville realized that a dramatic move had to be made to revive the city. That move was a strategy to invest significant public funds to encourage private investment in the city's decaying downtown. Those funds upgraded public facilities and improved sites, opening up new development opportunities for private investors. Spurred by public support, a series of projects has led to a fairly significant comeback for Centerville's downtown. Centerville's success is a useful model for other cities of moderate size in the midst of revitalizing their downtowns.

As a medium-sized city, Centerville had a close-knit and generally progressive business community. The business leaders knew and trusted each other. Those relationships helped to convince them to take some risks to revitalize their downtown. The camaraderie was so strong that, once the process began, no one wanted to be left out. That feeling was essential. The city leaders felt that the redevelopment would never have happened if any one participant had failed to join—that is, if the public–private partnership were less than complete.

In Centerville, 90% of all deals involving public commitments include the city's economic development corporation (EDC), Civic Central Area, Inc., a private, nonprofit business organization. The EDC is headed by an executive director and employs 32 people who work to attract new development, retain business, assist small businesses, and package financing. This active municipal component, along with Centerville's mayor, initiated and promoted the downtown revitalization strategy. The public commitment to development has been consistent and predictable, thus making the development environment more hospitable. Centerville's strategy was to initiate development through bold steps that would ripple through the downtown.

The city's early redevelopment efforts were convincing evidence of the need for this direction. One of the first projects conceived in the late 1960s and constructed in the early 1970s was a six-block pedestrian mall on Fourth Avenue downtown. When the mall was on the drawing board, the retail sector had not completely deteriorated but the suburban shopping trend was clear. By the time the mall was completed, a second suburban shopping center had opened and the true impact on downtown was felt. The mall, unfortunately, was an example of too little, too late. That experience, however, taught Centerville a lesson: Only a large investment would affect the downtown's economy.

Centerville's size is also a plus. Although the city has suffered economic decline, as have many midwestern industrial cities, Centerville does not have the larger pockets of poverty characteristic of larger cities. The extent of poverty, housing problems, and economic decline is not so extreme, and solutions are easier to find.

Yet the citizens' attitude toward the downtown in a moderate-sized city like Centerville is harder to break than in a larger city. In Centerville, the public saw no possibility of reviving the downtown. In large cities, the central business district frequently has kept its traditional office function, making retail core revitalization easier, but in medium-sized cities such as this one, the public often perceives the downtown as dead for all purposes. Therefore, Centerville launched a major public relations campaign to overcome this negative attitude.

To formulate a new strategy, the city and Civic Central Area, Inc., formed a committee to study the downtown's problems. At that time, the city had a strong governmental complex at its western edge, a large medical complex on the east side, and the Belvedere Hotel on the north. Fourth Avenue, the heart of the central business district, was clearly suffering.

The committee recommended the construction of the Pigeon Dome, a new center-city sports complex, combined with retailing to be located in the heart of the downtown, in order to fill the hole in the donut. The city provided the seed money to plan the Pigeon Dome. The plan envisioned an integrated project of an office, retail, restaurant, and hotel attached to the 25,000-seat indoor sports arena. Municipal support for the project was reinforced with a pledge from the business community to assist in developing necessary feasibility studies and assistance in land assembly. With that commitment, the committee was entertaining a deal with the team owner Al David. Al wanted the community to finance the entire project and pay no rent for the first 10 years. In addition, Al asked for the Pigeons basketball team to control the revenues for the entire stadium parking for the life of their 20-year lease.

The total project cost, $142.5 million, would be financed by the city and state, federal grants, and private sources. Federal funds would be used to acquire land and construct a department store, leased to its operator. City funds constructed the garage from the land monies and built the public open space, including the Pigeon skyboxes. The organized financial and public support from downtown business owners, the city leadership, and the state made a strong partnership—and, the codeveloper believed, an essential one—to make the project work.

However, very significant community opposition has developed. Neighborhood activists have attacked the project as a giveaway to wealthy sports owners. Schools and community groups claim that $150 million could go a long way toward restoring all of the programs cut out of the school budget, lowering class size, and providing housing for the homeless.

Proponents for the Pigeons argue that the dome is an investment and cannot be compared with funding the schools or homeless projects. Furthermore, bringing the Pigeons to downtown will prove that a major project in a city of this size

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would give high visibility all over the Midwest. The project is demanding public attention and dominates the media. The value of the Pigeons playing downtown will bring millions in unpaid advertising to the city. This visibility is a major component in an overall strategy for cities of moderate size—particularly in overcoming negative attitudes and replacing them with civic pride in the downtown.

The mayor of Centerville argues that physical redevelopment must precede business and jobs. An important way to attract new firms is to show potential companies an exciting city with a major sports franchise at its heart. The private and public sectors, working together, can make this happen.

African American leaders have been especially critical of the downtown Pigeon Dome proposal. They point out that, other than a few star players, few Blacks will benefit from the arena. They have come to the city with a plan that would require that African Americans be given opportunities for equity participation in all future downtown projects. The proposal before the city council would require that 20% of the equity in the Pigeon Dome be set aside for local Black investors. Half of this 20%—or 10%—would be from city funds invested in the projects and passed on to a coalition of African American leaders to be held in a trust fund for minority education. The remaining percentage would be allocated by the developer to Black residents who would either provide services, cash, or secured notes to gain their share of the project. Finally, the coalition is requiring Al David to donate 5% of the team's ownership stakes to a minority development corporation.

Assume you are on the mayor's chief economic development advisory board and develop a winning strategy for the mayor that does not contribute to racial injustice.

PLED PROBLEM SOLVING 8.3
The Portside Plan

One of the newest trends for raising capital in cities involves minority equity participation programs intended to increase the participation of minorities and women in new development. Such plans are designed to help pay for affordable housing, economic development, and other needs in city neighborhoods. Communities all across the nation from San Francisco to Boston, from Seattle to Jersey City, are attempting to find ways to bring minorities and women and neighborhoods into the development process. The concept is to design a system that provides for a combination of taxes and incentives to make developers involve minorities and women in city development projects.

The Portside Minority Equity Participation Program is an innovative "bottom-up" strategy that uses downtown development to fuel growth in the city's neighborhoods. The Portside Minority Equity Participation Program is essential to the city's health in that it can help create self-reliant, locally based entrepreneurship in low-income, minority neighborhoods. Such programs stress self-employment, small businesses, and worker or community ownership, emphasizing adequate wages and benefits, decent working conditions, stability, job control, and opportunities for upward mobility. A city is thus rebuilt neighborhood by neighborhood, as small, locally controlled enterprises create jobs for nearby residents.

Portside is giving a whole new meaning to bottom-up development programs by earmarking downtown development through its Minority Equity Participation Program. The program has three components. First, a new Minority/Community Equity Participation (MCEP) Commission is being appointed. The new commission will have responsibility for establishing guidelines for minimum minority and female participation in all projects with city investments of more than $100,000. The commission is to establish a point system as part of the bidding process so that developers can bid for projects with varying amounts of minority participation, jobs, and other benefits in any project. The project with the greatest overall city benefit would be awarded the opportunity to develop the specified site. Second, the Minority Equity Trust fund is being established. This trust fund is designed as an alternative to direct equity or jobs participation. Developers can contribute to the trust fund in lieu of or in addition to meeting other community goals. Finally, the MCEP Commission was authorized to recommend a downtown development fee (tax) on all downtown developments on a per-square-foot basis. The fees collected would be designated for the trust fund.

Within this framework, the MCEP Advisory Board has proposed that a linked development requirement be instituted for downtown commercial development. This would require the developer to design a companion project in one of several low-income neighborhoods. Innovative programs proposed by the committee included a variety of loans for start-up enterprises headed by low-income people, minorities, and women, as well as housing and job training projects. One loan program, for example, would provide these businesses with working capital at low interest rates and favorable repayment terms.

Another component of the MCEP Board's plan was first-source hiring agreements to ensure that the city's most needy residents would benefit from the jobs created by downtown development. Any employer who receives a publicly subsidized grant or loan or who is involved in a commercial project involving city financial participation would have to use the mayor's Office of Employment and Training as a "first source" of employment referrals for any new jobs created.

A third component of the MCEP Board's recommendations is a plan for Portside city government to make half its purchases from city small businesses and 25% from businesses owned by minorities and women.

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The Minority Equity Participation Program was adopted without a single dissenting vote in the city council. However, now that the commission is in operation, the city attorney and business groups are raising questions about the legality and the advisability of the MCEP proposals. The city attorney is arguing that the point system is a violation of the *City of Richmond v. J. A. Croson Co.* decision of the U.S. Supreme Court, which prohibits any plan based solely on race. Moreover, the commission, City Attorney Jane Gonzales argues, has not established a nexus between downtown development and the proposed development fee. This, she states, is a clear violation of the *Nollan v. California Coastal Commission* decision, which requires a nexus between any tax or fee and the actual project impacts.

The chamber of commerce is livid because the use tax and exaction fees are perceived as antidevelopment. The chamber argues that the office market is too soft to withstand these taxes and that the result of their implementation would be a rapid acceleration of suburban office construction and job growth. "We have talked to developers and those who have done major rehabs, and they say that an additional $2 a square foot [the average exaction fee] can kill a deal," asserts the president of a local business organization.

Several factors have prevented implementation of most of the Portside MCEP proposals. These have included city council fear, developer and real estate opposition, and the unsettled legal questions. The mayor thinks that the city attorney's objection is correct but that her approach is incorrect. What the mayor and a majority of council members want is to find an acceptable formula for implementing the MCEP commission recommendations. Can you figure out a way to resolve the impasse for the mayor, the advisory board, and the city attorney?

Conclusion

Locality development is the most well-known technique for stimulating economic development. City officials are generally comfortable with most aspects of this concept. Everyone wants to live in an orderly, well-maintained community that is proud of itself. Every community needs to be able to successfully adapt to changes in its economy. This does not happen by chance. A city's urban design plays a critical role in its ability to adapt to negative and positive economic trends. In addition, farsighted leadership combined with the prudent use of incentives and disincentives can enable the community to meet its economic goals. No community can afford to "sit on its assets."

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9

Business Development

Business development is an essential component of local economic development planning because the creation, attraction, and retention of business activities builds and maintains a healthy local economy. Active business development is required in both good and bad economic times. When our national economy was booming in the recent past, there were still soft areas in fast-growing economies like Silicon Valley, where neighboring East Palo Alto benefited very little from the robust economy. Other areas, such as much of rural Appalachia, saw some improvements in low-wage jobs but little real economic gain. Clearly, many inner-city residents, such as Harlem's long-standing low-income Black and Hispanic residents, benefited little from the robust New York economic resurgence that welcomed former President Clinton to the community and led to rising real estate prices, pushing longtime renter households out of the community.

No matter how poor a local economy appears to be, however, it still has economic potential internally and opportunities to reach larger external markets. For example, America's inner cities, which had been in continual decline due to postwar suburbanization, came to be seen as new markets ripe for picking at the end of the 1990s (Cuomo, 1999). This vast potential was first tapped by just a handful of pioneering retailers, but the trend grew exponentially, bolstered by the new urbanism and Smart Growth movements, resulting in the "back to the downtown" movement of housing, headquarters, offices, hotels, and restaurants as well as retail activity. The movement came from local entrepreneurs and national or international developers, businesses, and franchise holders. Today, there is a growing

emphasis on stabilizing inner-city economies through deepening the local economic base with industrial activity (Leigh and Hoelzel, 2012).

Retailers and other business can come into distressed communities only if new partnerships can be forged between community and business interests. These new partnerships are developed by public planners in the name of community. Frieden (1990) said the following:

> Planners have many compelling reasons for taking on the function of public sector developers. For professionals whose usual complaint is lack of influence, public sector development offers a rare opportunity to get major projects done. For professionals whose usual output consists of planning documents, it provides visible, measurable accomplishment on the ground. And for professionals usually required to have the time-sense of a geologist, it offers the satisfactions of making an impact within a few years.
>
> Getting the projects done poses challenges that many people find exciting. The public sector developer has to mediate between public and private interests in order to find solutions that meet both an economic and a political bottom line. Achieving success means delivering a project that is economically sound and that serves public purposes beyond financial returns. For a planner who wants to influence the character of a city on a large scale, and wants to do it reasonably early in his or her career, public sector development is a promising choice. (p. 427)

Business development is intended to redress the balance between community as a social construct and business as an instrument of wealth generation for planners. Lockhart (1987) put it this way:

> Community [is] more than a bedroom and service annex to alien commercial interests. Such a notion of community begins with the recognition of the crucial role that the building of shared commitments to the common well-being plays in the attainment of social health and individual satisfaction. (p. 57)

In this context, community and business development are merged as a vehicle to mobilize essential community resources for the generation of shared wealth, both in terms of individual and collective well-being and in terms of a stronger set of economic institutions that can compete both locally and globally. Andrew Cuomo (1999), former U.S. Department of Housing and Urban Development (HUD) secretary (1996–2000), articulated this concept: "Increased business investment can transform many inner cities from places left behind by the new economy into places leading the way to economic success—bringing shoppers, billions of dollars in consumer spending, and new

jobs to urban America" (p. vii). Even though business opportunities are important to minority communities, this should not lead to the conclusion that small business is the only way to create such opportunities. For example, the 600,000 to 800,000 new U.S. companies created annually include many self-employed workers. The U.S. Department of Labor estimates that nearly 11% of Americans were self-employed in 2009. This includes those professionals who work on their own, such as consultants and actors, as well as people who work from home in association with millions of small businesses. Rates of self-employment are highest among Whites (7.4%), men (8.3%), and older workers (18.1%). These 2009 data reflect a continuing trend (Hipple, 2010).

Regardless of whether we are promoting new businesses or retaining existing enterprises, there are at least 12 basic tools or techniques normally considered central to business development. They include one-stop centers, start-up and venture financing companies, Small Business Development Centers (SBDCs), women's enterprises, group marketing systems, promotion and tourism programs, research and development (R&D) programs, incubation centers, microenterprises, technology and business parks, enterprise zones, and entrepreneur development courses.

The choice of tools depends on the local business development strategy. Business development strategies can have one or more of four basic dimensions: (1) to encourage new business start-ups, (2) to attract new firms to the area, (3) to sustain and expand existing businesses in the area, and (4) to increase innovation and entrepreneurship within the community. Table 9.1 illustrates how the tools emphasize the different dimensions. Clearly, they can be mixed together to incorporate several dimensions, depending on the circumstances. In fact, few communities use one tool alone. Most communities use a combination of tools integrated into the total local or community economic development strategy.

Table 9.1 Matching Business Development Tools and Objectives

Tool	Objective			
	Business Start-Ups	**Business Attraction**	**Business Expansion/ Retention**	**Nurturing Innovation and Entrepreneurship**
One-stop center	X	X	X	
Start-up and venture financing company	X	X	X	
Small business development center	X		X	X

(Continued)

Table 9.1 (Continued)

Tool	Objective			
	Business Start-Ups	Business Attraction	Business Expansion/ Retention	Nurturing Innovation and Entrepreneurship
Group marketing system	X		X	X
Promotion and tourism programming	X	X	X	
Research and development (R&D)				X
Incubation center	X			X
Technology and business park	X	X	X	
Enterprise zone	X	X	X	
Entrepreneurship development activity	X			X
Women's enterprise	X			X
Microenterprise	X		X	X

Creating a Good Business Climate

A "climate" conducive to business development is often created with the participation of local governments and neighborhoods. There are published business climate studies in leading business and professional magazines worldwide. The significance of these studies of states, cities, and metropolitan regions remains clouded. After examining their methods and uses, Rodney Erickson (1987) concluded the following:

> There are clearly shortcomings of business climate studies. . . . Does that mean that we should forget about competitive position and business climate studies? . . . In my mind the answer is "no." Whether we like it or not, business climate studies are here to stay. . . . Good business climate studies can help to focus attention on the particular nature of problem issues and lead to some worthwhile introspection. (p. 62)

Business climate studies receive media attention externally and internally. Citizens feel better about a well-ranked community, whether or not there is a real difference in the economic or social outcomes associated with the subjective measure used in such studies. Most business climate studies measure the comparative aspects of conducting business in one community over another. However, issues in firm location or relocation have more to do with the comparative advantages a city offers for the particular enterprise, such as the nearby location of important suppliers, customers, or scientific information. The key to a good climate is determining what kinds of regulatory and policy tools will facilitate business development for the type of firms that use the locality's asset base, such as a harbor, university, or supplier. This is not an easy task, but it can be achieved. There is no strict, standard mixture with respect to the kinds of incentives and support programs offered. The main goal is to fit the program to the businesses desired and to be flexible.

Therefore, both local neighborhoods and cities need to look at existing regulations to see whether they "guide development" to the places and types of activities desired or merely prevent those activities considered undesirable. Finally, the issue of environmental outcomes must be considered. The fact that a community has space or facilities for some environmentally contaminating uses does not mean that these should be the best or only industries a community attempts to attract.

Entrepreneur Development and Economic Gardening*

An entrepreneurial community strategy seeks to grow local businesses and create jobs from within the local economy. It requires a critical mass of entrepreneurs, strong support networks, and a community that is ready for change and seeks innovations (Lichtenstein, Lyons, and Kutzhanova, 2004).

An entrepreneur, as defined in the *Oxford English Dictionary,* is someone who undertakes a business or enterprise with chance of profit or loss. Put more simply, an entrepreneur is a risk taker. Not all risk takers are successful, however. To be successful, the entrepreneur needs to be proficient in all aspects of decision making. Successful decision making by entrepreneurs involves three skills:

1. *Self-knowledge,* or the knowledge to specify the objective; imagination and analytical ability to focus on the factors that lead to decisive action
2. *Research skills,* necessary for collection of data and foresight to estimate data

*Georgia Tech graduate students Ellen Anderson, Jason Chernock, and Melissa Mailloux contributed to this section.

3. *Decision-making and implementation skills,* which require computational skills for applying the data to the decision rule and communication skills for formulating implementation plans. In addition, the entrepreneur needs to have delegation and organizational skills to involve and utilize specialists as required.

The entrepreneur's goal is to "create or capitalize on new economic opportunities through innovation—by finding new solutions to existing problems, or by connecting existing solutions to unmet needs or new opportunities" (Lichtenstein and Lyons, 1996). We highlight here six methods that can be used to foster an entrepreneurship local economic development strategy; these are elaborated on to some extent in other sections of this chapter.[1]

1. *Develop diverse sources of capital.* This can be local venture capital firms, organized networks of angel investors, and public or private seed capital funds.
2. *Create an enabling community culture.* This should be founded on the entrepreneurs' common vision for the community's future, their commitment to giving time and money back to the community, and their willingness to share ideas and information.
3. *Foster networking.* "Consummate entrepreneurs are networkers who thrive in communities. Networks are essential because they link entrepreneurs to potential sources of capital, new employees, strategic alliances, and service providers such as lawyers, accountants, and consultants" (Edward Lowe Foundation, 2002).
4. *Provide supportive infrastructure.* Perhaps most significant is the presence of a local college or university because of its role in education, R&D, and fostering an open-minded, risk-taking local culture. However, more traditional infrastructure, such as transportation and high-speed Internet access, is also important.
5. *Make government entrepreneur friendly.* Local governments that streamline processes work in a spirit of entrepreneurship instead of bureaucracy, so it is easier for local entrepreneurs to do business.
6. *Foster entrepreneurship education.* This education should be targeted to primary and secondary schools as well as adult education. Linking entrepreneurship with education develops human capital and makes this method of economic development more sustainable (Dabson et al., 2003).

Cities can facilitate the identification of people with entrepreneurial talent and interests and develop them via the creation of social and professional networks as well as through secondary and postsecondary education programs.

Social and professional networks connect business owners with service providers as well as grant access to resources, materials, labor, financing, and new markets. Mentoring, another critical aspect of fostering entrepreneurship, occurs on a voluntary basis. The cost for both networks and mentoring programs is typically small and supports logistical and organizational activities.

Youth business programs can be established in high schools, while entrepreneurial training programs can be established in the junior or community colleges. Some big-city newspapers such as the *Oakland Tribune* in California have sponsored business start-up fairs and training sessions to release local entrepreneurial talents in the resident population.

While it is difficult to compare the budget of an entrepreneurial strategy with those of traditional business recruitment incentive packages, it is clear that the costs of this strategy can be significantly lower than the latter category of economic development expenditures. For example, the incentive packages that seven states offered in 1996 for just a single manufacturing plant ranged from $2.35 million to $12.475 million (Spicer, 1996). In contrast, the 2005 total budget for a Littleton, Colorado, economic gardening strategy (described next) was $600,000, or one quarter of that of the lowest amount spent on a single manufacturing plant by any of the seven states in the mid-1990s.

Entrepreneurial Community Program: Growing an Economic Garden

In 1987, the City Council of Littleton, Colorado, decided it wanted to grow jobs by fostering entrepreneurship within the community rather than by recruiting companies to relocate to or expand in the area.[2] It developed an economic gardening program based on the idea that business success comes from three places: (1) an ability to adapt to changes while retaining an identity, (2) a sense of self-organization that encourages action at the individual level versus top-heavy organizational structures, and (3) a local culture that favors risk taking, innovation, and diversity (Gibbons, 2005).

Littleton's economic gardening program has three core activities. First, it provides tactical and strategic information to existing or potential local businesses. This is called "competitive intelligence" (Society of Competitive Intelligence Professionals, n.d.)[3] and involves providing information to local Littleton businesses that is usually available only to large companies. The intelligence provided can include marketability studies, the tracking of new products, legal research, and answers to specific business questions.

Second, Littleton has ensured that necessary infrastructure improvements were made for supporting business. This includes not only physical improvements but also ways to enhance quality of life, such as providing enjoyable open space, sponsoring community events, and creating an intellectual framework through offering courses and training to promote competitive business practices.

Third, the entrepreneurial strategy focused on creating connections between Littleton's business community and outside organizations, including trade associations, R&D firms, think tanks, and academic institutions such as the University of Colorado and Denver University.

Littleton's Department of Business and Industry Affairs, which created the economic gardening concept, annually assists 200 to 300 businesses with the competitive intelligence aspect of its program (Gibbons, 2005; Hamilton-Pennell, 2004). In the 14 years prior to Littleton's adoption of economic gardening in 1989, business recruitment strategies attracted a total of 4,000 jobs to the city. From 1989 to 2004, employment grew from 15,000 to 29,000, for a total increase of 14,000 jobs. During this period, *no* money was spent on attracting outside industries (Hamilton-Pennell, 2004). Thus, the number of employees grew by 93%; however, Littleton's population increased by only 30% from 1989 to 2004. Using business retention strategies, an annual average of 278 jobs was created. With economic gardening, employment grew by an annual average of 1,000 jobs. There are now more than 2,000 companies located in Littleton, the majority of which are small businesses.

One-Stop Business Assistance Centers

One-stop business centers are relatively common components of local government today. In many cases, the one-stop center has a small business mediation function located in the office of the mayor, the city manager, or economic development.

The traditional role for a one-stop center is an information center designed to serve as a key contact point between businesses of all kinds and local government. To be a one-stop advice service for businesses, the center must contain information on all planning and development matters of interest and concern to businesses—local economic indicators and labor market statistics, local development plans, land availability, building regulations and permits, all aspects of finance, and other useful business information. It must also be able to make this information available promptly. Clearly, the center's size will be a function of the size and complexity of the economic

zone it serves. In large cities and towns, for example, a one-stop center for businesses might employ several people. In neighborhoods or community-level and rural places, in contrast, it might employ one person on a full-time or even a part-time basis.

A one-stop center is a valuable business development tool. It benefits businesses by eliminating frustrating referrals from one department to another and by saving time that would have been spent—perhaps without result—trying to procure information on local regulations on their own. In addition to assisting businesses, a one-stop center provides valuable services to local government. Statistics from the center can be used as the basis for reports that describe the number, nature, and geographical breakdown of all business requests. The center's data can also indicate short-term business trends or identify potential business development problems. Moreover, the establishment of an organized professional approach to information dissemination for enterprises strengthens business confidence as well as local governments or neighborhoods.

Start-Up and Venture Financing Companies and Development Banks

Small firms constitute the vast majority of all business enterprises. The formation of new small businesses has effectively utilized both capital and human resources, resulting in employment growth. However, few financial institutions specialize in meeting the needs of small enterprises.

A small business is usually formed using venture capital from the entrepreneur and his or her relatives and friends. If the business is successful, growth is rapid, and the available funds are quickly consumed in buying equipment and/or stock. At this stage, growing small firms need venture capital, which will both improve their profitability and lower their risk of failure. The small business owner then usually approaches a bank for finance. However, the existing financial system is not equipped to provide adequate venture capital to stimulate the growth of innovative small-size enterprises. Reasons for this shortcoming include constraints on different classes of institutions, an inability of existing financial institutions to evaluate the asset value of highly technical or market-driven innovation, and a general insistence on physical assets as collateral for loans. Banks are primarily lenders to rather than investors in small business. Their emphasis on financial security requires some small firms with an inadequate security or equity base but sound profit expectations either to seek higher-cost sources of finance or to defer or cancel development plans if such alternative sources

are unavailable. Venture capital is available primarily from private investors or stock issues. However, many projects and business start-ups in the retail or community service sectors cannot raise funds via the stock exchange, and there are seldom sufficient active local private investors.

The establishment of a mechanism that allows local people to invest in local businesses is therefore an important business development initiative. This can be done through the formation of a start-up and venture financing company—specifically, a community development finance institution (CDFI). CDFIs are a new class of institution with a variety of roots. Some CDFIs are traditional community development corporations (CDCs) that now, with federal government support, offer venture and equity capital. This business development tool can provide venture capital to selected eligible small firms unable to obtain finances from traditional lending institutions and thereby contribute to local economic and employment development. CDFIs, according to Avis Vidal (1995), are not a substitute for ensuring that conventional finance institutions provide equal access to credit and other services in poor inner-city neighborhoods and rural communities of color—places where that access is now clearly deficient. CDFIs appear to be playing a useful role both in pressing conventional institutions to do this and in demonstrating how to do it (p. 194).

The Northern California Community Loan Fund (NCCLF) is an illustration of this form of investment organization. Headquartered in San Francisco, the NCCLF provides small start-up loans to emerging enterprises in disadvantaged and rural communities. The NCCLF obtains its loan funds from private investors who agree to invest in the fund and forgo the interest return on their funds and from foundations and private corporations interested in socially responsible investments.

Development banks are a larger and more established mechanism to provide capital for low-income and female- and minority-owned enterprises. A development bank is a regular lending institution that devotes its resources to fostering economic development (Parzen and Kieschnick, 1992). A development bank might take the form of a savings and loan, a bank, or a community credit union. There is now an association of 40 institutions forming the National Association of Community Development Loan Funds (now known as Opportunity Finance Network). Massachusetts, New York, and Wisconsin have statewide programs with very similar orientations, and the Ford Foundation's Local Initiatives Support Corporation (LISC) provides loan funds or capital support for community development or community enterprise funds on a regional basis for some CDCs. By providing venture capital, local development groups become shareholders in the companies in which they invest. A community shares with other stockholders in the

success (or failure) of investments; it is therefore vitally concerned with their long-term development. Groups like the NCCLF provide the opportunity for residents within a community to invest in small business and share in its success without the risk of investing in just a single enterprise.

To be successful, a CDFI or other community venture group must invest only in those small businesses, existing or new, that are commercially viable and have the greatest potential. LISCs or similar groups should not invest in businesses that are not commercially viable, even for social reasons. The community investment program must be run by a board of directors made up of commercially aware and experienced businesspeople with relevant business expertise.

In sum, community-based (CDFI) groups should prefer to invest in small businesses that do the following:

- Have an innovation in product, process, or marketing
- Have potential for rapid growth
- Have potential for future sales outside the region
- Can demonstrate sound management skills or, if those are absent, is willing to put them in place
- Are willing, if selected, to establish, with the help of the community, an experienced board of directors to assist in planning the future growth of the business (the composition of this board should complement the skills of the small business owner in financial, marketing, and management)

By using these criteria, a good community venture group can embrace a wide range of innovations or technologies in traditional business areas or in the newer high-tech enterprises. A CDFI, in particular, should seek to support a business, not run it, by holding a share of up to 50%. Moreover, because an investment is worthwhile only if at some stage the investor can get his or her money back, a CDFI must have a method of exit via one of the following:

- Selling its share back to the entrepreneur
- Selling its share to another private investor
- Selling its share through the stock market

Finance—particularly local finance that can stimulate new creative enterprises—is the core of small business development. Therefore, every city or neighborhood that wants to pursue this avenue of business development must be prepared at some level to put its money on the line. Timothy Bates (2000), one of the leading scholars on small business in general and minority small business in particular, warned that we must examine all the euphoria

about small business as a good investment. In fact, he pointed out that few minority small businesses are good investments for anyone, including government. Most successful enterprises of this type that pay back loans and investors are Asian small restaurants and similar services employing captive linguistically challenged populations who work in poor conditions and are paid low wages. Even so, many of these enterprises barely provide a living for their owners. Bates (2000) warned that "students of economic development should take note: Honest reporting of small business loan losses is rare in the world of local economic development institutions. . . . Absent of subsidies, the insistence of government sponsored CDFIs to actively fund high-risk, high-cost loans is a recipe for disaster" (p. 240). Bates is correct in his observations. The concept that small business is the cornerstone of neighborhood recovery in inner-city communities has been somewhat oversold. Bates and others admit that there is room for businesses, both large and small, in the inner city; however, to consider local ownership via small enterprises as the best or only solution is not warranted and is bad advice.

Small Business Development Centers

Despite the importance of small businesses as employers and sources of entrepreneurial drive, research evidence suggests that the failure (as distinct from discontinuance) rate among new and small firms is substantial. Poor management is the most frequently cited reason for this. An obvious and arguably cost-effective means of improving the economic performance of the small business sector is to establish SBDCs.

These centers provide management training, counseling or consulting, and research services to small firms, with training as the dominant activity. An SBDC should support the training function in various ways. The center that provides these activities could effectively achieve five interrelated objectives:

- Encourage a higher rate of new business starts with the potential to succeed.
- Reduce the level of business failures.
- Improve the general financial performance and growth rate of the small-firm sector.
- Raise the potential of small firms to create new jobs and improve employment levels.
- Raise the general level of technological innovation and productivity.

Although small business training, research, or counseling activities may be provided through any of several alternative organizations, the best form

is a specialist institution organized in close association with rather than within appropriate educational institutions (e.g., university business schools, advanced education, and technical colleges).

Another approach is to turn unemployed workers into business owners and operators through a business resource center. The purpose of these centers is to tap the entrepreneurial talents of laid off workers and find niches in the local market in which they might start their own enterprises. Business resource centers are usually started by local service clubs, the chamber of commerce, local employment and training institutes, or even a separate nonprofit development and training company. This type of nonprofit organization is designed to use the skills of the underemployed as a basis for generating new employment using business resource centers. These centers provide the following:

- Practical training in business start-ups
- Low-cost, small premises
- Centralized services, such as photocopying, telephone answering, and accounting
- A big brother or sister for the new business

Microenterprise

In 2006, Muhammad Yunus won the Nobel Peace Prize for pioneering the concept of microenterprise supported by the Grameen Bank. The spread of the microenterprise and associated microlending concept is a rare example of the transference of an economic development tool that originated in the developing world to the developed world. In the United States, in particular, both rural areas and inner cities are adopting this tool.

The basic microenterprise concept is to loan funds to a group of borrowers who plan to go into very small labor-intensive businesses in the same community. Microenterprises are usually operated from the home or on the street. They include such enterprises as homemade jewelry or garments, handmade shoes, or specialty foods for restaurants.

Microenterprise programs usually make very small loans to a group of 5 to 10 borrowers, each borrowing under $1,000. The group is responsible for each member making his or her loan payments on time. There is usually some form of prebusiness training and group building before loans are made to potential entrepreneurs. These programs are now in place in many parts of the country, although it is too early to assess their efforts. The programs include the Micro Industry Credit Rural Organization in Tucson, Arizona, and the Lakota Funds on the Pine Ridge Reservation in Kyle, South Dakota. Microenterprise development is not a panacea for the poor, according to

Lisa Servon (1999). However, she maintains that the locally initiated nature of microenterprise programs makes them particularly responsive to their constituencies. This local orientation has allowed them to stay flexible, boosting training capacity, broadening or narrowing the target population, increasing loan-size ceilings, and so forth.

Women's Enterprises

One of the most underutilized resources in the nation is the entrepreneurial talent of millions of women. In the mid-1980s, a pioneering organization was established in Minneapolis–St. Paul to assist women of low income and on welfare to start their own businesses. The mission of this organization, called WEDCO (Women's Economic Development Corporation) and now known as WomenVenture, was to assist women developing small enterprises through an intensive self-help program.

Women Venture has more than 10 affiliate operations around the country. Each is based on a very similar model. Low- and moderate-income women are put through a 7-week intensive training program. The program focuses on assisting them to identify their talents and interests and on building the self-confidence to start a competitive enterprise. The program is rigorous, with few dropouts. Although not all women start their own business, many complete the training with enough confidence to seek work in challenging and rewarding fields.

Servon (1999) has provided an insightful analysis of women's microenterprises in that they offer a means of changing attitudes more than incomes. At the conclusion of her book of case studies, she remarked, "Perhaps one of the most important things that micro-enterprise programs accomplish is that they help change people's attitudes by creating forward motion, giving them the hope they need to believe they can take charge of their own lives."

Promotion and Tourism Programs

The tourism industry has grown rapidly over recent years. Communities have favored and continue to promote tourism in the belief that it is a significant economic and employment development tool. However, surprisingly little is known about the economic and employment implications of the tourism industry. Empirical economic studies of the tourism industry remain few in number. Such studies have been hampered by a lack of consistent data, particularly at the regional level. Objective studies of tourism that measure the economic impacts indicate that tourism at a national and state level is

not a major industry in terms of its contribution to the gross domestic product or employment.

However, these results obscure the vital fact that tourism is spatially selective. Tourism is not ubiquitously but regionally located. Three types of regions can be recognized with respect to the role of tourism:

Regions lacking tourism significance. These are predominantly rural inland regions with no particular or unique attraction for the public traveling for recreational purposes and towns off the main business travel routes. They include most of the nation's small towns, particularly those in the Midwest and Southwest. However, even a community without observable tourism significance can alter its destiny by offering an unusual opportunity, such as "weekend on the farm," or capitalizing on a specific historical event such as the birthplace of a famous or infamous personality.

Regions of high tourist significance. These are areas with substantial scenic wonders and/or excellent climate. They have national and international appeal without increased promotion. They are generally in or near large metropolitan areas. Among those that come to mind immediately are such places as Yosemite National Park in California; San Francisco, California; or Miami, Florida.

Centers of some tourist interest. These are places that have tourism as a component of some other major economic activity. Southern California's film and television industry provides this form of tourism or recreation opportunity.

Although tourism can be an asset, it does not provide the solution for most of the regional or urban areas currently in a state of low growth or decline and should not be promoted as an economic recovery solution. Indeed, research on regional economics indicates that local demand for goods and services is more important than visitor demand. Even in those instances in which the tourist industry has been a major source of growth or decline, there is some doubt that it has ever reached a level of economic importance equal to that of the local permanent population growth. If this is the case, it follows that local planning authorities might focus more on attracting permanent residents—retirees, business managers, and the like—than on seeking to boost tourism from distant places as a source of economic and employment development. Of course, the need for social and physical infrastructure development to keep pace with the rate of population growth must be borne in mind. In sum, for the majority of American communities, tourism is best seen as one component of an economic development strategy rather than as the entire strategy itself.

To be successful, a tourism program of any kind must be well planned and managed. It must have explicit objectives, such as business development, as well as the active support of all local parties with an interest in and effect upon tourism. It should be planned around specific themes, such as business conventions for the industries identified in the region's industrial development strategy. It should also be targeted toward specific populations, such as nonlocal businesspeople, and be promoted and marketed in the places of residence of these populations.

Research and Development

A dominant feature of today's economies is the knowledge-intensive high-tech enterprise. World market competition requires nations to develop value-added and research-intensive products to remain competitive. As a result, technological developments require an increased knowledge base for industry cultivation. The microcomputer industry, which both receives and supplies information, is a prime example of the use of intelligence as a product. But many other new information and telecommunication-related technologies exert profound influences on traditional production technologies. Indeed, it can be said that all tomorrow's industries will be knowledge intensive or they just will not exist at all.

An economy is emerging based on new environmental industries, biotechnology, and information technology (IT). Since the first edition of this book in 1989, for example, the cellular telephone business has emerged and now dominates telecommunications marketing. Many other start-up industries need a place to begin. They require a community interested in mixing uses, such as housing and retail. Communities that provide the right atmosphere for start-up firms will attract them. If they nurture these firms by providing the right kind of atmosphere, they can become the headquarters for new companies or the centers of revitalization of older ones.

Local communities are well placed to identify their target technology sectors and activities. Moreover, those investments should be directed toward developing infrastructure to suit new firms. Improved links between universities and other research organizations, as well as industrial and business companies, should be encouraged and more joint funds established by companies and universities for common research and new product commercialization.

Inventors need a supporting environment during the crucial period between the conception of a new idea and its development to the point at which it can be taken to the venture capitalist. The lack of a supporting

environment during that critical period can result in many fine ideas never taking off. Incubation centers (also known as "incubators" or "technology development centers") are intended to provide this supporting environment. They provide low-rent workplaces and are usually located adjacent to educational institutions, which provide small inventors with equipment, facilities, and advice on business management and work support from student assistance to put together business plans and approach venture capitalists. Other centers can be found within some technology and business parks.

Technology and business parks, in this context, refer to parks that house commercial activities rather than R&D activities. They usually cover several acres and have the following general features:

- A campus-style physical environment
- A mixture of ownership and management, ranging from government to the private sector
- A frequent association with some form of university- or science-oriented establishment
- Low-density development with high-quality buildings
- Specific criteria for the eligibility of prospective occupants to ensure that all the activities within the park are compatible with each other

The technology and business park development is still a relatively recent strategy, so it is difficult to draw any significant conclusions about its likely success. However, ingredients for success apparently include the following:

- Adherence to a carefully thought-out and very specific development objective, including type of desired activities
- Availability of good management and entrepreneurial skills
- Access to venture capital and the accompanying advice on how to use it
- Involvement of the private sector in planning the development
- Presence of meaningful community support

Other locational elements that appear to be influential include transport access, the availability of skilled labor, an attractive living environment, proximity to appropriate research facilities, and the presence of a suitable major manufacturing enterprise that acts as a catalyst. These findings are derived from a range of empirical studies on technology parks. It is important to note that these studies commonly suggest that the development times for technology and business parks are varied—generally 10 to 20 years.

Enterprise Zones

An enterprise zone is a defined area in which planning controls are kept to a minimum and attractive financial incentives are offered to prospective developers and occupants.

The concept of enterprise zones was introduced in the United Kingdom in the late 1970s based on the Hong Kong record of increased job attraction through reduced regulation. They were designed as a last, desperate measure to be tried only on a small scale in depressed areas where conventional economic and employment development policies and tools had failed to arrest decline. An underlying assumption is that the removal or streamlining of certain statutory and administrative controls will encourage entrepreneurs to create or expand businesses, providing the jobs and taxes that distressed areas so badly need.

To achieve this objective, policymakers need to emphasize labor-intensive industries that match the skill levels of potential workers. This can be achieved by offering strong wage subsidies in addition to tax relief packages and land.

Thirty-seven states have created enterprise zone legislation. Louisiana has 750 enterprise zones, and in Ohio, virtually all of Toledo and Cleveland have been declared enterprise zones under state legislation. Federal legislation provided for between 50 and 100 enterprise zones during the Clinton administration. Although enterprise zones have many advocates, the jury is still out on their real benefits. Recent studies indicate that enterprise zones do generate jobs only because of the concentrated attention of policymakers and not entirely because of the incentives provided by localities or states (Green, 1991; Rubin and Wilder, 1989). However, the few assessments of the latest wave of enterprise zones in Harlem and Detroit indicate renewed retail and commercial activity. In Harlem, Magic Johnson, Old Navy, and Starbucks are now part of the retail base. In Detroit, General Motors is headquartered in the city center, along with two new professional sports parks and a gambling casino—all of which were lured by packages of tax and enterprise zone incentives.

Nevertheless, policymakers need to avoid thinking that tax giveaways are the only or best tool to generate new economic activity. Policymakers also need to be careful about the temptation to view enterprise zones as potential for high-tech parks, ignoring any relation between the employment structures of high-tech firms and the skill levels of the local workforces. Other disadvantages of zones of any kind are that large developers and well-established corporations are likely to be the major beneficiaries.

Such areas also place an unfair burden on existing commercial taxpayers outside the zones.

Incentivizing or Subsidizing Local Economic Development?

> *Many people call subsidies "incentives," but that's not really accurate. An incentive motivates someone to do something they would not have done otherwise. A mountain of evidence suggests that development subsidies are often abused by companies that would have done exactly what they did anyway. "Subsidy" is also a more accurate description of what an aid program does when designed and used well: taxpayers subsidize companies to cover the additional cost of building where they serve a public purpose but could not afford to locate without public assistance. Subsidies of this type have what's called a "but for" clause that companies must meet, proving that but for help from the subsidy, the project would not happen at the site.*
>
> —Good Jobs First, n.d.

As this quote implies, *economic development incentives* is the predominant terminology used when describing public efforts to attract firms to specific state and local economies. However, *subsidy* is the more accurate descriptor for the majority of attraction efforts because it is not standard practice to prove that the firm requires public assistance in order to be able to locate on the site. Further, what cannot be proved until after the firm chooses its location is whether the subsidy actually did influence the location or whether it was provided because it was designated as an entitlement that all relocating or expanding firms receive. Concern about the potentially unnecessary use or overuse of subsidies has long been raised, accompanied by increasing calls for transparency and accountability for their use. A major advancement on this front occurred in the United States in the second half of 2015 and will be discussed subsequently.

Subsidies provided to firms can take the form of direct or indirect expenditures, and they come in many forms. Examples of direct expenditures can be purchasing land or making infrastructure improvements for the specific benefit of the firm. Indirect expenditures are typically tax expenditures—that is, tax revenue the government does not collect from the firm. A description of the key categories of subsidies is provided in Table 9.2.

Table 9.2 Types of State and Local Benefits

Direct Subsidies

- *Grant/low-cost loan*. Money award or loan when meeting job performance or other goals. May be "forgivable" if certain goals are met.
- *Training reimbursement*. Programs that pay for or reimburse companies for the cost of training new or existing employees.
- *Cost reimbursement*. Programs, usually involving film production, that reimburse companies for specific expenditures (other than worker training) in the state.
- *Infrastructure assistance*. Programs that cover costs such as installation of utilities or building of private roads at a company facility.
- *Industrial revenue bond*. Low-cost financing based on tax-exempt bonds.
- *Tax credit/rebate and grant*. Programs that combine tax credits or rebates with grants.
- *Tax credit/rebate; property tax abatement*. Programs that combine income or sales tax credits or rebates with property tax abatements.

Indirect Subsidies

- *Tax credit/rebate*. Corporate income tax credits, sales tax exemptions, and other programs reducing or rebating a firm's tax obligation.
- *Property tax abatement*. Reduction of real property (land, structures, rights, and interests) or business personal property taxes.
- *Enterprise zone or Empowerment Zone (EZ)*. For investment or location in specific geographic areas, bundled state and/or local tax breaks and other subsidies.
- *Tax increment financing (TIF)*. The firm receives various subsidies paid by government-issued bond revenue that, in turn, is repaid by the increment of property taxes attributable to the higher assessed value brought about by redevelopment.

Restrictions on Subsidies

- *Clawbacks*. The firm agrees to reimburse subsidies received if it fails to deliver in a specified time period the guaranteed benefits such as number of jobs, level of wages, or sales tax revenue.
- *Performance-based subsidies*. The firm receives incentive only if certain conditions (e.g., number of jobs) are met; thus, subsidy is provided after the company locates.
- *Community benefits agreements (CBAs)*. Legally enforceable contracts between developer or firm and the community in which it is locating. The agreement identifies specific benefits or amenities, as well as mitigations to the community, from hosting the new economic activity. Examples of mitigations are actions to address increased traffic congestion, noise, and pollution. Of the many examples of benefits, establishing local hiring goals, job training, and living wages, as well as contracting with local small, minority, or women-owned businesses appear to be the most prevalent.

In the United States, it has been estimated that state and local incentives to businesses cost taxpayers over $70 billion each year (Dolan, 2015). Opportunity costs can be incurred when subsidies (either direct or indirect expenditures) are provided to firms. For example, when a firm is offered a reduction in property taxes as an enticement to locate, this can lower the amount of funds a local school system receives since property taxes are the primary funding source for schools (at least in the United States).

A recent analysis of 4,200 economic development incentive awards made in 14 states found 70% of the incentive packages and 90% of incentive dollars went to large companies. These were defined based on meeting one of three criteria: having more than 100 employees, not being independently and locally owned, or having 10 or more establishments. The study authors recommend excluding large recipients from receiving incentives and instead investing in what small and large businesses alike could benefit from: job training, education, and transportation. Further, small businesses would benefit most from having better access to capital and higher paid local jobs that increase consumer purchasing power (LeRoy et al., 2015):

> Governors and state legislators routinely praise small businesses for their contributions to economic growth and job creation, but states actually give big businesses the dominant share of their economic development incentive awards.

The quote just given is from the founder of Good Jobs First, Greg LeRoy. Good Jobs First is a national policy resource center focused on accountability in economic development. Its work in tracking subsidies has been nationally and internationally recognized.

In Table 9.2, the third category, "Restrictions on Subsidies," summarizes efforts to ensure that communities and local businesses are protected when subsidies to firms do not provide the expected economic development benefits.

U.S. Versus International Perspectives

In the United States, incentives are provided by state and local governments and development authorities. States and localities make the choice to participate in the business of providing incentives, but if they decide they don't want to engage in a bidding war with another location, then they risk losing out on a new firm that could have substantial economic benefit.

Such bidding wars are frequent. They are typically managed by site consultants under contractual obligation not to reveal the industry client

they are assisting in finding a new location. As a consequence, states and localities frequently don't know the actual firm they are trying to attract, who their competitors are, nor what level of incentives they must out-compete.

Further, obscuring the subsidization of firm location is the state and locality practice of maintaining secrecy during—and even after—the negotiation process for incentives to the prospective firm. This may be an actual requirement of the firm evaluating the location. But other factors may motivate this secrecy, such as to reduce the possibility landowners might seek higher-than-market rates for properties needed for land assembly to accommodate a potential firm's site needs. Even when the negotiations are concluded, the amounts of subsidies that were offered or implemented if the negotiated deal was successful may not be revealed or tracked to determine if they met the conditions of the deal.

The practice of secrecy and failure to monitor outcomes is going to change significantly as a result of the recent action of the Governmental Accounting Standards Board (GASB; 2015). The GASB has issued a formal statement (Statement 77) that establishes financial reporting standards for tax abatements offered by state and local agreements. From the definition that follows, it can be seen that economic development incentives and subsidies are what the GASB (2015) labels as tax abatements:

> A reduction in tax revenues that results from an agreement between one or more governments and an individual or entity in which (a) one or more governments promise to forgo tax revenues to which they are otherwise entitled and (b) the individual or entity promises to take a specific action after the agreement has been entered into that contributes to economic development or otherwise benefits the governments or the citizens of those governments. (p. 2)

To meet the GASB (2015) new standards, state and local governments will be required to disclose the following:

- Brief descriptive information, such as the tax being abated, the authority under which tax abatements are provided, eligibility criteria, the mechanism by which taxes are abated, provisions for recapturing abated taxes, and the types of commitments made by tax abatement recipients.
- The gross dollar amount of taxes abated during the period.
- Commitments made by a government, other than to abate taxes, as part of a tax abatement agreement. (p. 3)

Good Jobs First sees Statement 77 as "a breakthrough against inequality" because it will allow the public to assess whether providing subsidies to the corporate sector results in under-funding essential public services such as K–12 education, transit, critical infrastructure, and fire and police protection. Ellen Harpel, president of the firm Smart Incentives, has observed that elected officials and community groups are demanding better data on incentive use from their economic development organizations. She has advocated that "incentives should be used to accomplish community goals—not just to win a deal" (Harpel, 2015).

The European Union and Australia offer two examples where government seeks to prevent what is called "poaching" of firms between localities offering subsidies. To dampen subnational competition, the European Commission has a strong centralized control system, while Australia developed a voluntary agreement in 2003 among subnational governments of five Australian states not to poach firms from each other (Markusen & Nesse, 2007).

In the EU, subsidies are not to be used by member states unless they contribute to the goals of the EU as a whole. The European Commission requires advanced notification of all planned subsidy agreements.

> Poorer areas of the EU can provide larger subsidies than richer ones, and the most prosperous regions are prohibited from giving any aid at all. Governments can thus only give support to firms in proportion to the disadvantage of the region. (Dadash, 2013)

Australia's sixth and fastest growing state, Queensland, refused to be part of the agreement when it was initiated and subsequently renewed in 2006. The agreement did not actually control the use of tax cuts and other incentives; it simply prevented multinational recruitment competition among cooperating states. Further, it supported transparency and accounting principles by states agreeing to provide annual reports. The agreement ended in 2011 after New South Wales and Victoria refused to renew the deal, making it unfeasible for the remaining states (Dunckley, 2011).

Two case studies of subsidy use are provided in this chapter. In Economic Developments 9.1, a case study of how the city of San Francisco provided subsidies to Twitter and other high-tech firms in exchange for community benefits is described. In Economic Developments 9.2, an example of how the European Union enforced its policies on improper provision of subsidies to the U.S. multinational corporation (MNC) Starbucks is profiled. The case illuminates how an MNC can manipulate its supply chain to maximize tax and subsidy benefits.

ECONOMIC DEVELOPMENTS 9.1
#Subsidizing Twitter*

We have about 350 employees. And based on our current growth trajectory, we can't stay on the two floors that we currently have. So, at some point we're going to have to look at other options.

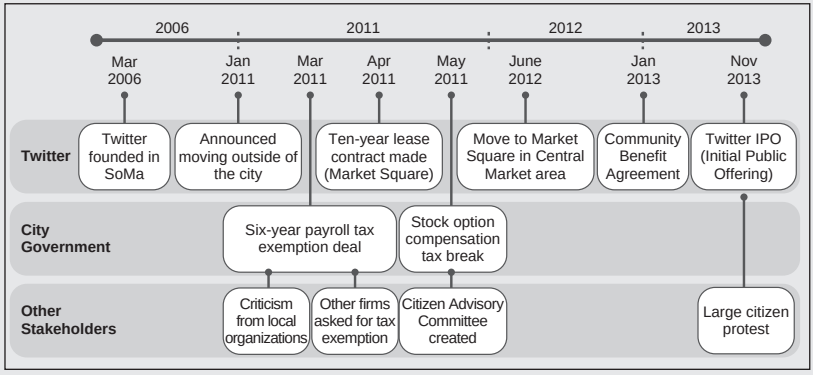
—Carolyn Penner, representative of Twitter, January 13, 2011

Twitter Inc. is a technology company that provides an international social network service. It began in San Francisco in 2006, and quickly grew into a social media giant with 302 million active users and 3,900 employees. Its estimated revenue was $1.4 billion in 2014.

The subsidy deal (see Figure 9.1) between Twitter and the city of San Francisco was initiated soon after the company's January 2011 announcement that it planned to leave the city. An agreement on a subsidy deal was reached only 2 months after Twitter's announcement. The incentive package provided a payroll tax exemption and additional public services. The package was granted under the condition that Twitter move to the city's economically distressed downtown neighborhood of Central Market. Subsidies given to the company were originally estimated to be $22 million, the largest provided to a company within California between 2007 to 2011 (Story, 2012).

Success in retaining Twitter, as well as other technology firms who subsequently became eligible to take advantage of the payroll tax exemption, is estimated to have contributed at most 5% of new city jobs between 2010 and 2013 (City and County of San Francisco, 2014a). Subsidizing the retention created strong concerns about gentrification around Twitter's relocation site and provoked protests by city residents against housing displacements, increased living costs, and the unfairness of subsidization.

Figure 9.1 Timeline of Subsidy Deal



Source: Figure created by Heon Yeong Lee

The deal between Twitter and San Francisco was made amidst high unemployment rates and stagnation of the city's real estate market due to lingering effects of the Great Recession. In response to a $483 million annual budget deficit, the city had also made cuts in its payroll and public services. San Francisco's unemployment rate was 9.2% in 2010, but the city proved resilient, as indicated by a 6-point drop in unemployment to 3.2% by 2015 (U.S. Bureau of Labor Statistics [BLS], 2016).

The creative and knowledge industries played a significant role in the city's economic recovery. These industries were stable during the recession and had stronger employment growth than any other industry (City and County of San Francisco, 2014b). Information technology (IT) accounted for 21,000 or 31% of jobs created in San Francisco between 2010 and 2013 (Mandel, 2014). Seeking to internalize the benefits of this growing sector, city government implemented new policy initiatives (e.g., summer internships, public school–tech firm partnerships) under the leadership of the tech-friendly city mayor, Ed Lee.

Regional Competition

There is strong competition for high-tech firms in the Northern California region (Avalos and Delevett, 2013). San Francisco's success over the region's traditional high-tech industry hubs has been attributed to its abundant urban amenities and closer relationships to the IT market (Vekshin, 2014). Because social media and mobile app companies seek proximity to clients, competitors, and their venture capital providers, they tend to prefer San Francisco over traditional industry hubs and have significantly increased the demand for premium office space. Even large firms, who build campus-style office complexes in traditional locations due to greater land availability, have been opening branch offices in the San Francisco Bay Area to take advantage of the urban environment and broaden their appeal to young tech employees.

Payroll Tax System

San Francisco has had an unusual corporate tax structure called the payroll tax system that levies taxes on employers based on employee compensation.** Currently, San Francisco's payroll tax is 1.5% of total payroll expenses; these include salaries as well as other compensation such as commissions, stock-based compensation, and property issued in exchange for the performance of service. San Francisco's payroll tax system was implemented in 1970. Typically, the rationale for a municipal payroll tax was to ensure that workers who commute into a city—and the businesses that employ them—pay their fair share of the public services provided by the city. However, the payroll tax has been criticized as an impediment to economic growth because it is seen to discourage new firms from locating as well as existing firms from expanding employment. It is particularly problematic for technology start-ups. These start-up companies frequently develop new

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business ideas and innovative technologies before they have concrete monetization plans. They also need to hire staff before they begin to make a profit, and the payroll tax makes it harder for the start-up company to show a profit and be attractive to investors (Steinmetz, 2014). The payroll tax can also discourage growing technology firms' location in the city because their successes in creating initial public offerings (IPOs) would incur large amounts of payroll tax from the stock options given to motivate and retain staff.

Downtown Neighborhood Revitalization

Rather than give tax credits to just one firm, which could be viewed as discriminatory, San Francisco designated a new tax exemption district around the Central Market and Tenderloin neighborhoods—San Francisco's economically distressed downtown area. Central Market was once a commercial center of the city, but its significance declined in the late 1960s and early 1970s.

Before Twitter's relocation, the city government was attempting to revitalize the area by establishing public–private partnerships, giving low-interest loans to local small businesses, and supporting local arts groups. However, success was limited. For example, the storefront vacancy rate was recorded at 31% in 2010, and it was expected to worsen because major tenants, including Bank of America's data center, planned to leave this area. Retail services for neighborhood residents and workers were lacking, and street crime, panhandling, and lack of foot traffic discouraged revitalization efforts (Committee of Supervisors, 2011).

The Subsidy Deal

The initial proposal included an ordinance for a new payroll tax exemption for 6 years and was submitted to Twitter in early February 2011. According to the ordinance, a business moving into or already located in the Central Market and Tenderloin areas is eligible to be exempt from payroll expense tax on additional employees for a maximum of 6 years. Twitter would still pay the payroll expense tax for its existing 350 employees. In addition to the payroll tax exemption, the Office of Economic and Workforce Development promised to give Twitter additional city services to address concerns about relocating to an economically distressed area, including extended foot patrol and additional express public transportation services.

Economic Outcomes

The result of an initial fiscal impact analysis of the new legislation reported a total of $22,032,000 dollars would be transferred to Twitter under the conditions that Twitter hired an additional 2,650 employees and paid a $102,000 average annual salary until 2013. The city also expected to spend $162,000 for initial one-time administrative work and $186,000 for annual audits. The cost for additional city services, such as extending policy patrol and additional public transportation

services, were not included in the initial analysis (Committee of Supervisors, 2011). Based on the fiscal analysis, the city would forgo 12.7% of Twitter's 6 years' tax responsibility.

Due to the pressure from existing high-tech businesses, the city legislated another tax break ordinance in May 2011, which gave a tax exemption for stock option compensation.

After the relocation of Twitter headquarters, 17 other technology companies, including Zendesk, Spotify, One Kings Lane, and Yammer, also moved into the revitalizing area mainly because of the tax exemption benefits. However, other companies, like Uber, Dolby, and Square that moved near Twitter headquarters did not take any tax breaks. The number of new jobs created by these technology companies has been estimated as between 6,000 to 10,000, according to LinkedIn, a business-oriented social networking service provider.

As a result of new firm location, total payroll tax collected in the Central Market and Tenderloin areas increased 648% from 2010 to 2013, a significantly higher rate than the city's overall average (City and County of San Francisco, 2014a). Neighborhood-serving retail businesses, however, did not appear to benefit strongly from the new jobs created, experiencing only a 10% growth in taxable sales compared to 25% for the city overall (City and County of San Francisco, 2014a).

The clustering of the tech industry in San Francisco also brought about an influx of high-tech supporting service sectors. Venture capitalists, who traditionally concentrate in Silicon Valley, moved to San Francisco to be closer to new start-ups and entrepreneurs. Of the $26.8 billion venture capitalists invested in California companies in 2014, 41% was invested in San Francisco–based companies (Somerville, 2015).

Gentrification

The Central Market area added new high-rise luxury residential buildings to house the influx of high-income knowledge workers. A number of older buildings with long-deferred maintenance, and that provided low-income housing, have been renovated into either luxury residential buildings or office spaces. Check cashing shops and shuttered storefronts are now replaced by upscale businesses such as cafes that sell $65 beers (Steinmetz, 2014).

Those displaced have found it impossible to attain affordable housing locations inside the city, due to the high cost of renting and home ownership. The median housing price was $813,000 in 2014 (Levy and Levy, 2014). Further, nonprofit organizations previously serving the local community are being pushed out by rising rents (Bowe, 2013).

Public pressure has led to the development of more community benefits agreements (CBAs). In the Central Market area, six companies, including Twitter, signed new CBAs with the Citizens Advisory Committee.

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Case Study Insights

Compared to conventional subsidization cases, the subsidy deal the city of San Francisco provided to Twitter has three distinguishing characteristics. First, the incentive package was provided to the headquarters of a relatively new and fast growing technology company, rather than for an existing industry. Second, the package was provided to retain a locally incubated company, rather than to attract external investment. And third, the incentive package was distinguished by its requirement for the company to relocate to a downtown, high-poverty neighborhood.

It's been estimated that each new high-tech job in a metropolitan area creates five additional local jobs in other industries (Moretti, 2012). Thus, inducing high-tech industries into economically distressed areas can create significant growth. From a place-based perspective, San Francisco's subsidization deal for Twitter and other IT firms could be deemed a great success.

At the same time, subsidizing high-tech industry can create significant gentrification effects. High-paid tech workers drive local real estate booms and introduce consumption patterns supporting new upscale retailers, cultural services, and goods. In a study of the 50 largest metropolitan areas, San Francisco had the second highest inequality (Berube, 2014).

The growth induced by the subsidized high-tech firms pushed out existing low-income residents and replaced them with high-income knowledge workers. Existing retail services and nonprofit organizations that previously served low-income residents were priced out of the area. Low-income residents did benefit from new job growth, but the low-skilled and low-income jobs to which they had access could not provide them with wages high enough to continue living in the area. Thus, from a people-based perspective, the outcomes of the Twitter subsidization deal are mixed and cannot be seen to advance the principles of sustainable local economic development (SLED).

*Research assistance for this case study provided by Heon Yeong Lee.

** Between 2014 and 2018, a phased replacement of the payroll tax with the gross receipts tax is occurring. See http://sfgov.org/sf/sfbiztax.

ECONOMIC DEVELOPMENTS 9.2
Roasted by Regulation: Starbucks Coffee's Selective Tax Advantages in the Netherlands*

The European Union has established specific policies to regulate tax incentives offered by member states to reduce unfair competition within the EU region. These polices provide a level playing field among states—more so than most other countries around the world without regulatory policies in place. According to both the 2007 Treaty on the Functioning of the European Union (TFEU) and the more recent "Guidelines on Regional State Aid for 2014–2020," EU countries are not allowed to produce legislation that artificially lowers taxes paid by companies, as this would give certain countries an unfair competitive advantage over other member states. Further, the Organisation for Economic Co-operation and Development (OECD), made up of members from the European Commission and other countries including the United States, updated transfer pricing guidelines in 2010 to prevent intrafirm monetary transfers among subsidiaries that might produce unfair advantages within corporations. Transfers must follow an "arm's length principle" so that taxable revenue should not be less than what it would have been under traditional tax legislation. Based on these guidelines, the European Commission monitors and regulates both incentives offered by member states and the tax structure of multinational companies locating in those states (European Commission, 2013). The case below on Starbucks demonstrates how these mechanisms are applied.

Headquartered in Seattle, Washington, the multinational Starbucks Corporation roasts, markets, and sells specialty coffee around the world and currently operates in 70 countries. There are more than 12,000 stores in the United States, approximately 1,900 in Europe, the Middle East, and Africa (EMEA), and around 3,300 in the China/Asia Pacific (CAP) region. In 2013, Starbucks Corporation earned $14.9 billion in gross profit, or $8 billion in posttax net profit (NASDAQ, n.d.). Of that revenue, 74% was in the Americas, 8% in the EMEA region (mostly in Europe), and 6% in the CAP region.

This case illustrates the complex structure of Starbucks' multinational corporation (MNC) that appears to have evolved in response to incentive opportunities. Both Starbucks Coffee BV and Starbucks Manufacturing BV are subsidiaries of Starbucks Corporation and located in the Netherlands. *BV* stands for the Dutch phrase meaning *private limited liability company*. The former, Starbucks Coffee BV, is the headquarters of the EMEA region and houses its intellectual property (IP) rights for coffee bean roasting recipes in the British-based Starbucks entity, Alki Limited Partnership (LP; European Commission, 2014).

According to Starbucks' corporate guidelines, Starbucks Manufacturing BV must pay Alki LP a royalty for IP rights to produce and deliver coffee around the EMEA region. Starbucks Manufacturing BV roasts, distributes, and sells coffee and food to

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Starbucks outlets throughout the EMEA region. It receives its raw green coffee bean supply from the Starbucks Swiss subsidiary, Starbucks Coffee Trading Company SARL, the French phrase for *limited liability company* (European Commission, 2015).

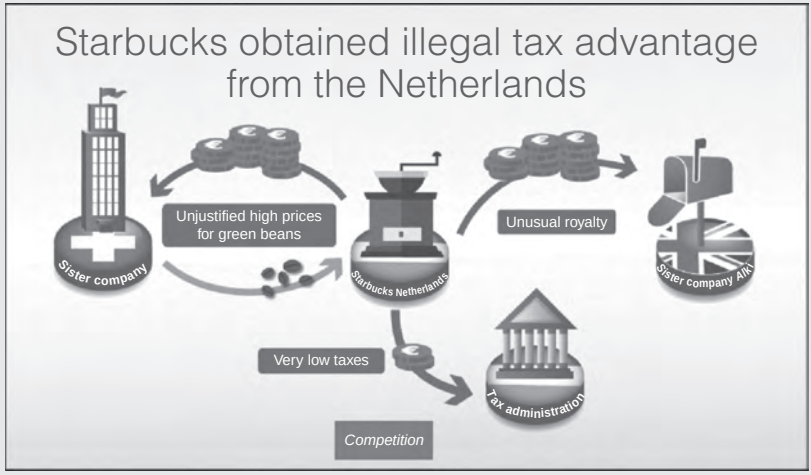
In June 2014, the European Commission began investigating allegations that Dutch tax authorities and Starbucks Corporation negotiated an advanced pricing arrangement (APA) for Starbucks Manufacturing BV, starting in 2001, which violated the OECD "arm's length principle" and TFEU guidelines. Investigators found that Dutch authorities formed special tax rulings allowing Starbucks Corporation the flexibility to create tax avoidance strategies that shifted taxable revenue outside of the Netherlands and decreased the company's overall tax burden (European Commission, 2014).

First, Starbucks tax advisers artificially marked up the price by 20% for the raw green coffee beans purchased from Swiss subsidiary Starbucks Coffee Trading Company SARL. Tax advisers justified this adjustment by considering Starbucks Manufacturing BV to be only a "contract manufacturer," an intermediary in the production process. The company paid a higher premium for the raw green coffee beans to the Swiss company to account for their absorbing more risk from sourcing the beans. However, investigators found that the Swiss subsidiary does not physically handle the beans and that Starbucks Manufacturing BV is completely responsible for the roasting and manufacturing of the coffee beans. The cost markup for raw materials does not take into account Starbucks Manufacturing BV's actual risks of the raw material inventory and therefore artificially raises the payment to the Swiss subsidiary (European Commission, 2014).

Second, royalties paid to Alki LP are based on coffee roasting recipe instructions, a concept of IP scrutinized by the European Commission. Further, the royalties do not align with the economic value of the IP rights based on Starbucks Manufacturing BV's annual sales. Instead, royalty payments fluctuate annually based on the profits of the subsidiary and increased from 1 million euros in 2010 to 12 million euros in 2011. If coffee and service material sales increased within the Netherlands, tax authorities adjusted royalty payments to Alki LP to transfer outside of the country the extra revenue gained. According to Dutch tax code, revenue transferred to Alki LP was not considered direct payment to the Starbucks Corporation in the United States and, therefore, not liable to Dutch corporate income tax. The European Commission's investigations also found little information about Alki LP itself, which seemingly had no registered employees or recorded financial statements. It was absorbed into another Starbucks subsidiary shortly after investigations began (Alderman, 2015; European Commission, 2014).

In October 2015, based on OECD and TFEU guidelines, the European Commission ruled that Dutch authorities indeed granted economically unjustifiable and selective tax advantages to Starbucks Manufacturing BV that shifted a large part of its revenue abroad and significantly lowered taxable profits. This decision requires the Netherlands to recover the €20 to €30 million in unpaid tax revenue from Starbucks Manufacturing (European Commission, 2015).**

Figure 9.2 Starbucks Tax Avoidance Strategy



Source: © European Union, 1995–2015.

The ruling occurred in parallel with other European Commission investigations of MNC tax avoidance schemes such as Apple Inc. in Ireland and Fiat Chrysler in Luxembourg. The investigations address the growing concern over countries providing tax loopholes for multinational companies and unfairly increasing their competitive advantage over regions in the European Union with high unemployment and sluggish growth.

Since the European Commission regulates EU state behavior rather than that of MNCs, all of these cases directly target the incentive-friendly tax rulings of the countries themselves and not the strategies of the global firms. Antitrust Chief Commissioner Margrethe Vestager stated the following in reference to the Starbucks ruling:

> Tax rulings that artificially reduce a company's tax burden are not in line with EU state aid rules. They are illegal. I hope that, with today's decisions, this message will be heard by Member State governments and companies alike. All companies, big or small, multinational or not, should pay their fair share of tax. (European Commission, 2015)

While work is left to be done, the EU stringent regulations on tax exemptions and subsidies provide more mechanisms than most incentive policies around the world to reduce unjust competitive advantage and promote a more level playing field among member states.

*Research assistance for this case study provided by Ashley Bozarth.

** Starbucks Corporation will be appealing the case, arguing that it has followed all tax laws and international guidelines.

Conclusion

Business is the engine of economic development. All business originates from a sense of opportunity to serve or gain. Irrespective of the motivation to start a business or maintain it, this motivation can be hampered or retarded by the actions of communities or local governments. No business wants to be where it is not wanted. However, communities need to consider carefully the types of businesses they want to host. Linking economic and employment objectives to the types of firms in the locality is an essential task for the community. (See Table 9.3 for a sampling of business development project starters.)

Table 9.3 Business Development Project Starters

Tool	Project Idea Starter
Attraction	*Organization development:* A local development commission with state finance backing loans funds to a nonlocal dying industry suited to the region to assist that industry to relocate and develop as a business development venture and possibly also as a tourist attraction (e.g., a local development commission's sponsoring surfboard-making industry). *Work space and support facilities for small business:* This aims to establish a privately or publicly owned project using a workhouse building or the like to provide work space and a support framework for small firms with common facilities (e.g., reception, telephones, Internet, copiers, cleaning, maintenance, conference rooms).
Small business and new venture start-ups	*Community business advice project:* This is an organization formed to provide professional advice and assistance to small businesses in the areas of management, marketing, accounting, financing, locating resources, and problem solving. One such organization is a nonprofit organization run by a committee that decides which clients to help and how much to charge them (e.g., no charge for low-income groups and marginal businesses and standard consultant fee to established firms). It employs a full-time business adviser who works directly with clients in their home or places of business.
Business expansion/ retention	*Export promotion scheme:* This is a scheme to assist small- and medium-sized firms in exploring new export markets by representing them at trade fairs and missions. *Regional technology center:* This is a center to research and identify technologies appropriate to the region's socioeconomic base and to help people who are developing these techniques start up a business. It provides the necessary backup support facilities and management advice.

Tool	Project Idea Starter
Local government	*Joint public–private ventures:* Joint venture agreements for construction of business venture facilities to revitalize the central business district, generate employment, and create revenue for the city government. These facilities could include a cinema complex or an administrative center with shops, parking garage, and sports facilities.

Businesses, and particularly small, new, innovative businesses, may become the large firms of the future. It was not that long ago that Microsoft was a small firm, but now it is a giant subject to antitrust action. Microsoft is a significant component of Seattle's economy. Bill Gates could have gone elsewhere. On the other hand, around three out of every five small businesses started will fail. Further, even if a small firm has an excellent business plan, if it is poorly capitalized, its survival chances will be very low.

The means communities use to grow, attract, and retain firms will depend on what resources are available. The most important factor in firm location is knowing the area's assets as well as having the correct attitudes and infrastructure to support the firm. Every community must develop special activities and tools to build the right type of infrastructure for the development and the employment it wants. Chasing tourists or high-tech firms should not top the agenda unless the community is particularly well situated for this form of economic development. The most important activity is building soft infrastructure, such as information and finance, to make the community attractive and supportive to enterprise. In essence, the community must become entrepreneurial in the use of its resources if it wants to grow, attract, and retain firms as a major component of its economic development strategy. See Economic Developments 9.3 through 9.5.

ECONOMIC DEVELOPMENTS 9.3
TARGETing Retail Gaps in a Low- to Moderate-Income City*

The city of Azusa is one of eight San Gabriel Valley foothill communities of Los Angeles County, California. It has 45,000 residents and 13,000 households, most of whom are Hispanic. Fewer than 20% of Azusa's residents over 24 years of age have earned college degrees (the state average is 30%; U.S. Census QuickFacts, Azusa, California, n.d.). Compared to the other seven foothill communities, Azusa has the lowest home ownership rate and median housing sales price (City of Azusa, 2010). Azusa has had difficulty competing with surrounding communities due to declining neighborhoods, falling property values, reinvestment activity, as well as increasing crime and rental property turnover. This was particularly the case for its retail economy, in which sales per capita in Azusa lagged behind those of the Los Angeles region by more than $2,000.

A 2006 study found Azusa's leakage of retail sales amounted to nearly $20 million (Klingensmith and Strother, 2006). The study calculated the market serving index (MSI) for each retail category. The MSI is a form of location quotient in which the proportion of firms for Azusa in a specific retail category is compared to the proportion for the larger retail market of which it is a part, in this case, the Los Angeles metropolitan area. Several retail categories for Azusa had MSIs of zero—that is, there were no retailers within the city limits. Among these categories were nursery and garden centers; men's clothing stores; hobby, toy, and game stores; book, periodical, and music stores; office supplies, stationery, and gift stores; and department stores. Other categories in which sales were lower than estimated demand included women's clothing stores, jewelry stores, furnishing stores, and shoe stores. From identification of these retail gaps, Azusa concluded its retail economy could best be strengthened by attracting a large value retailer such as Target (see Figure 9.3). While Target normally looks for a more urban and upscale market than that found in Azusa, the city approached Target and was able to convince it to open a store due to several factors.

First, countering the weak retail market indicators was the fact that Azusa has two universities, Azusa Pacific University and Citrus College, with a combined student population of more than 20,000. This effectively increases Azusa's consumer base by 50%. Locating near the two college campuses would significantly add to retail sales, since Target carries product lines with particular appeal to the college market.

Second, the regional transit system called the Metro Gold Line planned to add two Azusa stops. The city proposed to locate Target at one of these stops developed as a transit-oriented development close to the colleges. Because the Gold Line would connect Azusa with neighboring cities, including Pasadena and Los Angeles, Target would help fill a gap in Azusa's retail needs as well as draw in new consumers from outside communities upon completion of the light rail extension (Klingensmith and Strother, 2006).

Figure 9.3 Target Azusa

Source: Photo by Austin Gordon, senior economics major, Azusa Pacific University; Ken Rhinehart; http://www.iwillride.org/?p=917.

Third, the city assembled the land for the store using its redevelopment authority and sold it to Target at less than cost. It also paid for the streetscaping of the site.

Several issues about the project arose during the planning phase, including the desire to preserve trees near the site; concern about nighttime lighting and visual cohesiveness with the surrounding area; the need to prevent theft of shopping carts; air quality and noise impact of delivery trucks, along with the relationship of delivery entry points in relation to the planned Metro line; and traffic flows and parking needs (City of Azusa, 2011).

Target submitted plans and technical specifications for the building in April 2009. The plans addressed many of the issues raised. The property's exterior was built to blend in with the Spanish architecture of nearby city hall and the greater community. The building itself is identified as a "unique" Target due to its alternative layout and appearance from the traditional big box, single-level store models. Because the site's footprint is limited to a single city block, designers had to be creative in maximizing its utility. The store has two floors, with the shopping level located above a ground-level garage with more than 400 parking spaces (Gresham, 2010).

Target opened ahead of schedule in 2010. In addition to its usual product line, the site contains a pharmacy, a fresh grocery, an alcohol selection, a Pizza Hut, and a Starbucks. Councilman Uriel Macias declared the successful recruitment of Target a "crowning achievement" in Azusa's rebirth (Tedford, 2010). Pointing to the

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city's effort to use the store as a cornerstone for future economic development and additional foot traffic, he said, "Our downtown has completely changed from what it used to be. It used to be something you would drive by. Now it is a destination point" (Tedford, 2010).

Economic and Community Development Director Kurt Christiansen (2012) believes Target provides a win-win for the city: Not only is it a convenient one-stop shop for residents with limited transit options, but it also provides additional tax revenue as well as revenue from increased municipal electricity and water sales. Another benefit worth noting is that Target invests 5% of its income from the Azusa store in grants to local schools, the library, nonprofits, and supporting city sponsored events. The store has also provided much-needed jobs to the city; Target hired 225 employees, making it the city's ninth largest employer. All in all, the project has helped to address Azusa's retail leakage, provided jobs for the local economy, and assisted in the commercial revitalization of Azusa's downtown.

*Research assistance for this case study provided by Patrick Terranova.

ECONOMIC DEVELOPMENTS 9.4
Mobile Entrepreneurs: Portland Food Carts*

"Street food" is an urban industry that has thrived because of rather than in spite of the Great Recession. Benefitting from lower overhead costs and greater flexibility than that of a restaurant, food carts have been an emerging sector in cities across the country. With hundreds of food carts and strong city policy support, Portland, Oregon is a leader in this mobile entrepreneurship movement that creates jobs, public revenues from business licenses and sales taxes, and demand for supplies often locally provided. Many food truck operators hope ultimately to open up brick-and-mortar businesses when they accumulate the necessary start-up capital.

In Portland, many of the food carts operate in "pods" of several carts clustered together in open spaces, especially along the edges of surface lots and vacant parcels. As of December 2010, Portland was home to 25 of these pods, one of which had 30 carts. Planners have welcomed this arrangement as a way to activate public space. Food carts generate pedestrian activity and encourage interaction among customers in common outdoor spaces. Like other forms of street vending, food carts provide a viable temporary use of land that that may ultimately have more permanent development when economic conditions are more favorable. Food carts can also contribute to urban safety by providing another set of eyes on the street, as illustrated by the New York City street vendor whose presence is credited with thwarting the attempted 2010 car bombing of Times Square.

While many of Portland's carts operate in parking lots or on temporarily vacant land, some developers have begun incorporating space for permanent pods in private developments. The first and perhaps most well known example is Roger Goldingay's Mississippi Marketplace. Goldingay's parcel of land had been slated for condo development prior to the recession. Goldingay built a market center instead and included a 10,000-square-foot lot specifically designed to accommodate 10 food carts, covered seating, electrical outlets, and recycling bins.

A study of Portland street food found that food carts benefitted local economic development because they fostered entrepreneurship and microenterprise, street vitality, and social interaction among consumers. Commissioned by the Portland Bureau of Planning and Sustainability and conducted by graduate urban planning students at Portland State University, the study found Portland's food carts provide an important opportunity for immigrants to become entrepreneurs, as roughly half of the street vendors surveyed were born outside the country. Citing the desires to be independent, to eventually open up a restaurant, to be a cook, and to have a flexible schedule, food cart operators were found to enjoy their trade and the relationship they have with customers.

Among the 78 vendors surveyed in the study, 63% agreed that street vending was a good way to earn a living to support themselves and their families. According to the study, start-up costs for a high-end food cart are less than half that of a small brick-and-mortar business with a single employee. While there are lower barriers to entry for food cart entrepreneurs starting a business, finding financial and other assistance to do so still proved to be a challenge for many vendors. Only 18% of vendors surveyed received any job training for their venture. About half of the food cart owners obtained start-up capital from family members and from their own savings. Eight percent utilized a home equity loan, and only 2% received financial assistance from an outside organization. Many never pursued bank financing. This suggests a role for community economic developers if there is a desire to grow the industry.

Another Portland State University study, "Food Carts as Retail Real Estate," assessed the impact of food carts on local economic development (Chastain, 2010). In 2010, 461 licensed food carts paid an average monthly rent of between $300 and $550, accounting for combined yearly rents of between $2 and $3 million dollars. Food cart operators spend between 13% and 14% of their revenues on rent. Much of this rent revenue benefits private property owners, as food carts often occupy private land. The study made rather wide-ranging estimates for job creation—between 500 and 1,800 local jobs—and total sale revenues of between $14 and $23 million.

While some restaurant owners believe the nearby presence of food carts can help business by increasing area foot traffic, others are concerned they have a negative effect on their business. Citing fewer government regulations and lower permit fees and overhead costs, many brick-and-mortar restaurant owners view food

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carts as unfair competition, cannibalizing business from restaurants. The Oregon Restaurant and Lodging Association states that carts should be categorized as restaurants and be subject to the same fees. Because food carts are technically mobile vehicles, permit holders do not pay personal property taxes on kitchen equipment like restaurants do. When business is bad in one area, cart owners may be able to relocate to a new area.

On the other hand, food cart business is subject to weather conditions, as 65% of food cart patrons walk to make their purchases from the carts. Further, the food cart customer base is also more vulnerable, as the carts do not have fixed, permanent locations. Finding a location for their business can be a key challenge for food cart operators.

While street food vendors have always operated in various cities across the country that allowed their activity, urban food carts are emerging as a significant new economic development in entrepreneurship. The food carts provide an eclectic range of choices in a retail food economy dominated by chains and brand names. Consequently, they can contribute to locality development and a community's sense of place.

*Research assistance for this case study provided by Patrick Terranova.

ECONOMIC DEVELOPMENTS 9.5
Small-Town Ideas Spur Big-Time Manufacturing Growth*

Many cities and towns around the country have struggled with shrinking manufacturing bases. In 2009, two Chrysler plants closed in St. Louis, resulting in the loss of thousands of city and regional jobs. Yet 80 miles south, the town of Perryville, Missouri, with a population of just over 8,000, has managed not only to maintain but also to actually grow its manufacturing base. Today, approximately one out of three workers in the town is employed in manufacturing. Perryville's success can be attributed to a series of innovative policies as well as a more than 50-year-old public–private partnership that established the town as a center of business attraction and expansion.

Up to the mid-20th century, Perryville was, like many other small American towns, dependent on a single industry. In this case, it was shoe manufacturing. When its two shoe factories shut their doors in the 1950s and the town lost hundreds of jobs, Perryville's economy lacked the resiliency that comes with industry diversification and quickly began to decline. In response, the Perryville Chamber of Commerce voted to form the Perryville Development Corporation (PDC; n.d.), a move that has been lauded as quite progressive (Sweet, 2012).

This established a public–private partnership where the PDC acted as separate entity to buy and sell land and recruit businesses with the support of the chamber of commerce.

To finance its establishment, the PDC sold 20,000 shares of stock at $10 each. It used this initial funding to purchase 24 acres of land that it sold to the partnership's first investor, Gilster-Mary Lee. A small baked goods company, Gilster-Mary Lee converted one of the old shoe factories into its manufacturing center, aided by investments from the PDC. The PDC remained a coinvestor in Gilster-Mary Lee by buying stock in the company. Gilster-Mary Lee has grown from a start-up business of 25 employees into a company employing 1,600 in the region today. Since the 1950s, the PDC has recruited and invested in a diverse array of companies including Toyoda Gosei Missouri (TGMO), a supplier of high polymer auto parts, Sabreliner, a company specializing in refurbishing old aircrafts, and Solar Press, a commercial printing firm. The PDC became a not-for-profit organization in 1997 and is financed through sales of stock, plus interest income, farm income, and rental income from a speculative building.

Perryville applied other strategic policies to attract and retain manufacturers such as tax increment financing (TIF), tax abatements, and infrastructure development at minimal cost to businesses. Thanks to these supportive strategies, the large and diverse manufacturing base has remained and provided stable, long-term jobs to residents. Perry County boasts one of the lowest unemployment rates of all counties in Missouri and has had consistently lower unemployment than the United States as a whole. In 2012, Perry County's unemployment rate was 4.2% compared to the nation's 7.9%, and in 2015, it was 3.4% compared to the 5% national rate (Homefacts, 2015).

Perryville is strategically located along the regional thoroughfare Interstate 55 and is also near one of the few Mississippi River crossings in the area. Many small towns, however, also have such locational advantages. Above all, it was the collaborative and innovative economic policies and partnerships that the town created in response to economic decline, which subsequently led Perryville to become a nationally recognized model for industrial diversification and manufacturing growth.

*Research assistance for this case study provided by Ashley Bozarth.

PLED PROBLEM SOLVING 9.1
Community-Based Business

"The bankers aren't interested. They tried this in the early 2000s, but they had a high rate of loss." The speaker was the head of the new government-guaranteed

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bank program. Reunion, a community business development bank, recently had approached local commercial banks seeking participation in a loan program to finance new inner-city ventures. The Reunion Bank was making overtures to use the commercial bank's community reinvestment funds for community purposes. The commercial banks they were approaching had tried inner-city loan funds in early 2000s and were disappointed in the loan losses.

These previous commercial, small, and minority business loan funds suffered from a number of major shortcomings. These funds often employed weak loan criteria and had little or no oversight. Bank managers showed little concern when the loss rates began to mount. In recent years, however, new community-oriented funds have emerged that reflect what administrators have learned from past mistakes. Although the community development banks are a new instrument, they have shown considerably greater success in their repayment rates.

The Reunion Bank's loan committee has identified nine new projects across the city that illustrate the success of the community development bank concept. One of the best examples of community-oriented loan programs is the Business Development Corporation of Centerville (BDCC). The emphasis of the BDCC is on Hispanic entrepreneurship to provide jobs for the area's unemployed population. Although capitalized with nearly $1.5 million in city funds, the first years of BDCC were disappointing, in part because the group followed the Small Business Administration (SBA) model. Community representatives, inexperienced in banking, made decisions. By the third year of BDCC in business, the loan loss rate was reported to have reached nearly 60%.

In that year, the city restructured the loan committee to include banking professionals, and a former commercial bank official was brought in as executive director. Then the development corporation's record of success began to change. During a 3-year period, BDCC made 32 loans to small businesses, mostly in the range of $15,000 to $75,000, with 3- to 5-year repayment schemes. Today, only three of the loans are in default.

Four key factors have made the new loan funds effective:

1. *Professional criteria.* It is important to use strict criteria in financing decisions. These criteria include the applicant's experience in the field, his or her investment of capital, and a convincing business plan.
2. *Careful monitoring.* Close monitoring and identifying if management assistance is necessary is essential to success and requires keeping to a manageable volume of loans.
3. *Training and technical assistance.* These offerings should complement basic entrepreneurship and, in most instances, be required of loan recipients.
4. *Involving others.* Most of the new loan funds, unlike their predecessors, will not fully fund the business start-up. For example, the BDCC will provide financing for only up to one third of the total monies needed, thereby requiring applicants to find other private sources. The involvement of other lenders provides

additional analysis of business plans, as well as enables BDCC to leverage its available loan funds.

The new success of BDCC in recent loan making suggests it can become a major antipoverty force if only it can hold true to entrepreneurial values: creativity, decentralization, and market discipline.

The Cadillac Foundation has become interested in minority lending. The foundation directors, chaired by John Jonas, have directed the staff to consider forming a loan guarantee plan for community development banks. Cadillac wants to support loans to the homeless on a model similar to the Hispanic enterprise programs. How would such a program be designed by the community development bank, or is this just too risky? Mr. Jonas is adamant about introducing a microloan for the homeless, but how would you devise a program using all of the methods detailed previously to move the homeless from their current status to self-sufficiency?

PLED PROBLEM SOLVING 9.2
A Small Town Determines Its Own Destiny

Steelnet's dream evaporated almost overnight. The Midwest Iron Range community, located on a two-lane county road in the northern Great Lakes region, began for just one reason: a low-grade iron ore called taconite. The Reservation Mining Company built the town in 1939 expressly for its workers, who earned good wages, financed their houses on easy terms through an employee credit union, and often had money to burn.

For years, Reservation's taconite mine, a joint venture of the Inland and Republic steel companies, was the most productive in the world. But decline in the U.S. steel industry and competition from other taconite sources finally closed the mine, decimating the town that at its peak was home to 30,700 people. Lacking proximity to anything but its iron mines, Steelnet had to scramble for economic survival. So did its residents—many of whom left as unemployment soared to 85%. The rapid exodus cut the population from more than 30,000 to today's 12,300. The average housing price plummeted to less than $15,000 per single-family home.

Steelnet could have become a ghost town. When the mine reopened a few years later, it recalled just 100 of its 1,500 former workers. What has kept the town alive—and optimistic—is the tenacity of its citizens and the mayor, Don Cole, a retired mine foreman. A smile and an easy laugh are part of the salesman's repertoire, and Cole is a salesman for Steelnet. His first priority was to train the town to market itself through a program launched by the state's Department of Energy

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and Economic Development. Named Star Cities, the program is designed to highlight and strengthen the state's most aggressive local development programs.

The certification requirements to become a Star City would daunt many small cities, but Steelnet had one key asset: a pool of unemployed volunteers who combined their talents to make the town a Star City in a record 4.5 months. The achievement won it visibility among state officials, which paid handsome dividends later.

The Steelnet city council also formed the Steelnet Area Development Association (SADA), inviting joint efforts with a nearby township that shares the same school district. Cole and the council never planned to settle for a passive role, even though a small board of citizens assumed control of economic development efforts. The same civic enthusiasm that had achieved a speedy Star Cities designation enlisted 435 individual and 29 business members to sustain SADA projects and committees.

Mayor Cole joined the search for funding sources. He recalled an effort to solicit foundation officials who had never heard of Steelnet and had no idea where it was or why they should care. Cole was a good salesman. He was able to attract foundation grants that provided $55,000 for the city's revolving loan fund, targeted for small business loans to local people who could not qualify for bank credit. Steelnet's skilled but largely unemployed workforce would become its main source of entrepreneurial talent for these loans.

Because the city had relocated its offices to a retail/office complex in a converted school building, the old city hall became an ideal trial site for SADA efforts. A Community Development Block Grant (CDBG) financed renovation of the building, while SADA loans allowed a pool table manufacturer and a small software games products firm to occupy it. SADA has relied heavily on board members' personal knowledge of loan applicants in taking risks. Yet the 20 SADA loans have shown a perfect repayment rate. The city did less well at first, however, in trying to attract new businesses from other areas. On the bright side, Reservation Mining's steady decline offered new opportunities for the reuse of abandoned buildings. A rubber tire plant, expanding to fill the Firestone disaster tire needs, located in a building formerly used by a pneumatic drill manufacturer. The city owned this facility, having purchased it for only $500,000. The new Kelos tire plant is being leased from the city for nearly $50,000 per year, and the tire plant is expected eventually to create 60 new jobs. Two other firms that will also locate in Steelnet to make use of the rubber for auto racing and high-speed windshields may add twice as many jobs by the end of the year.

Steelnet's strategies finally seem to have paid off. This little town didn't give up or die. There is a lesson here for many small towns dependent on natural resources or a single industry.

One of the union leaders is opposing the plan for the reuse of the mining facility by an outside firm. He argues that outsiders are nonunion and that these union-busting firms are the cause of Steelnet's problems. Joe Bartowski, a former union steward, argued that "we should loan some of that money to ourselves and reopen the rubber plant ourselves. After all, we worked in it before," he said. "Who knows the market and the products better than we do?" Mayor Cole thinks Joe is a little crazy. "Working in a place ain't like running it." Who is right? Maybe they both are for different reasons. Or is there something in what Joe says that can be used by Steelnet before they let the new firm in?

PLED PROBLEM SOLVING 9.3
An Incubator as a Revitalization Tool

When the Kanter Corporation, a metal fabricating company, abandoned a 73,000-square-foot facility on three acres of land one mile north of Jonesboro, Kanter gave the land and buildings to the city for $1. Jonesboro originally wanted to use the facility for a new community college, but a feasibility study showed this would not be financially prudent. The Greater Region Economic Development Foundation then asked the city council to allow it to investigate the site's suitability for an incubator facility.

Canton was able to obtain a Small Cities Block Grant to perform a feasibility study. The study, which included a building and site evaluation, marketing strategy, and incubator plan and program, came back favorable to an incubator facility. The Greater Region Economic Development Foundation obtained a $70,000 matching grant from a private donor and a $70,000, 5% loan from the city, with repayment beginning in 3 years. In addition, the city charges the incubator no rent. The $70,000 from the city is money that the city would have needed to spend on security, maintenance, and so forth for the incubator building if it had remained empty.

The Women's Economic Development Corporation (WEDCO) Center will run a business incubator for women-owned firms in Canton. Women who want to rent or lease space may do so only after they have completed a special training program organized by WEDCO. The incubator offers newly established businesses the opportunity to rent space at below-market rates and have access to free telephone receptionist services, secretarial services, business management assistance, custodial and maintenance service, and a business technical library. In addition, the businesses have an opportunity to network with each other. Most of the

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entrepreneurs at WEDCO Center either are first-time female business owners or are moving to the incubator from their garage, basement, or barn.

The WEDCO incubator currently houses eight businesses, including a manufacturer of wooden playground equipment, a company that sells bagged ice to convenience stores and bait shops, a firm that makes tools for air conditioner repair, and a computer services business. Lake College also plans to relocate its Business and Industrial Institute to the incubator. The institute will offer 50 different programs, including technical manual writing, computer training, management training, and blueprint reading. Each business in the incubator will be entitled to one free class. The Lake College programs are developing into an entrepreneurial training institute for businesspeople in the area.

The primary function of the incubator's operating committee is to screen applicants. More prospective tenants are rejected than are accepted. The major criterion for acceptance is the business's ability to create jobs for women, either now or in the future. The incubator is not promoting professional people or service sector businesses that offer limited job creation, emphasizing manufacturing and information processing businesses.

The incubator staff assists approved businesses to prepare a business plan and steers them in the direction of local lenders who have been extremely supportive in lending start-up capital to incubator businesses. Each company occupies 500 to 2,000 square feet at a rental rate of $3 per square foot per year. Leases can be for up to 5 years, but no business has signed on for more than 2 years, hoping to move to larger quarters by that time. The incubator is expected to create 120 jobs and currently has a 65% occupancy rate, ahead of the 15% predicted by the end of 1 year of operation.

The community goals of the incubator are to create jobs and ownership for women. Some of the incubator businesses may be able to move to the city industrial park in a few years to help revitalize this city-owned, underutilized facility. By the third year of the incubator's operation, it should be self-sufficient and able to begin repaying the city loan.

The mayor and Regional Development Foundation are now in the process of calculating the return on investment (ROI). They are unfamiliar with the appropriate methods to use. The building with improvements is valued at $1 million. Most of the rental spaces will rent at less than market rates, as discussed earlier. A consultant has been hired to assist making the calculations; however, the committee wants to provide the consultant with the parameters for the study before it commences. What are the variables that need to be considered, and how will the city know if it is in fact making both a social and economic profit?

Notes

1. The first five methods have been identified from the work of the Edward Lowe Foundation (2002), a nonprofit organization devoted to developing entrepreneurship. The sixth is drawn from recent work by the Corporation for Enterprise Development (Dabson et al., 2003).

2. The official title it gave to this effort was the New Economy Project.

3. Defined by the Society of Competitive Intelligence Professionals (n.d.; now Strategic and Competitive Intelligence Professionals) as "a systematic and ethical program for gathering, analyzing and managing external information that can affect your company's plans, decisions and operations."

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10

Human Resource Development

In this chapter, we focus on two critical aspects of human resource development. We begin with the traditional economic development focus on workforce development, surveying the range of practice and efforts to make workforce development more effective in responding to the challenges of the knowledge-based 21st century. Then we turn our focus to education, the essential foundation to workforce and economic development that the practice of economic development has neglected.

Workforce Development

> *Workforce development is not a problem—it is an opportunity—the chance to unleash the creative, productive, and innovative forces, found only in people, for the economic and social betterment of our cities, states, and nations. People-centered development has the unique advantage of promising increased equity, efficiency, and economic vitality.*
>
> —Garmise, 2006, p. 146

The author of this quote is urging us to turn around the traditional problem-focused approach to workforce development. Consistent with the definition of *economic development* guiding this book, Shari Garmise (2006) argued that equity is extended by increasing access to skill and talent development. Further, this extension is essential for an economic development strategy to

succeed in the global economy of the 21st century, in which people and place survival skills are being placed directly on creative and innovative abilities.

We will begin our discussion with a review of the problems that have preoccupied the practice of workforce development in recent decades. There is the concern that certain individuals and groups in society are not able to compete in the emerging growth sectors of biotechnology, electronics, information, computing, and health industries. Another concern is that jobs have literally been moving away from people to suburbs and other nations. In the first case, the new locations for jobs are physically far away from where people (inner-city residents and rural communities) are most in need of work. In other cases, jobs are transforming or disappearing faster than the population has been able to adapt. The clearest evidence of this is the rapid decline in the labor input to the manufacturing sector. However, many service jobs are also being deskilled or eliminated as a result of automation. At the same time, while the postrecession unemployment rate had yet to fall below 8% in mid 2012, employers across all sectors complained they could not find employees to hire with the right skills.

Realities of an Undertrained Workforce

American workers are undertrained for their current jobs and not prepared for future opportunities. While about $60 billion was spent on "human capital investment," the annual survey of U.S. employers by *Training* magazine found there was a significant decline in company education and training expenditures during the early 2000s (O'Toole and Lawler, 2006).

Large companies are more likely to offer workforce training than are small companies (fewer than 50 employees), but O'Toole and Lawler (2006) cited a University of Michigan survey finding that less than 20% of workers took advantage of employer-offered training. They concluded the following:

> Given the nation's growing competitive challenges and the need to create greater mobility (and good careers) for workers, the decrease in the amount spent on training—coupled with the number of employees who apparently are not participating in training programs—leads us to conclude that the already undereducated American workforce also is being under-trained. (O'Toole and Lawler, 2006, p. 128)

Or, as Mark Elliott (cited in Kleinman, 2000) of Public/Private Ventures put it, "It's hard to compete in the global economy with a lame workforce" (p. 2). This is even more the case when the undertrained workers are also some of the most expensive in the world, as can be seen in Table 10.1.

Table 10.1 All Employees: Indexes of Hourly Compensation in Manufacturing, Selected Countries, 2006

Country or Area	Index
Americas	
United States	100
Argentina	22
Brazil	20
Canada	98
Mexico	13
Asia and Oceania	
Australia	102
Israel	49
Japan	82
Korea, Republic of	57
New Zealand	54
Philippines	5
Singapore	46
Taiwan	27
Europe	
Austria	124
Belgium	123
Czech Republic	—
Denmark	129
Finland	119
France	114
Germany	139
Hungary	28
Ireland	105
Italy	97

Country or Area	Index
Netherlands	119
Norway	156
Poland	21
Portugal	32
Slovakia	22
Spain	74
Sweden	116
Switzerland	121
United Kingdom	114

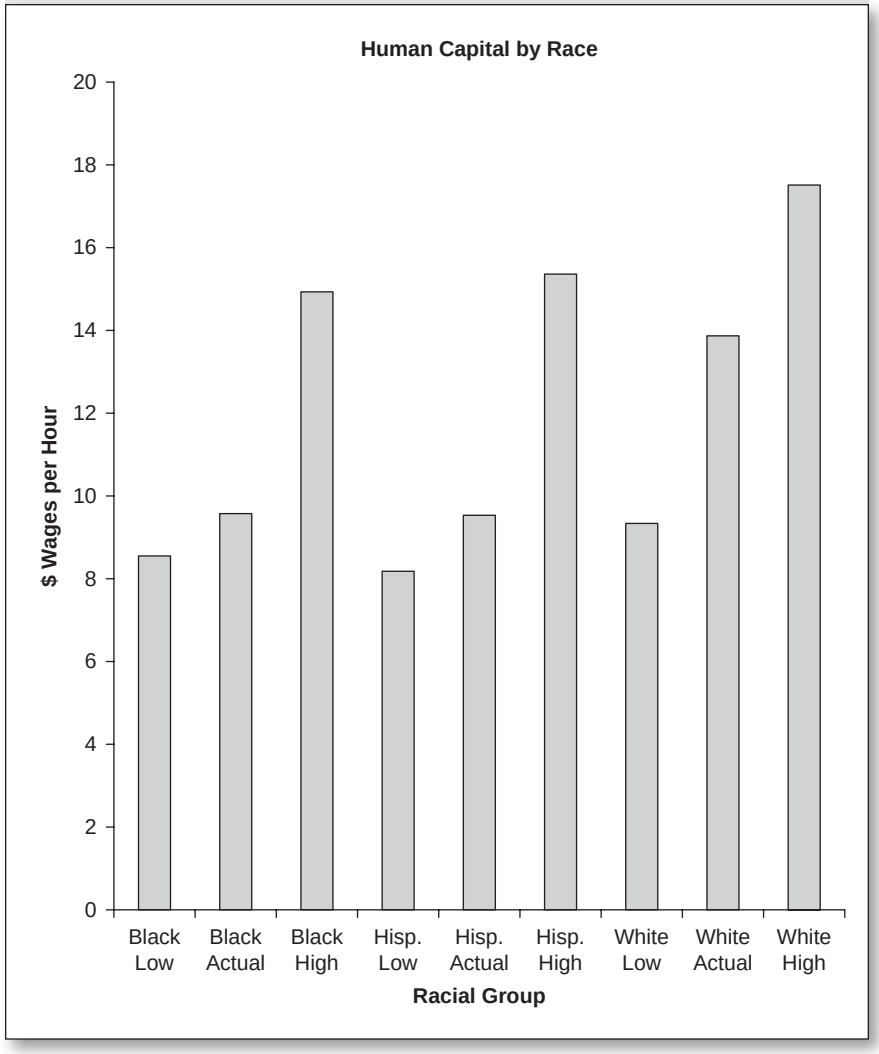
Source: U.S. Department of Labor, Bureau of Labor Statistics (BLS), Economic News Release, January 2008, Table 7.

Note: Dash means data not available.

The nation is not preparing its human resources for competition today or tomorrow. Furthermore, even in good times, minority workers are not as well rewarded as White workers, as is illustrated in Figure 10.1, which shows hourly wages for workers with low and high education levels for similar work in the Boston metropolitan area. Race and wage rates in Boston reflect a pattern similar to that of the nation. Race matters, but so do skills. No matter what color the worker, education and training pay. The average families with two or more professionals with professional degrees had incomes of more than $147,000 annually versus a similar family of high school graduates, who had a combined family income of only $48,000 per year. Although even the low-income number is well out of the poverty range, the fact that it takes several members of the household to get this income means that catching up with the professional "Joneses" is impossible to do without an education.

Even as jobs are being shed, people remain an important community resource and are crucial to a locality's economic recovery. Good labor that adds value to production is always the critical asset when it comes to firm location. The United States has tended to place more of its national resources in income-support programs than on job skills development and maintenance schemes. In contrast, other developed nations, such as Sweden, have recognized the need to make job skills development the key component of their labor market programs. This need is only now being recognized here.

Figure 10.1 Human Capital Endowment by Race, Boston



Source: Bluestone and Stevenson (2000).

Note: Low means low education. *High* means high education—some college or specialized training.

Public Role in Workforce Development

Human resource development has long been a public–private partnership—one that dates back 100 years or more and has involved the public schools.

Initially, informal employment training agreements were made between employers and schools that set certain expectations for the roles to be played by public and private interests to ensure that workers could perform in the workplace. Basically, schools had the responsibility to prepare people to enter the workforce, and the employer had the responsibility to train the worker for the specific tasks that needed to be done at work. Preparation for entering the workforce involved literacy skills, simple math, and a sense of civic responsibility. Some generic skills were also taught, such as measuring and the use of simple tools.

Once students got to the workplace, they were trained in specific skills needed by their employers. On-the-job training was often simple, with factory work being learned quickly. Moreover, people stayed in the same job for many years, gradually progressing through higher skill levels in the company based on performance. Apprentice training was the model for more complex training in crafts, which combined classroom instruction with structured on-the-job training under the supervision of master craftspersons.

Structural economic changes have altered that old compact, beginning with the shift to what has been labeled the New Economy. In general, this term refers to the substantial shifts in industry structure from the effects of the information and communications revolution. But the New Economy continues to evolve as new industries develop, such as biotechnology and nanotechnology, which themselves have profound impacts for traditional as well as emerging industry. The overall result is that the kind and level of training required to enter the workforce for many jobs are greater and must be responsive to the needs of quickly evolving industry.

While it has been estimated that 90% of the fastest-growing jobs will require postsecondary education, an increasing number of people come to the workplace without even the basic skills expected (U.S. Government Accountability Office [GAO], 2007). Recent adult immigrants, for example, lack language and work skills, and people who get displaced from certain jobs because of technology need to acquire a number of basic skills just to be able to undertake regular training programs. People older than school age thus find themselves needing special programs, which may be available only through partnerships with employers. Furthermore, the very high dropout rate from high school by low-income and minority youth, including many first-generation immigrants, also creates many barriers for participation in the New Economy.

Government at all levels—federal, state, and local—has an important role in providing support for a workforce development system. The last major federal program development for this resulted from the passage of the

Workforce Investment Act (WIA) in 1998. By 2012, the WIA was considered long overdue for reauthorization and criticized for not responding to changes in the economy. The National Skills Coalition (n.d.) observed that "the law's original emphasis on short-term training and rapid re-employment is increasingly inconsistent with growing demands for longer-term training aligned to high-growth and emerging industries." The current structure of the WIA is described next.

Under WIA, responsibility for managing the programs devolved from the federal government to the states, and ultimately to local Workforce Investment Boards (WIBs), which make most of the decisions. In contrast to previous approaches, the WIA recognized that training needed to respond to the following:

- Economic swings that had more to do with the readjustment of the competitiveness of major industries than periodic cycles
- Global competition that led to unexpected swings in markets with consequent employment impacts
- Firms and employees that did not change would be left behind and suffer not only unprofitability but also extinction
- Employees who were likely to change jobs and careers as many as 10 to 15 times in their working lives due to necessity and opportunity
- Unskilled or static-skilled workers who would be left out of the New Economy

The WIA asked for stronger coordination among multiple training and service providers in the context of one-stop career centers that would allow individuals more flexibility to choose from a larger number of training options linked to employer needs. Thus, a majority of the WIB membership is composed of business representatives. For the first time, the WIA program permitted the use of resources to train employed persons. Previously, funding was restricted to unemployed persons. The WIA also provided new employment-generation tools that states can use to transform their workforce development programs.

Economic developers have found that partnerships with institutions engaged in workforce development provide many benefits. From the training providers' perspective, changes in the economy and federal regulations have combined to force them into a three-way partnership with business on one hand and economic development organizations and training providers on the other. Consequently, government resources and private resources are being used more effectively as trainers seek to ensure the service they provide is directly related to what business really wants and that the people they train can find jobs in the most promising firms. Economic developers in turn realize that they need the training professionals to produce a top-quality workforce

that is able to meet the needs of existing businesses or the businesses that might be attracted to the area.

The economic developer wanting to utilize a human resource approach to building jobs and creating a stronger economic base in the community must first identify the existing programs at the core of the workforce development system. These major training institutions increasingly are partners in economic development, a recent trend necessitated by the growing awareness that training programs can partner with job development programs and thereby make both systems more effective. Thus, the primary training providers are increasingly also the leading strategic economic development resources for local community leaders. Some examples follow.

- *Job training programs*. The federal job training providers are typically nonprofit contractors who work with the federal programs to train people in specific skills or sets of skills. This also includes state-supported training programs, which often contribute funds to businesses that provide their own curriculum and instructors.
- *Nonprofit community development corporations (CDCs)*. Increasingly, nonprofit housing, social service, and other programs are providing job training to their clients, often including disadvantaged groups, immigrants, women, inner-city residents, and so forth.
- *High schools*. The high school, as a resource for community economic development, offers an untapped but growing potential for students and teachers. The schools have many opportunities to couple teaching with internships, business formation, and summer activities for both students and faculty.
- *Adult education programs*. The public school system in most communities also sponsors an adult school that offers courses in English as a second language (ESL), job skills, and recreational and cultural topics.
- *Nonaccredited postsecondary training programs*. Training institutions are often connected with industries and certificate programs that train students. These programs are typically run by business associations, unions, or equipment suppliers specifically for a set of firms. Nonaccredited programs are also provided by schools that charge students fees, promising them training for jobs related to cosmetics, truck driving, sales, or computer repair.
- *Accredited colleges and universities*. The range of accredited programs starts with 4-year colleges and universities, in which new programs are linking coursework with industry areas. In addition, and increasingly important in economic development, are community colleges that provide specialized training for industries on a fee basis. Community colleges also partner with other economic development programs to provide training and technical assistance to local firms.

In addition, federal and state programs link employment training with other programs. For example, in the area of health and welfare, programs include senior community service, job services, veterans' programs, Wagner–Peyser Act funds, trade adjustment assistance, vocational rehabilitation and supported employment, food stamps, employment and training, and refugee assistance. Many states have conservation corps and programs for troubled youth. In areas of housing and community development, many job training programs and employment services are targeted to residents. Finally, the Stewart B. McKinney homeless assistance programs and inmate employment and vocational education for incarcerated youths and adults also provide training resources.

Coordinating these various training resources is a massive task that is increasingly assigned to WIBs and their one-stop service centers. The types of activities undertaken by these human resource–coordinating programs depend on the local situation. Generally, their task involves doing more than just assuring that training is available, such as the following:

- Managing workforce training schemes, such as group apprentice schemes, adult retraining, and new training initiatives
- Offering business support services that increase employment
- Developing shared facilities for training activities
- Operating general literacy and community education projects
- Developing on-the-job training and work experience activities for young adults
- Attempting to reduce discrimination in employment for disadvantaged groups

These many training avenues can actually achieve significant economic development goals in a local community and result in good partnerships for all. Using a human resources strategy implies that community economic development goals are pursued in tandem with the training and educational assets of the workers, helping businesses to grow and to locate in the local community.

Goals of Human Resource Programs

Human resource programs are typically focused on one of four categories of workers who are developing skills needed by employers. First, programs focus on people *entering the workforce for the first time.* Typically, these are youth or high school students but also immigrants, homemakers, welfare recipients, disabled people, and other groups. Programs for these people include considerable attention to basic work skills and work readiness, as well as help in the job search.

First-time entrants to the workforce have traditionally been helped in schools, but the schools have not always done an adequate job of preparing people for work due to the emphasis given to preparing people for college. A national program called the School-to-Work program has helped schools better address the students not going to college. Other programs throughout the country help individuals gain practical work skills, prepare resumes, and learn job search skills.

Second, some human resource programs focus on people who have been *displaced from the workforce* and are unemployed, seeking to return to work. The old model assumed that when individuals lost their jobs, unemployment would be temporary and they would be recalled when economic conditions improved. However, increasingly, the people losing their jobs are finding that the layoffs are permanent.

Traditionally, workforce development personnel were reluctant to train displaced workers for two reasons. Trainers believed that workers were temporarily laid off and that, at a moment's notice, they would go back to work. It was also believed that such programs were unnecessary for laid-off workers because they presumably had adequate skills for the job.

Third, workforce programs have focused on providing training for *incumbent workers* who need to upgrade their skills in order to remain competitive in their firm and for the firm to remain competitive with other firms. Business itself is the largest provider of workforce training, without assistance from government or economic development programs. Reportedly, business spends some $6 billion on training each year, though the majority of that goes to management and high-ranking professionals. Nonetheless, throughout companies, considerable training goes on to improve workforce skills. These efforts are strongly supported by training programs that are tailor made for certain skills. Courses in commonly used software or in safety when working around high-voltage lines are examples. In addition, businesses that require licenses for certain jobs need to provide both initial training and recertification programs. Professional conferences typically train people in new techniques and legal requirements that affect their business.

Workforce programs can also be targeted to *potential employees* of firms that are being attracted, that are moving into an area, or that are expanding. These firms see worker training as a major cost of doing business in an area and often look to workforce development programs to help support training their new workers. Typically, worker training benefits account for a large proportion of the incentives given workers under business attraction schemes (see Chapter 8), as they are a large one-time cost associated with a relocation or expansion. In these cases, specialized training programs are funded by using either training professionals from the firm or faculty at specific training institutions, such as community colleges or private training firms.

Matching Human Resource Programs and Economic Development Objectives

The following paragraphs give more detail about the various types of human resources development and training programs in existence. The correlation between job placement efforts and economic development is also discussed.

Workforce Investment Boards

Generally, local employment and training boards, formerly known as Private Industry Councils (PICs) and now WIBs, are more than happy to cooperate with local employment strategies if they are aware of the economic development goals of the community. They have been created to repair the continuing gulf between employment and training efforts and economic development, particularly for the disadvantaged. In the past, preparation for employment has been a "revolving door" for many people. They attend courses that frequently lead to dead-end or unsatisfying occupations, only to be sent to additional training as a remedy for their unemployment. Recently, with the help of WIBs, community groups have attempted to pull together local business and community-based economic development programs into a single employment network.

For example, WIBs attempt to coordinate the frequently fragmented efforts of parties interested in employment within a region. Although they vary in composition, WIBs generally include representation from key local firms, local government, state government, unions, and educational institutions. The members of the board must commit themselves to creating more flexibility in both training systems and job entry arrangements.

WIBs must also pull together multiple government-sponsored training initiatives and integrate them with local economic development. One of their major responsibilities is to identify and encourage new ventures that have skill requirements readily met by local people. Another is to match local training activities with the needs of local employers.

Community employment programs (discussed in the previous chapter) offer an appropriate mechanism for coordinating economic development and employment. They offer a vehicle for communities that wish to combine the community-based concept with more traditional economic development activities.

First-Source or Targeted Hiring Agreements

First-source agreement refers to a contractual obligation entered into by firms that receive substantial government assistance, such as tax holidays and

government loans. Under the contract, the assisted firm agrees to interview, as the first source, local people for the available positions. After reviewing them, the employer may select anyone for the vacancy. This agreement generally stipulates the referral source and the number of referrals required before the employer can place advertisements or interview persons from outside the specified geographic area. First-source agreements historically have been targeted to firms directly. More recently, a variant of these agreements is being incorporated into community benefits agreements (CBAs) targeted toward developers of large-scale projects. That is, in the legally enforceable contract between community groups and a developer that the CBA represents, targeted hiring is one of the specific benefits being spelled out. This is done to ensure that the promises of job creation that come from developers and from local government agencies promoting the development will benefit the community from which both parties seek cooperation and approval.

In their manual on CBAs, Gross, LeRoy, and Janis-Aparicio (2005) have suggested that possible target populations might include the following:

- Individuals whose jobs are displaced by the development
- Residents of the neighborhood immediately surrounding the development
- Residents of low-income neighborhoods anywhere in the metropolitan area
- Individuals referred by local, community-based job training organizations
- Low-income individuals generally
- "Special needs" individuals, such as public assistance recipients or ex-offenders (pp. 45–46)

In some instances, firms will request local referral voluntarily as a civic obligation in high-unemployment areas. These voluntary efforts are also used to stimulate employers to look at local youth as a first source. Youth-oriented first-source agreements generally have a "job tryout" component.

Employment Maintenance

Employment maintenance or support programs use unemployment funds to develop jobs for hard-to-place people. In this scheme, a local government or nonprofit organization receives the welfare payment as a subsidy for employing a person at the full wage level. A large number of CDCs have employed this approach with considerable success. This type of project was one of the keystone initiatives of the Clinton administration. Many urban and rural local governments have indicated an interest in this type of

program as a means of restoring teachers' aides, playground supervisors, assistant librarians, and many other paraprofessional positions.

Skill Banks

This is a relatively simple concept, aided by the advent of the microcomputer. The idea is that the employment officer or a local volunteer group or other person(s) collects refined information on the skills and backgrounds of local unemployed persons. This skill inventory can be used for a number of purposes. First, it serves as a source of community data on the nature of the job development needs of the unemployed. Frequently, communities know that there is high unemployment, but they do not know what kinds of skills the unemployed have or the kinds of jobs they need. The skill bank helps address this problem. Second, the dominant use of the skill bank is its inventory of skills that can be matched to available vacancies in the local area. Finally, skill banks collect unemployed people into cooperatives or community-based employment initiatives. A skill bank is an invaluable tool for assessing local abilities and building new jobs or services on the basis of these skills.

To initiate a skill bank, organizers should first do a survey to document the demand for various occupations or skills and the availability of skilled labor to fill those needs. As a second step, the existing training and education facilities in the region should be assessed by their accessibility, suitability, and ability to meet further labor market needs. Recommendations for upgrading, extending, or modifying education/training programs should be made on the basis of these studies.

Training Programs

> Particularly in the last decade, an observable convergence of trends has heightened the need for more, and better, job training: the increasing speed of technology change, the increasing sophistication of foreign competitors, the export of manufacturing jobs, downsizing due to pressures to increase productivity, shortcomings in the quality of formal education (particularly at the high school level), and the aging of the workforce. All told, those trends amount to an almost perfect storm, creating an ever-increasing need for workers to update their skills regularly and, often, to develop entirely new ones. (O'Toole and Lawler, 2006, p. 127)

In this section, we review a range of training concepts developed, with more or less success, to tackle labor force problems in local economic development. Most contain provisions for special courses to meet the needs of local employers and include upgrade training, apprenticeship courses,

retraining of dislocated workers or of women reentering the workforce, as well as traditional course offerings. Local training councils, such as WIBs, help to integrate these efforts with local development strategies. For example, communities that embark on tourism strategies need to develop courses that provide initial education and upgrade the skills of those already in the hospitality industry. Wolman, Lichtman, and Barnes (1991), after examining education, training, and skills, concluded that training in a specific skill area does have a significant payoff for the underskilled. Specialized training approaches include the following.

Customized Training

The concept of customized training is relatively simple. It provides training either at the employer's site or at the local college through courses specifically designed to meet employer expectations. Human resources are thus used to attract business because of the reduced cost of staff development.

Although this type of program is usually reserved for new firms moving into an area, it may also be used by existing firms that are expanding. These programs are typically operated at the state government level to support their industry recruitment efforts. Two of the best known are North Carolina's NCWorks program and Georgia's Quick Start program. The latter program reported for fiscal year 2015 that 10,611 jobs were created or saved, 115 customized workforce training projects were delivered, and companies from more than 15 countries used the program (Quick Start News, n.d.).

An early (1987) innovative customized training effort was the Ohio High Unemployment Population Program (HUPP), which targeted training and employment services to chronically unemployed minority males. In this program, the employer's premises were used as a home base or site to aid participants in on-the-job training and education for a credential or degree. The basic idea was for a person to develop job habits and a job resume while gaining a degree. Today, prominent nonprofit training programs focused on hard-to-reach, long-term-unemployed individuals are administered by Goodwill Industries and the St. Vincent de Paul Society.

Competency-Based Training

In competency-based training, human resource professionals work with a group of employers to articulate the competencies that are required for workers in a particular industry. For example, a group of banks simplified their training into three sets of tasks (i.e., cashier, financial analysis, customer service) and developed the specific skills that were necessary in each. A hierarchy of skills allowed people to be trained for simple tasks first and

more complex functions later so that they could progress in their track and receive more challenging jobs. As they received training, each employee received a certificate that was recognized by other banks.

Overall, this strategy is similar to the training in many apprentice programs sponsored by unions, and it allows workers to move easily from one employer to another. From an economic development perspective, it can simplify training programs and reduce costs for all the firms involved. Although many tasks in the New Economy do not fit well into competency-based programs, an increasing number of employers can benefit from the better training such programs provide.

Comprehensive Training to Meet Social Needs

The strong link between human resource development and meeting the social needs of people outside the workforce is readily apparent to anyone working with persistently unemployed persons. For example, a key barrier for many welfare families is the lack of child care. In other cases, substance dependency or physical disabilities may be a barrier to steady employment.

Community-based organizations serving groups with barriers to full participation in work often are in a position to provide multiple services and training. One example is a program in Oakland, California, that used various public and private funding to assist the hardest-to-place persons. This program was comprehensive in that it did full intake assessments and started with work readiness training, such as timeliness, work attire, persistence, and so on. Participants were assisted in solving important social problems like finding housing and child care, getting proper clothes or tools, and being sober and safe. They were also helped to identify at least three jobs and careers paying at least $14 per hour for which they could be trained, based on prearranged contacts with potential employers who agreed to take the graduates. Students were then placed for trial periods at the workplaces, where they could observe each job. Many found that the job they thought they wanted was not good for them (e.g., a student thought she wanted to be a nurse but discovered a fear of blood). After choosing their job, students received intensive training supported by internships and on-the-job supervision as they progressed. Upon graduation, they remained in touch with the program to ensure that problems could be solved.

This program was so successful that students had a high level of security that they would remain employable, with only a few needing more training. But this approach is expensive and intensive, something for which funding is not always adequate.

Youth Enterprise

There is growing interest in helping young people to become acquainted with business development. In part, this is an attempt to rekindle entrepreneurial spirit in the nation's youth. It also represents a new emphasis on helping people create jobs for themselves rather than waiting for jobs to be created for them.

Youth enterprises have been started through the Community Youth Employment Program as well as various service clubs, community-based organizations, and schools. These vary in size and focus, and a few have become major self-supporting enterprises.

The basic idea is to start businesses within the skill range of youth to give them some experience in how the business system works. Community-based groups have considerable resources and training to foster such activities. They can offer vacant space or equipment to the youth enterprise as well as mobilize service clubs and others to provide the technical assistance for the projects. Youth enterprise has even developed to meet critical needs of communities.

The Bulldog Express is a student-run grocery store in the small rural town of Leeton, Missouri. It began in 2009 and has drawn national attention. The town had lost its only grocery store 10 years earlier, and the closest grocery store was 15 miles away. The store is located in what was a closed bank building. Leeton school administrators and students worked together to form the store and received broad support from the community. Students staff, stock, and manage the store, receiving earnings and valuable business experience in the process. The store provides essential goods to the community and a gathering place for the small town, and is particularly appreciated by senior citizens for whom driving has become more difficult.

University–Industry Technology Transfer

One of the most interesting sets of human resource programs involves universities sharing their research with local businesses. Although some technology-transfer programs are limited to patents and products, many find that the most effective flow of technology is through students trained in specific programs to meet specific needs of industry. For example, university programs in biotechnology can meet the needs of industry, whereas less specialized biology programs may not.

University programs operate either by providing specific project support to firms wanting new technology or by making scientific results available to businesses with whom they are shared. Many states have created specialized technology programs in which business funds part or all of specific research projects.

Examples are Pennsylvania's Ben Franklin Technology Partners and the New York Centers for Advanced Technology. All these programs leverage private funding of faculty research and train students—usually graduate students—who apply their knowledge in industry, often in nearby industrial parks.

University programs that maintain specific project-by-project collaboration with industry benefit all participants. For example, the University of California Toxic Substances Research and Training Program leverages faculty interests by linking with firm needs. In this instance, graduates of the university program receive not only good industry–university education but also the benefit of a new generation of products and processes to detect, control, and remediate toxic substance problems in the environment.

Although university relations with industry are most clearly seen in tech parks, such as Stanford Research Park (electronics industry) and Research Triangle Park (North Carolina), college and university programs in fact work with industry at many unseen levels because of the common flow of people and ideas from university to business.

Self-Employment Initiatives

These initiatives attempt to assist unemployed people of any age to create employment ventures themselves, using their own labor as the primary resource. They include small business start-up efforts in which the unemployed receive small loans and grants to initiate a new, independent, community-serving business. During the period when the business is being organized, unemployed persons receive an allowance equivalent to an unemployment benefit. This allows the enterprise to reach the stability point before wages have to be paid.

There also are programs available that support self-employment ventures organized by a group rather than by an individual. In these projects, such as the microloan programs discussed in Chapter 9, a specialist works with groups to examine opportunities and exploit them using unemployed persons as the basic resource.

Career Ladders

Career ladder programs are aimed at helping workers in low-skill and low-wage jobs move into higher-level and more secure employment. For example, Fitzgerald (2005) noted career ladder programs have helped nurses' aides to become licensed practical nurses and clerical workers to become information technology (IT) workers. The career ladder programs identify the training and education needed for the worker to move up the

ladder and provide support services and financial aid to help the worker prepare (Fitzgerald, 2005).

Disabled Persons Skills Development

Physically, emotionally, and educationally disabled persons have always had difficult placement problems. Intervention in this situation ranges from sheltered workshops to employing a special disability placement officer (DPO).

The DPO is responsible for seeking out employment opportunities for disabled persons that fit their capabilities. With modern equipment, there are more of these opportunities than most employers realize. The job of the DPO, then, is to see how the work environment can be made to fit the person rather than the person fitting the job. The DPO also provides employers with information on assistance schemes for disabled persons and their employers. Local governments can assist DPOs and the disabled by being positive examples, such as including the disabled in the development planning process and by allowing council offices to be used by the DPO or others working on issues of the disabled.

Education as the Foundation of Human Resource Development

There are two major reasons that economic developers focus on human resource development. First, referring to our definition of local economic development, we seek to provide sufficient and rising standards of living for all persons in the economy, reducing inequality in the process. This requires giving individuals the opportunity to attain this standard of living through quality employment and good compensation packages. This, in turn, requires providing quality education opportunities. It has been estimated, for example, that every additional year of education increases a worker's earnings by 10% (Schweke, 2004).

Even if we were to fall back to the traditional definition of *economic development* that simply emphasizes job and wealth creation, the importance of a well-educated labor force should be clear. At a minimum, employers need workers with strong basic skills. The most desirable employment in today's knowledge-based economy, however, requires advanced education and skill levels.

Thus, it seems logical that when economic development has focused on the role of education, it has done so primarily at the university or

postsecondary level. We discussed previously the role that community colleges and vocational and technical training institutions play in providing employee training. There has been a long-term trend away from employers providing in-house training to workers; the role of vocational–technical (or voc–tech) schools and community colleges has become more important as a result. Working closely with these institutions is a key component of a human resource–based economic development strategy.

Less appreciated is the idea that local economic developers should also be concerned with the quality of the local prekindergarten and kindergarten through high school education systems. With regard to prekindergarten or early childhood education programs, economists have found that investments in these programs bring significant public and private returns on investment (as much as 16%). Indeed, Grunewald and Rolnick (quoted in Schweke, 2004, p. 16) stated, "We are unaware of any other economic development effort that has such a public return, and yet early childhood development is rarely viewed in economic development terms."

Additionally, there are a number of reasons economic developers should concern themselves with the quality of the local K–12 school systems. First, quality primary and secondary school systems generate higher proportions of students who qualify for advanced education and training that generates higher-quality employment and earnings opportunities. Second, quality primary and secondary school systems can help to attract the firms that make up the knowledge-intensive sector of the economy. These firms may seek to hire local workers as well as seek high-quality communities for their existing employees. The lack of quality primary and secondary education has been shown, for example, to be a barrier to growing the biotechnology sector because firms cannot attract needed research scientists (Leigh, Wilkins, and Riall, 2001).

Third, providing high-quality school systems, particularly in low-income areas, increases the likelihood that disadvantaged or at-risk youth will graduate. This, in turn, has been shown to reduce crime and incarceration rates as well as welfare dependency (Schweke, 2004). All of these factors increase the attractiveness of a local community as well as free up public resources that can be devoted to improving the local economy.

Implementation of a Human Resource Development Strategy

Economic developers interested in applying a human resource development strategy in their community to expand jobs and improve community

well-being need to discover how the increase in skills of current or potential workers can expand opportunities for groups of people or businesses currently not fully participating in the local community.

Knowing about training gaps and workforce problems of employers is key to identifying a possible development opportunity. The examples in Economic Developments 10.1 through 10.4 show how some businesses and communities responded to changes in the economic climate of their community. Table 10.2 offers several ideas to help get a human resource project started.

Table 10.2 Human Resource Development Tools and Techniques

Tool	Goal			
	Vocational Training and Education	**Job Placement**	**Client-Oriented Job Creation**	**Job Maintenance**
Customized training	X		X	X
First-source agreements		X		
Supported work program				X
Local employment officer	X	X	X	
Skill banks	X	X	X	
Training programs	X	X		
Youth enterprise	X		X	
Self-employment initiatives	X		X	
Disabled skills development	X	X	X	

ECONOMIC DEVELOPMENTS 10.1
Betting on Downtown Las Vegas*

In the late 1960s when the flashy casino "Strip" located 5 miles away established itself as the central tourist and entertainment destination, downtown Las Vegas began to decline. New big box retail stores and shopping malls sprang up in nearby suburban-like neighborhoods, supporting vehicle-centric lifestyles at the expense of the downtown shopping core. Development sprawled out to surrounding plentiful and cheap land and over time, downtown became a disinvested, crime-ridden area. Las Vegas was also devastated by the 2008 financial crisis and by 2010 had more foreclosures than any other city in the United States (Berfield, 2014).

In 2012, CEO Tony Hsieh announced his multibillion-dollar company, the very successful online shoe retailer Zappos Inc. with more than $2 billion in annual sales, would relocate from its existing headquarters in a suburban office park in Henderson, Nevada, to the previous city hall site in downtown Las Vegas. The move was estimated to have long-term regional economic impacts upwards of $336.6 million and to add $395,000 in annual property taxes to the city (Miller, 2012).

The relocation of Zappos is part of CEO Tony Hsieh's larger vision to transform downtown Las Vegas into a denser, more livable and walkable community. He and several partners are also investing $200 million over 5 years in downtown real estate projects as well as $50 million each to small businesses, tech start-ups, and arts and education. To attract development, Hsieh's Downtown Project offers no-interest loans and salaries to business owners, which will be repaid by their eventual profits. Thanks to the funding, bars, clubs, restaurants, and even a gourmet doughnut shop and gluten-free pizzeria have opened. The Downtown Project is responsible for Container Park, an outdoor mall made of shipping containers, and the Gold Spike, an old casino rehabbed into an informal work/live/play space that replaced slot machines and blackjack tables with lounge chairs, a bean bag toss, and fire pits (Berfield, 2014). Ideally, these revitalization projects will attract innovative entrepreneurs, strengthening the creative profile of downtown workers and residents.

City officials have been enthusiastic about the Zappos relocation and Hsieh's Downtown Project. This sort of innovative development, however, isn't without risk. Some downtown businesses, including a bar and several coworking spaces, have already closed their doors (Berfield, 2014). Small robotics maker Romotive, supported by the Downtown Project's $50 million technology fund, grew so rapidly that it had to relocate to the Bay Area because there was not enough technical support available in Las Vegas ("Delivering a New Downtown," n.d.). The question remains whether Hsieh and a small group of like-minded innovators can build on the success of Zappos to transform the downtown district. Another key question is how much the original residents of the Las Vegas community will benefit from these projects, especially since there is no official community benefits agreement (CBA) that would guarantee predefined neighborhood improvements from the new development. Professor of sociology Michael Borer from the University of

Nevada, Las Vegas, criticizes Hsieh's vision of downtown Las Vegas as a "blank slate" that "overlooks an existing culture that has high numbers of people struggling with low incomes, physical and mental disabilities and unemployment" ("Delivering a New Downtown," n.d.). Indeed, very few local residents actually belong to the creative class Hsieh hopes to attract. The Zappos relocation and Downtown Project reflect the growing trend of companies moving from sprawling suburbs back to urban centers that, while creating economic revitalization and wealth, also raises concerns about gentrification and displacement of existing residents.

*Research assistance provided by Ashley Bozarth.

ECONOMIC DEVELOPMENTS 10.2
A Holistic Approach to Workforce Development*

The Southwest Alabama Workforce Development Council (SAWDC) is 1 of 10 regional workforce development councils established in Alabama in the mid-2000s to provide a more direct link between local labor forces and the workforce needs of local industries and businesses. The Alabama Department of Commerce's Workforce Development Division provides support to the regional councils, headed by business leaders in each locality focused on creating regionally centered workforce development systems. SAWDC is also responsible for approving workforce development grant applications from community colleges in their region and submitting those applications for state funding. Between 2008 and 2014, $20 million in community college grants came into the region—about 25% of total state funding. This is a significant amount since the Southwest region makes up only 14% of Alabama's total workforce (Davis, Chandler, and Covert, 2013).

SAWDC formed in 2008 and is governed by a board of directors and council members made up primarily of local business and industry leaders as well as various economic development officials. (See Figure 10.2.) This helps to integrate the SAWDC commitment to producing a quality workforce with the region's economic development goals. In 2011, SAWDC joined the National Fund for Workforce Solutions, a workforce intermediary initiative focused on career advancement of low-wage workers through employer partnerships. This initiative was supported by the Social Innovation Fund. The National Fund provided SAWDC with funding totaling $780,000 through 2016 to pilot workforce development programs, matched by SAWDC through $780,000 in cash contributions as well as $6.3 million in aligned funding from other organizations (Quimby, 2016).

SAWDC implemented the National Fund's model by establishing four workforce partnerships based on industry clusters with high labor demand in the southwestern Alabama region. These clusters include maritime, aviation, industrial

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construction/manufacturing, and health care. The council promotes the industry cluster framework by connecting training providers such as the community colleges in the SAWDC region to employer needs within those clusters. SAWDC works with the community colleges to develop workforce-training programs on a case-by-case basis stemming from these pinpointed demands. SAWDC then works with the Alabama Career Center to recruit and screen potential employees and offers on-the-spot training based on skills needed for the existing job gaps. SAWDC's workforce partnerships focus on breaking down barriers to successful training, such as lack of job placement assistance and career center/community college connections. Community colleges, for instance, must get all workforce development programs approved by the council to ensure resources are properly aligned to fill existing skill gaps (Laura Davis Chandler, personal communication, January 29, 2016).

The Maritime Workforce Partnership was the first cluster partnership that SAWDC created, bringing together global shipbuilder Austal USA, the Gulf States Shipbuilders Consortium, Bishop State Community College, and Mobile Works, the local workforce development board. The cluster had much potential for growth due to unmet labor demand and the relatively high wages and benefits offered to employees in the industry. Besides direct training offered through the AIDT Maritime Training Center (MTC), SAWDC also developed a project management and coaching model, including an onsite industry coordinator at the MTC to work with participants throughout training. This improved what previously had been a weak linkage between training completion and job placement. Maritime cluster worker training has resulted in more than 800 new maritime employees and 58 incumbent workers with upgraded skills, and a $3.50 average increase in hourly wages (Quimby, 2016).

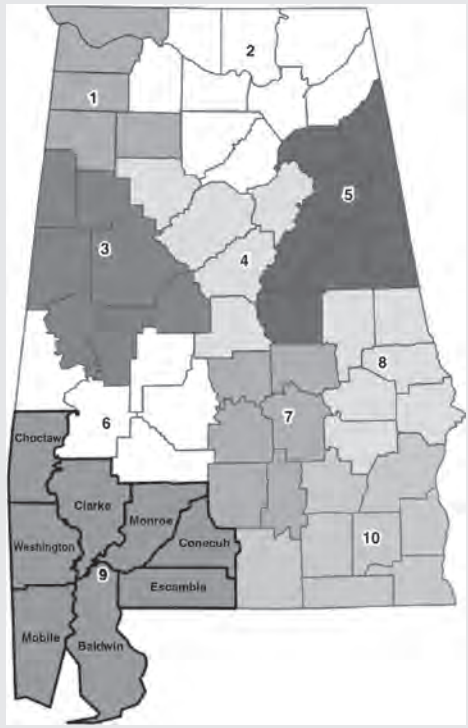
As part of the health care industry cluster initiative, SAWDC partnered with the Bay Area Healthcare Coalition to design programs aligned directly with health care employers' needs. Employers had been facing high turnover rates of entry-level certified nursing assistant (CNA) positions, creating a high demand for incumbents with training in acute care. SAWDC coordinated eight CNA pilot program sessions for both new workers without certification as well as incumbent CNAs in need of skill upgrades. As a result of the training, 99 workers elevated their skills, and 37 received CNA certification. SAWDC also advocates for the workers that participate in the training by forming agreements with employers that benefit from workforce development. In this case, after the incumbent workers completed the CNA training, they all received wage increases of 5% (Laura Davis Chandler, personal communication, January 29, 2016; SAWDC, n.d.).

SAWDC continually tracks and reports program outcomes in terms of rates of successful completion, employment placement, and job retention (Davis et al., 2013). These metrics create a constant feedback loop and provide SAWDC with quantitative information to identify improvement areas of the training programs. For instance, in the case of one training program, SAWDC data showed that the pass rate to qualify for training was only 50%, since many potential participants lacked fundamental math

and reading skills. In August 2015, AIDT collaborated with local employers to establish a foundational program to build these critical skills. Up to 60 people have already completed this pretraining—some of which have continued on to industry-specific workforce training (Laura Davis Chandler, personal communication, January 29, 2016).

SAWDC also considers K–12 career awareness a critical component of successful, regional workforce development. Though the council's central focus is on adult training, SAWDC remains involved in K–12 youth programs by establishing implementation partners such as the Mobile Area Education Foundation (MAEF). MAEF helped create a dual-degree credit program for high school students at a local secondary school with an aviation and aerospace specialization. Students can spend their junior and senior years taking courses at the two-year Alabama Aviation Center and participating in an internship in the aviation field. These partnerships allow SAWDC to maximize funding through complementary programs in

Figure 10.2 The Southwest Alabama Workforce Development Council, Region 9



Source: Recreated by authors from the SAWDC website: http://www.sawdc.com/about-sawdc/.

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the industry clusters, and avoid doing duplicative work (Laura Davis Chandler, personal communication, January 29, 2016; Davis et al., 2013).

SAWDC brings together key stakeholders from local businesses and industry clusters, local government, nonprofits, K–12 schools, and community colleges to target existing skill gaps between local employment needs and low- to moderate-income populations. Over the past 5 years, SAWDC has served over 1,300 jobseekers and 181 incumbent workers. SAWDC hopes to build upon these positive results by planning for future opportunities such as meeting the future training needs of aviation suppliers expected to locate to the region thanks to Airbus's new production site in Mobile (Quimby, 2016). By expanding existing regional partnerships, leveraging funding for potential programs, and tracking program outcome data, the intermediary approach of SAWDC continues to align training for the local labor force with the needs of employers in specific industry clusters and enhance the region's competitive advantage.

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* Research assistance for this study provided by Ashley Bozarth.

ECONOMIC DEVELOPMENTS 10.3
The Inverclyde Training Trust

The Inverclyde district of Scotland lies in the west Central Lowlands and includes the towns of Port Glasgow and Greenock. Shipbuilding was the area's major industry with 6,500 workers in 1981. By the end of the decade, however, fewer than 1,000 shipbuilding jobs were left (Fitzgerald & McGregor, 1993).

The workforce intermediary, Inverclyde Training Trust (ITT), was established in 1986 as a training placement agency. The leaders of ITT understood that, due to international competition, there was little chance that shipbuilding would return as a significant regional employer. There was a critical need to help displaced workers acquire new skills to fill vacant positions in local companies as well as to attract new businesses to the region (Fitzgerald & McGregor, 1993).

The ITT role as an intermediary training broker spurred local economic development by providing a stable system to match unemployed workers' individual needs with existing training programs available through the national and local governments, as well as the European Social Fund. As a freestanding training broker that promoted separate training programs, ITT needed very few internal resources to sustain itself (Fitzgerald & McGregor, 1993).

Surveys of ITT participants from the late 1980s and 1990s indicate mixed results from the training placement program. During this time, there was a 95%

completion rate, but only 50% of former shipbuilders and one third of participants from other industrial sectors found employment or pursued further education after the initial training. While only 50% of displaced shipbuilders considered their training helpful in finding employment, 91% indicated they would recommend the training to others. This positive perception may have to do with the soft skills participants acquired during the program. In fact, 33% of trainees emphasized personal confidence rather than job-related skills as the most advantageous takeaway from the training (Fitzgerald & McGregor, 1993). This increased confidence helped unemployed shipbuilders seek out jobs in new industrial sectors. The Inverclyde enterprise zone, which lasted from 1989 to 1999, worked in parallel with work training programs to attract businesses in new sectors. From the early 1980s on, tax exemptions offered within the zone attracted more than 30 businesses to Inverclyde, employing around 2,750 people. Many of the new companies located on redeveloped shipyard sites ("End of Inverclyde," 1999). As the ITT helped to enhance the skills of local residents, the enterprise zone was critical in providing posttraining job opportunities.

The ITT merged with other local organizations in the mid-1990s to form the Inverclyde Community Development Trust (ICDT). Known locally as the Trust, the organization continues the mission to "contribute to the overall economic development of Inverclyde by providing or creating jobs for people from disadvantaged groups or areas" (Development Trusts Association Scotland, n.d.). One ICDT department is "Trust Employability Services," which offers support through digital CV and online application workshops, digital job search assistance, interview skills support, job matching, and job training.

Although there is some overlap of services offered, unemployed residents receive training services separately from low-wage and/or underemployed workers. Some of the services for the unemployed include information technology (IT) training, goal setting, customer service training, social care skills training, youth employment support, and personal development workshops. Examples of current services for low-wage and/or underemployed workers include health and safety certification training for the construction industry, customer service skills, and first aid training. The Trust offers workshops in the classroom and through an online e-learning platform (ICDT, n.d.). It has formed various partnerships over the years with public sector organizations such as the Inverclyde Council and Objective 3 Partnership to deliver these employability programs (Development Trusts Association Scotland, n.d.).

The Trust was founded on the principles of creating employment opportunities for those affected by shipyard closures in the 1980s and has progressed to incorporate technology training and other services relevant to the community's needs today. The initial formation of ITT as a training broker rather than training provider, as well as its role as an evolutionary intermediary that supports residents' dynamic needs, has made it a long-term catalytic force of local economic development in Inverclyde.

ECONOMIC DEVELOPMENTS 10.4
The Mark of the Maker Movement*

Accompanying the "maker movement" has been the rise of "makerspaces" and tech incubators that provide individual entrepreneurs and start-up businesses the space, advanced hardware, and software to transform innovative ideas into tangible products. Makerspaces are popping up in old warehouses and industrial facilities, office buildings, and public spaces such as public libraries and universities. These transformative spaces have increased accessibility to innovative technologies and tools, previously limited to big companies, to local, creative minds that now have the means to fabricate products faster and more cheaply. 3-D printing, for instance, allows makers to transform digital designs to injection moldings within the same day. Besides access to products like 3-D printers, laser cutters, and specialized design software, crowdfunding through public-benefit corporations such as Kickstarter enables adequate funding for local manufacturing. Innovators present their ideas on Kickstarter's website, and viewers can choose to support and fund particular projects. According to Kickstarter's website, $2.1 billion has been pledged to individuals and small businesses. Once the makers finalize their products, local retailers and online craft manufacturing stores like Etsy provide the outlet for makers to market and sell the products (Tierney, 2015).

Artisan's Asylum is a nonprofit makerspace in Somerville, Massachusetts, established in 2010 by robot engineer Gui Cavalcanti and costume designer Jenn Martinez. The founders wanted to create a more affordable space for people with different talents and abilities to collaborate and access the fabrication tools and equipment necessary to make their envisioned products. Cavalcanti and Martinez chose Somerville, with the second highest number of artists per capita in the United States after Manhattan, in which to locate the studio. The fabrication center began in a 9,000 square foot facility with low-rent workspaces for 80 artisans. It is now located in a 40,000 square foot former envelope factory with more than 150 studio spaces and is one of the largest makerspaces on the East Coast. As of mid-2014, there were more than 400 active members.

Individuals can buy memberships to use 3-D printers, drill presses, and other industrial equipment in numerous shop facilities such as woodworking, welding, jewelry/metalsmithing, screen printing, electronics, and robotics. Membership includes access to shared work areas and equipment as well as invitations to speaking events, workshops, and product demos. Before using the equipment, certification is required, gained from either on-site training or previous experience. Artisan's Asylum offers training classes such as Introduction to Fermentation Workshop for beer making, Arts Marketing for Artists & Makers, Introduction to 3-D Modeling, Introduction to Leatherworking, CNC Plasma Cutter 101, and many more.

Individual makers at Artisan's Asylum can access funding to use the space in various ways. Crowdfunding has been a key approach to fund technological and design projects, and to date, Artisan's Asylum members have raised $4 million on

Kickstarter for such projects. In addition, $3.5 million in venture capital has been offered to start-ups (Kalish, 2014). Artisan's Asylum also offers seasonal grants to applicants with innovative project ideas to cover all membership and storage space costs and some course fees. One recent recipient got funding to fabricate toys for special needs children; another learned coloring techniques for steel. Companies ranging from new start-ups to well-established corporations can also become Asylum "Corporate Associates" if they sponsor their employees to explore, work, and create in the makerspace and benefit from private team training.

These company partnerships as well as space, equipment, and training courses accessible at a low cost have broken down barriers to local creativity and design in Somerville. Thanks to makerspaces like these around the country, manufacturing equipment previously located exclusively in large companies behind closed doors is now accessible to the public. In general, communities have taken advantage of these new opportunities and spaces to learn and grow. Since the foundation of Artisan's Asylum, for instance, the space has been home to 40 to 50 small manufacturing enterprises and manufacturing in Somerville has increased by 50% (Pierce, 2013). The maker movement is generating a new source of innovation and entrepreneurial activity to local economies. In doing so, it is adding diversification, a basic principle of local economic development planning. Further, it provides the possibility for the community to benefit from the scaling up and ultimately exporting of products from the most successful makers.

*Research assistance provided by Ashley Bozarth.

PLED PROBLEM SOLVING 10.1
Employment Planning as Economic Development

How does an older Northeastern city with a declining industrial base, high unemployment, uncoordinated federal economic programs, and a reputation for poor service in job training and placement overcome its handicaps and use its federal resources to build a job training and referral system that draws industry back into town, creates jobs, and wins the respect of private industry?

In Eastport, which has come a fair way toward achieving these goals, the answer rests in a combination of the city's commitment to provide real job service to the private sector and its determination to save neighborhoods by seeing that there are jobs for the people who live in them. Indeed, the key to the economic turnaround of Eastport is jobs—especially new jobs in the heart of the city to replace those lost. The blueprint for achieving this is Eastport's Employment Development

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Plan, with a realistic approach to urban planning and a coordinated use of federal funds. The plan's principal goal is creating jobs and assuring people's access to them.

The essence of the Eastport Plan is the coordination of the efforts of all the federal urban economic stimulus programs into one local agency used to build a base for both short- and long-term improvements in the city's economy. Federal funding for public works, economic development, and training and employment had been coming into the city under separate programs. The plan provides a means to combine these programs at the local level. Its goal is to create 14,000 new permanent jobs over 5 years.

The city of Eastport had some successful experience in downtown revitalization to draw on in putting together the plan. The city had already faced all the problems of many older cities—a declining inner-city tax base, movement of the middle class to the suburbs, increased demands for social services by those remaining, and a growing unemployment problem. As one response to its problems, the city chose to make a direct investment in the downtown waterfront, transforming this decaying and obsolete commercial area into a housing, commercial, and tourist center that has attracted national interest. The success of the downtown revitalization effort demonstrated to residents that the city could be made livable again. The city proposed to revitalize several neighborhoods. Residents, who had seen the downtown successfully restored, had reason to hope that the new plan might work in their neighborhoods.

One of the first steps the city took was to reorganize the city's various employment and economic development activities into a single agency, the Employment and Economic Policy Administration (EEPA), and to give it responsibility for providing new or expanding industries in the area with trained workers or federal job training program enrollees whom a firm could train.

Before the city could undertake job training and referral services for the private sector, it had a major handicap to overcome—its reputation for providing poor-quality employment services to those industries. Private employers felt that the city had provided inadequate job orientation services to the potential workers it referred. Many trainees had dropped out of the program in which they were placed, or the employers were so dissatisfied with them that they did not go back to the program for more. There were few links between the city employment program and the community organizations that understood the special needs of the cultural and ethnic groups living in the inner city, from which many of the prospective workers were drawn. Private employers felt that the city did not give a high priority to the services it provided.

The EEPA set out to correct this situation. The city sponsored a survey of employers to find out what specific problems they had experienced in the past and asked for their advice on how to improve the situation. One problem frequently identified was a lack of direct involvement on the part of the city officials in dealing with private-sector industry. To correct this, the city first transferred on-the-job training activities from the independent agency that had been acting for the city to

the EEPA. The EEPA then formed a coalition with the National Association of Business (NAB) and the Urban League to provide the close contacts among the city, jobs, and people, which were lacking before.

Later, the on-the-job training program of the EEPA formally merged with the NAB. The two agencies are now housed together, with each agency maintaining its own role in the employment process. The NAB staff aggressively approached the business community to find jobs for the economically disadvantaged. Firms that agreed to participate could hire individuals directly or through an on-the-job training program. The payoff to the firms is the screening, job orientation, and employability counseling provided to each person by the city agency before the initial employment.

One illustrative program is a training program underway to provide long-range training opportunities in the marine and computer fields. The harbor is the site of a major new industrial park that will provide jobs for 3,500 skilled and unskilled workers. Using a variety of funding sources, the city renovated and equipped one of the buildings in the park to serve as a job training center—the only vocational training facility directly linking the growing marine industry with a skills training program.

The center's staff identified specific highly skilled occupations that required no more than 10 months of training. They then verified the need for workers with these skills with the firms operating the Marine Industrial Park. Under the agreements entered into between a potential employer and the center, each employer must appoint a training supervisor to assist in the design of the training programs. Each of the participating firms must use the plan developed as the basis of the agreement with the job training center. The job trainees are trained either at the center or on the job site. All employers using the center's services must make a commitment to hire first the individuals trained through the center program. This has not been a problem, because the agreements provide for heavy employer involvement in the specification and design of the training courses in all skill trades with known labor shortages.

Eastport seems to be well on its way to a healthier job base than it has had in some time. But there is more to the plan than the link between jobs and economic development, although that is a key element. Through the strengthening of the city's economic base and by providing jobs to unemployed city residents, the city's leaders believe they will reduce the problems of crime, poor housing, inadequate health facilities, and inaccessible recreational facilities.

One of the most exciting features of the plan is the one providing unemployed workers with loans to start their own businesses. Under this program, the unemployed continue to receive their unemployment insurance payments for a full year with a supplemental payment while they start their new business. Participants must take up to 6 weeks of small business training before they open a business and become involved in the SCORE (Service Corps of Retired Executives) program for technical assistance to their new firm. The program has received a lot of criticism from local merchants who claim that their firms were not subsidized at the outset and these new businesses represent unfair competition. On the other hand, the

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program guidelines are relatively strict on the new firm competition area by restricting new start-up firms to business types not represented in the local community. What do you think of the complaints of the local businesspersons, and how might their issues be resolved if at all?

PLED PROBLEM SOLVING 10.2
Young Need a Job—Make Your Own!

Tung Ng was offered a job as a Vietnamese youth director by the Viet Family Life Center but wasn't sure if the ideas he had for the job would be acceptable to the organizers of the Viet Family Life Committee. That was 2 years ago, and Ng now draws $4,000 a month for work that has become a mission.

Ng's idea for the largely Vietnamese and Cambodian lower-income Crestview Park neighborhood was a program that would teach youngsters aged 14 to 21 about business, personal money management, and entrepreneurial savvy. Ng brought a lot of business know-how with him from Vietnam. He had worked for the U.S. Air Force in the Base Exchange. His family ran restaurants and variety stores in Saigon. He felt that the American born and raised Vietnamese and Cambodian youth were using their entrepreneurial skills to form gangs instead of starting their own businesses.

Ng started his program, called Youth Action, with only 20 youngsters. Based at a local center, the program is open to any child in the community. Only about 30% of its members belong to the Viet Family Life Center. Ng admitted Youth Action has many components similar to Junior Achievement. However, Youth Action is more professional because it is geared to help young people actually own and operate businesses in their communities. It also differs from standard job training programs because it doesn't teach them how to do a particular task in someone else's business. Youth Action shows youths how to develop "minibusinesses" of their own. They learn by attending a 10-week training program after school and on weekends. They also act as interns in jobs they can accommodate year round, after school, and on weekends.

At the conclusion of the training program, each youth has a business plan. These plans are screened by a panel of local Asian businesspeople. Those that meet the test of business worthiness are seed-funded with a grant of $4,000 and a small loan. The business must be in community-related areas and fit a community need. The youth cannot merely find a nice white-collar occupation outside the community as the answer to their problem.

"We live in a world where even many white-collar jobs in big and smaller companies are becoming scarce for experienced, educated adults," Ng pointed out.

"Asian youngsters must be trained early to turn their talents and skills into jobs they create for themselves."

The basis for Youth Action, said Ng, is "working to re-create historic values of building something for yourself and fostering a self-dignity, independence, and pride essential to long-term achievement." Ng hopes to expand the program if it continues to be successful.

The Family Life Center provides facilities for Youth Action activities but takes no money from them. All the money Youth Action generates is used to support its projects and for the youngsters' salaries. Members must give 15% of their earnings back to Youth Action. These funds are held in a trust account for each member's future education at the college or vocational level. A person who does not go to college forfeits his or her accumulation.

Since the program began, the teenagers have launched a prospering catering business, a computer training center, a web design service, a graphics business, a summer tutorial program for elementary school children, and an answering service. In addition to those ongoing services, Youth Action has sponsored several one-time projects such as yard sales, breakfasts, bake sales, and an ice cream store day (they made the ice cream at a local outlet and sold it). In the planning stages are a babysitting service, a Vietnamese and Cambodian book fair to encourage cultural restoration among inner-city youngsters, and a children's computer and electronic swap meet. To encourage sound money management, members must plan a personal budget and establish a savings account at the Korean-owned Community Savings and Loan Association. That bank was chosen, Ng noted, because he wants the youngsters to get in the habit of supporting local Asian business.

"The bank officers know them so well now that they've gone a long way toward establishing a sound relationship with a bank," said Ng. "I explained to them how important that will be when they're [old enough] to apply for credit and need good references."

Ng said, "I've found that most of these kids have lots of talent. They all have things they can do. If I say I need a sign made, or whatever, someone will say 'I can do it,' and they do it."

The adult board of Youth Action wants to consolidate all businesses under a single corporate or limited partnership status. The rationale for this move is that the business license and other procedures are too complicated and make business start-up more difficult than business operations. Several board members counter that this is the essence of the experience. Ng objects to this change. The cost of opening these ventures is time consuming and creates a liability for the Family Life Board. Assume the board has come to you as an economic development expert and asked you to chart an alternative plan for the youth businesses that is less expensive and reaches more youth.

Conclusion

We noted at the beginning of the chapter that human resource development incorporates workforce development and education. While workforce development has been a traditional focus in economic development, it has often operated as essentially a parallel system, and the two systems did not coordinate effectively. Consequently, the outcomes for economic development and workforce development were insufficient to promote sustainable local economic development (SLED). Education is also a critical factor to both systems' success. Quality education at the kindergarten through high school level provides the foundation for potential workers to receive training and to acquire additional certifications and education. Employers may reject locations that do not offer quality K–12 education because they don't think they will be able to secure the quality of workers they desire, or they won't be able to attract advanced employees to their location because such highly sought after workers seek quality schools for their children.

Horn et al. (2015) observed that "workers and employers . . . face new realities and uncertainties that current public policies and programs were not designed to address" (p. 1). For the practice of local economic development to advance, it will be critical for the education, workforce development, and economic development systems to work closely together.

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11

Community Economic Development

The difference between community development and economic development is often a source of confusion, especially for new students of local economic development planning. The confusion can be cleared up by noting that *community* development focuses on a broad range of development issues that include housing, business and job development, health and safety, and child development as well as education and other critical public services. Business and job development can readily be identified as components of the economic side of community development. However, it is important to understand the spatial scale at which the economic aspects of community development are addressed. As Ferguson and Dickens (1999) noted, "No one argues that community development can effectively counteract the business cycle or fend off major transformation in the macroeconomy. Neither can it compete with income-transfer programs as short-run responses to poverty" (p. 2).

Community economic development focuses on the neighborhood scale of socioeconomic transformation in a distressed locality. Community economic development seeks to improve conditions within a geographic area that is populated by the disadvantaged and unable to control its socioeconomic direction or resources, both human and physical. The development efforts focusing on improving internal conditions within the neighborhood may very well need to focus on strengthening linkages external to the neighborhood. Strengthening those linkages often entails the economic side

of community development by linking neighborhood residents to opportunities for work outside of their neighborhood as well as by attracting new investment and businesses (and therefore jobs) to the neighborhood.

Fundamentally, *community economic* development has a narrower focus within the broader community development sector that is aimed at improving conditions and overall quality of life in poor and working-class neighborhoods. William H. Simon (2001) has defined *community economic development* as engaging in "(1) efforts to develop housing, jobs or business opportunities for low-income people, (2) in which a leading role is played by nonprofit, nongovernmental organizations, (3) that are accountable to residentially defined communities" (p. 4).

He also has noted that the community economic development movement has spawned significant legal and institutional innovations. These include the use of peripheral legal forms such as charitable corporations and cooperatives (Simon, 2001). Further, one of the most significant innovations was the passage of the Community Reinvestment Act (CRA), which requires banks to demonstrate lending and business development in disadvantaged communities.

The community economic development movement has grown more sophisticated in recent years. For example, the Center for Community Economic Development (CCED) is part of a national network of organizations creating local-level Families for Economic Security (FES) projects. According to CCED (2008), the FES project is as follows:

> Broad-based coalition comprised of legislators, advocates, direct service providers and foundations who support policies that build economic security for families, elders, and the communities in which they live. We define economic security as having enough money to cover the basics like rent, food, child care, health care, transportation, and taxes, and enough money to develop savings and assets. Savings and assets are what allow people to weather the inevitable economic ups and downs of life, and to build a more stable future. CFES [Californians for Family Economic Security] advocates that policymakers use more realistic measures of what it takes to make ends meet as they develop policies and allocate limited resources.

Efforts such as that of CCED have proliferated over the past several years due to the failure of the general economy to serve the needs of particularly disadvantaged communities. These development initiatives aim to generate *socially useful,* and *labor-intensive* projects that meet their expenses or make a profit while improving the employability of the participants. They also seek to create greater local control and ownership in a community. Parzen and Kieschnick (1992) observed the following:

> Ownership is integral to the notion of economic development. It has become commonplace to describe economic development by citing the old parable that you can feed someone for a day by giving them fish, or you can feed someone for life by teaching them to fish. This may be true. But the twentieth century postscript to the story is that what really matters is who owns the pond with the fish. There is surely a difference between two communities, one with all of its tangible assets owned by distant investors and one with a significant degree of local ownership. The absence of local ownership implies either a lack of local capital or a lack of confidence in local investing on the part of local owners of capital—neither is consistent with a policy of economic development. (p. 5)

The basic objective of these initiatives is to teach people at the neighborhood level to own their own pond and to fish it. This is accomplished by the following:

- Generating employment for particular segments of a disadvantaged community
- Capturing local or neighborhood spending to build local wealth
- Inspiring self-help and cooperative group-oriented (social capital) assistance
- Operating programs such as health, education, and nutrition for the public benefit
- Providing an alternative or intermediate sector to create jobs in the local economy
- Promoting democratic management and local ownership and control of enterprises

Nearly all of the activities discussed elsewhere in this book can be undertaken as community economic development initiatives. Around two decades ago, Teitz (1989) warned those who espoused neighborhood or community economic development:

> Neighborhoods, by their very nature, are problematic as a target of economic development strategy, in so far as a strategy is intended to generate economic activity and employment directly within their boundaries. As the places where people live and work, neighborhoods reflect most clearly the conditions of life of their residents. Thus, they are a logical focus of advocacy and political mobilization. But the historic divorce of workplace from residents is now so far advanced in

ECONOMIC DEVELOPMENTS 11.1
Brownfield Redevelopment Principles to Prevent Neighborhood Gentrification

Most older and poor neighborhoods have brownfield properties that are especially difficult to redevelop because they have known or expected environmental contamination. Prior to being redeveloped, these properties have to undergo assessment and cleanup of the environmental contamination, which increases their cost of redevelopment. There has been a range of public efforts at the national, state, and local levels to foster the cleanup and redevelopment of brownfields, whether in poor or prosperous neighborhoods. However, since these efforts began in the mid-1990s, the main brownfield redevelopment focus in both the public and private sectors has been on the most marketable and larger properties that are well located (i.e., not in the poorest neighborhoods). The rationale for the public-sector focus has been to maximize return on public investment, while the private sector logically and appropriately has sought to maximize profits.

The remaining brownfield inventory is increasingly composed of small and medium-sized sites, many of which would be considered marginal redevelopment prospects by the private sector due to their locations, limited end uses, and profit potentials. But neglecting their redevelopment stigmatizes and devalues surrounding nonbrownfield properties and acts as a barrier to neighborhood revitalization. The neighborhoods in which they are located are left further behind those being revitalized due to a proactive redevelopment climate catalyzed by major public initiatives such as the U.S. Environmental Protection Agency (EPA) Brownfields Revitalization Act as well as "back to the city" and urban sprawl containment (or smart growth) strategies. Thus, there is increasing concern over how brownfield redevelopment practices can contribute to growing urban income inequality and displacement of low-income residents from gentrification. The four principles that are discussed next are proposed to ensure brownfield redevelopment policy and public funding do not help foster these undesirable trends:*

1. Focus on brownfields in neighborhoods with the worst health exposure and greatest need for economic development.
2. Require demographic and economic impact assessments of projects as well as displacement projections and prevention/redress plans.
3. Emphasize a neighborhood approach in any provision for communitywide multipurpose grants for use for both assessment and cleanup on multiple sites.
4. Encourage the development of workforce housing on appropriate brownfield sites.

Following these principles may seem especially daunting with the lingering effects of the Great Recession's devastating impacts on the real estate market. However, the urban real estate market is exhibiting strong signs of recovery in major U.S. cities. Thus, brownfields in the poorest neighborhoods may be experiencing gentrification pressures or continue to be overlooked, contributing to greater inequality within cities as a result. One potential resource to counter this is the U.S. EPA "Brownfields Area-Wide Planning (BF AWP) Program," which began in 2010 as a planning approach to community brownfield challenges in recognition "that revitalization of the area surrounding the brownfield site(s) is critical to the successful reuse of the property as assessment, cleanup, and redevelopment of an individual site" (U.S. EPA, n.d.).

*See Leigh, Nancey Green. Testimony regarding "Revitalization of the Environmental Protection Agency's Brownfields Program." U.S. House of Representatives Committee on Transportation and Infrastructure, Subcommittee on Water Resources and Environment, February 14, 2008.

American cities that localized economic development efforts face great difficulties. (p. 112)

Fortunately, the tide is beginning to turn for the exodus of jobs and businesses from central cities across the nation. Over the last decade, there has been a "back to the downtown" movement occurring in our major cities, due to the rejection of suburban living by certain demographic groups (e.g., aging baby boomers, young professionals) as well as firms seeking to avoid the costs of urban sprawl (Birch, 2005). This *could* be a very positive trend for neighborhood revitalization and community economic development efforts. However, there are legitimate and growing concerns over how this back to the downtown movement contributes to growing income inequality and displacement of low-income residents due to gentrification. Thus, this major socioeconomic trend has the potential to overcome some of the inherent barriers to neighborhood or community economic development that Teitz (1989) identified by bringing economic activity back to central cities. However, unless the tools of community economic development can effectively be brought to bear on this new trend, the neighborhoods that were the focus of community economic development efforts may look and work much better for their new residents, but their efforts will have failed to improve the standard of living for the original disadvantaged residents. See Economic Developments 11.1 for community economic development principles that can guide neighborhood revitalization when brownfields are present.

Table 11.1 Comparison of Organizational Forms of Community-Based Economic and Employment Development

Organizational	Objectives	Methods
Community development corporation (CDC)	Build community-level institutions	Community organization and business formation
Community cooperative	Community/worker producer control	Collective business
Local enterprise agency (LEA)	Unemployed/community business formation	Local resource mobilization
Employee/worker ownership	Worker control	Worker finance
Community employment and training board	Human resource development	Training
LEED for Neighborhood Development (LEED-ND)	Mixed-income communities	Development projects

This chapter will focus on organizational form and objectives rather than specific activities of community economic development. We focus on six organizational forms: (1) community development corporations (CDCs), (2) community cooperatives, (3) local enterprise agencies (LEAs), (4) employee/worker ownerships, (5) community employment and training boards, and (6) Leadership in Energy and Environmental Design (LEED) for Neighborhood Development, or LEED-ND. The sixth organizational form can be distinguished from the other five forms because of its spatial orientation. They are compared in Table 11.1.

Community Development Corporations

The CDC is an institutional form pioneered in the United States that has attracted the interest of European governments.

CDCs were conceived as part of the War on Poverty in 1966, when Congress authorized a demonstration program as an amendment to the Economic Opportunity Act. The legislation was vague, however, and the concept was still just beginning to take shape when the first CDCs started to receive federal funding in 1968. The early years of the CDC movement included a number of forays into ghetto development. Some basic principles

that still guide community-based economic development were formulated then—community control, a comprehensive approach, a focus on business and economic development—but at that time no one knew how to apply them. Those early years also saw a number of failures, but even so, CDCs began to take hold.

They have gradually made the sometimes subtle transition from antipoverty agencies to economic development institutions. Their management and investment strategies have become more sophisticated. CDCs have expanded their resources not so much through the original War on Poverty program or the later (now defunct) Community Services Administration as through other development programs, primarily in the federal government. To illustrate these changes, early CDCs concerned with community-control issues usually started and managed day-care centers, employment and training, and housing assistance as in-house enterprises.

Few early CDCs considered investing in start-up businesses and few CDCs now manage their own ventures (examples are real estate development and technical assistance efforts). Instead, CDCs tended to take minority equity and debt positions in proven (although often young) firms with experienced management. And although CDCs still select projects in response to community priorities, they do so within the constraints of market feasibility. CDC investments are risky, but in general they have become more successful with smaller investments. As a corollary to this trend, CDCs now work much more closely with the private sector—particularly small businesses and the financial community. Joint ventures with entrepreneurs, housing development syndications, and bank credit lines are now common CDC features.

The U.S. Senate Committee on Health, Education, Labor, and Pensions, in assessing the effectiveness of various ways of delivering federal job training programs, concluded that community-based agencies performed exceptionally well as economic institutions. Avis Vidal of the Community Development Research Center at the New School in New York provided a detailed assessment of CDCs in 1995. At the time of her study in 1995, CDCs had produced more than 435,000 units of urban housing and 115,000 rural housing units since 1980 and acted to stabilize many of the nation's most seriously distressed neighborhoods by promoting and financing home and business ownership. Moreover, CDCs were considered cost effective, which encouraged the Ford Foundation to create the Local Initiatives Support Corporation (LISC). LISC has produced several hundred million dollars in real estate and economic development activity nationwide by leveraging public and private development dollars.

A long-term and comprehensive approach to development requires an institution that can develop and sustain a consistent but flexible strategy. CDCs are such organizations, and they provide full-time professional staffs and at least some planning capacity. Although some CDCs may rely heavily on community volunteers for help, most of their projects require professional and technical skills. The CDC staff must be competent enough to develop housing and businesses in distressed communities avoided by the private sector. This formidable task requires full-time energetic professionals. CDCs usually have in-house planning capacity to deal with the land-use and zoning issues as well as long-term land assembly and affordable housing development. Good CDCs develop strategies that are coordinated, comprehensive, feasible, and responsive to community needs. Such sophisticated planning allows CDCs to go head-to-head with better-financed organizations.

Institutional Advantages of Community Development Corporations

Given the difficulty of developing low-income areas, the notion that community-based organizations have been able to succeed where others have failed or simply stayed away may seem difficult to accept. After all, where there is a market, it should be adequately filled.

CDCs succeed because they consolidate issues and organize capital to deal with market failures in low-income areas. That is, CDCs reestablish the economic and social structure of low-income areas. Banks and other institutions try to work on the economic issues but may not take social barriers into consideration. Vidal (1992) concluded that CDCs "make a major impact on the problems of poor neighborhoods" (p. 19). The financial success of a CDC project is due to sensitivity to both political and business practices. This necessarily demands a comprehensive and coordinated strategy, incorporating social, economic, and physical planning. Because of their purpose, structure, and approach to economic development, CDCs combine characteristics that make them unique institutions. They do the following:

- Use private development techniques for public purposes
- Target benefits to communities and individuals in need
- Mobilize local initiatives to address local priorities
- Take a long-term approach to development
- Link planning to implementation
- Link complementary projects within a comprehensive strategy
- Understand and work with the processes of both the public and the private sectors

- Have legal authority to attract both public and private resources in a variety of roles
- Work directly with small businesses
- Reinvest resources in the community
- Use incentives to operate programs efficiently
- Transfer capacity among program activities

These characteristics are not, of course, limited to CDCs. Other institutions, including local governments, often perform some of these functions. Moreover, not all CDCs have the capacity to do all these things well. But CDCs are extremely flexible institutions. They can complement the activities of other local participants, develop their capacity through the assistance of these other institutions, and take increasing responsibility for development. In most communities, this process can be cooperative rather than competitive.

A city government, for example, may be able to use its powers of eminent domain to assemble land and its bonding authority to attract private capital for development and then let a CDC develop and manage the project. In a rural employment training program, a local community college or the state's extension service might design a curriculum while a CDC identifies and screens possible trainees and then places them with employers after the training is finished. States can contribute to these local partnerships by identifying roles for different organizations and by supporting innovative arrangements.

Challenges for Community Economic Development

Community economic development in organizations has not enjoyed enormous success in this new era of finance. The best example of this transition is the downfall of the once powerful Eastside Community Investments (ECI) of Indianapolis, Indiana. ECI was the poster child of CDCs. In its heyday in the 1970s, it employed more than 100 people in a variety of community endeavors from housing to social services. ECI was a paragon of community activism and respect—one of the best examples of a CDC serving a distressed area of more than 28,000 residents. ECI had a housing corporation, a credit union, and health and community welfare services. It became a powerful community force, maintaining partnerships with Aetna Life and Casualty and Indiana National Bank with an available $1 million mortgage loan pool. As projects increased in size and offered opportunities to invest in housing and small business, ECI ran into a quagmire of financial red ink. In August 1997, ECI faltered and began to unravel (Johnson and Reingold, 2000).

Many CDCs were founded and organized for social, not economic development, purposes. As a result, their staff may not have the necessary skills for managing complex economic projects. They also lack the oversight capacity of a sophisticated board of directors knowledgeable in business ventures. The internal dynamics of community development institutions focus on social over tough business decisions. Community development organizations may place emphasis on increasing staff over increasing economic returns. Furthermore, the multiple funding sources with different reporting requirements make the finances of community development organizations complicated, as well as difficult to monitor. Finally, CDCs have no reserves or investment capital. As a result, any emergency can expose and unravel the entire fabric of the organization.

Community Reinvestment Programs

Community reinvestment is a social philosophy and a movement. Its aim is to replace capital that flows out of minority and disadvantaged communities by pressuring banks and other lending institutions to develop new lending practices for housing, businesses, and social institutions in low-income areas. The key to such reinvestment is the use of the CRA originally authorized in 1977, which states in part that regulated financial institutions "have a continuing and affirmative obligation to help meet the credit needs of local communities [in] which they are chartered . . . consistent with safe and sound operation of such institutions" (quoted in Squires, 1992, p. 11). In 1994, to further address credit scarcity in poor communities, the Community Development Banking and Financial Institutions Act was passed. This provides for grants, loans, equity capital, and technical assistance to community development financial institutions (CDFIs).

Thus, community reinvestment straddles an ideological dilemma of finding good loans in impoverished neighborhoods. Proponents of this movement have helped to devise a number of coalitions across the nation designed to identify neighborhood goods, such as housing, and match them with qualified minority or community-based institutional borrowers. The community reinvestment movement has had some impact on reducing redlining and other adverse lending practices by major financial institutions. For example, it has spawned a new finance industry that seeks low-income lending opportunities and has gained enormous impetus with the tightening of the community reinvestment legislation in 1997. Banks seeking mergers must show that the mergers will not do harm to low-income areas and show a record of low-income community investments. As a result, more capital is seeking low-income opportunities than is available for the banks.

However, even its strongest proponents acknowledge that good investment opportunities able to meet the test of the law are difficult to identify. Moreover, enormous racism and selectivity remain in lending practices in the financial community. One response to the lack of community-based financing in minority communities has been the emphasis on the creation of nontraditional lending institutions such as community credit unions. Another answer to this dilemma is the development of CDFIs. Some CDFIs operate like traditional retail banks while others are community development organizations or credit unions that provide business-, home-, or other forms of asset-backed lending. The major difference between CDFIs and other lenders is that they are actually involved with their borrowers. They provide technical assistance and identify other lending sources, such as government funds, to enhance the borrowers' opportunities for success.

Community Cooperatives

Until recently, cooperative ownership was largely restricted to primary industry. But interest has grown in this form because of its labor-intensive character and its democratic management potential. Further, the themes of community economic development "have a distinct affinity with the cooperative form" (Simon, 2001, p. 130). The primary foci of community cooperatives in the United States are job creation, housing, and credit.

Cooperatives are owned by their membership. According to the University of Wisconsin Center for Cooperatives (www.uwcc.wisc.edu), cooperatives have seven internationally recognized principles as the basis for doing business:

1. Voluntary and open membership
2. Democratic member control
3. Members' economic participation
4. Autonomy and independence
5. Education, training, and information sharing
6. Cooperation among cooperatives
7. Concern for community

Several general situations give rise to the formation of community cooperatives, including the following:

- When a business owner wishes to sell to a community group in order to continue serving the community

- When a community service such as child care, elder care, or other care requires delivery
- When a group of skilled people who are underemployed or unemployed form an organization to sell their services collectively for community benefit

In each case, the steps for forming a cooperative are the same. First, a feasibility study needs to be conducted to ensure that the activity has real potential for success within a cooperative framework. Second, the organizational structure should be well thought out. Ownership shares, leadership, and similar matters need careful early discussion. Although there may be early enthusiasm for cooperative forms, this may quickly subside when people understand the system's rules. Finally, intensive training needs to be given to help the participants adapt to the new system.

Cooperatives require business plans as well as feasibility studies. Such work should at least provide answers to questions on the following topics:

Product Specification

- What evidence is there that a market exists for the product or service to be provided by the business?
- Are there similar products on the market or services available? If so, is their local business, with which you will be competing, offering the same product or service?

Workers

- Are the workers sufficiently trained in cooperative management?
- Is there a real balance of skills among the workforce? Cooperatives will not work if there are differential skill levels.

Premises, Equipment, and Materials

- Are there low-cost premises available for the initial start-up?
- What transportation cost will be incurred in operating the venture?
- What are the sources of supply? Are they all under the cooperative's control? For example, is the cooperative selling products made by members or community groups?
- Can the cooperative obtain the necessary credit and access to capital to operate the facility?

Management Skills

Are there sufficient management skills in the group to provide for the following?

- Designing the product or service
- Organizing the production or distribution
- Handling the banking and finance
- Marketing

The cooperative is a recognized legal form, and in most states it has to be incorporated under the appropriate state statute to engage in business. Most states have statutes specifically governing cooperatives. Cooperatives can take advantage of a variety of public and private support, which includes favorable federal tax treatment, as well as access to credit from the National Cooperative Bank (Simon, 2001).

Local Enterprise Agencies

LEAs are organizations dedicated to the creation of employment through the support and development of indigenous local enterprises, providing an intermediary link between public and private institutions and the community. They function primarily by facilitating access to capital and technical or professional assistance. LEAs are usually formed by a coalition of local business unions and government, along with community-based organizations. They facilitate nonprofit distribution that may or may not set up profit-making subsidiaries.

The primary functions of LEAs are to do the following:

- Provide extensive advice and services for small business entrepreneurs through a permanent organization
- Provide complementary services that assist new businesses to get started by securing finance and technical assistance
- Build confidence in the total community by forming new networks of professionals and grassroots groups
- Improve local marketing capacity of new firms or existing firms

Employee/Worker Ownerships

Employee/worker ownerships are a recent phenomenon. They are a potential response to pending firm closures. Workers and community groups

become interested in assessing whether the companies can succeed if they are taken over by the workers. Not all company closures are due to failing business. Sometimes a company can be part of a larger portfolio of a diversified corporation that has realigned its strategic focus and the company does not fit with the new perspective. There are several legal structures that may be explored in this type of project. The two better-known examples are employee stock ownership plans (ESOPs) and worker cooperatives.

Employee Stock Ownership Plans

ESOPs allow a company to establish a trust in order for it to be purchased. The trust acts as fiduciary agent for the firm's purchase using stock issued to the employees. Employees purchase shares through a combination of wage reductions, actual cash, and borrowing. Over the years of the plan, employees acquire vesting rights to their stock. All stock owned by an employee is resold to the company in the event that the employee leaves the firm or retires. The steps for forming an ESOP are as follows:

1. An employee corporation is formed.
2. The trust is formed and an ownership plan drafted.
3. ESOP borrows capital for equity contributions and operating capital.
4. Financial requirements are determined for the purchase of shares and to build equity accounts.
5. A debt service plan is organized.
6. The employee management structure is established.

State and federal laws govern the technical aspects of stock issues and trusts. These technicalities require close study by attorneys and other professionals because there are many potential pitfalls. Most ESOPs are likely to be in closely held rather than publicly held companies and provide an average of 10% to 40% of total company stock and limited voting rights, but the plans can be used to create majority employee-owned, democratically structured companies (Rosen, 1989, p. 258).

Worker Cooperatives

In worker cooperatives, the employees remain employees as such but are joint owners of the enterprise. Shares are issued to all of the employees, and these are reinvested for the firm's growth and development. Allocation of income at the end of the year is determined by weighted votes of employees,

usually based on years of service. That is, an employee with 3 years of service has more votes than a new employee.

A worker cooperative differs from a conventional business, however, in that membership rights are personal rights, assigned to the people working in the company because they work there. In other words, the workers' voting and profit rights can never be bought. In a conventional business, by contrast, membership rights are transferable property rights attached to the shares of stock. The shares may be sold to any person who has the cash to buy them, and the person need not be connected with the business.

In worker cooperatives, the workers are the owners. The division of duties and responsibilities in such a system must be considered carefully. Not all employees may bring equal skills or talents to the firm. As a result, serious ruptures may occur in the democratic management process. Some members of the worker cooperative may not end up with a meaningful say in how firm development is carried out in their name. For this reason, staff development requires continual consideration.

Leadership in Energy and Environmental Design for Neighborhood Development

LEED-ND is a program created by the U.S. Green Building Council (USGBC). It extends the focus on creating green buildings that was the original motivation for the council's establishment. USGBC created the LEED system to foster a more sustainable built environment by providing "building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions" (USGBC, 2012). USGBC developed a rating system that measures how a building's location, construction, and operating systems can lower costs, reduce waste going to landfills, reduce greenhouse gas (GHG) emissions, conserve energy and water, and increase the health and safety of its occupants. Buildings receive ratings ranging from silver to platinum based on the extent to which they achieve the criterion. The LEED system has different metrics for new construction versus existing building retrofitting.

Prior to the creation of LEED-ND, the LEED system influenced developers to build or redevelop in a more sustainable way that benefited the building owners (in reduced operation costs and other financial impacts) and the building's occupants. LEED-rated buildings could appear in community neighborhoods needing new development, but their relationship to the neighborhood was not a consideration. Their presence could add to gentrification, the jobs–housing imbalance, or traffic and carbon emissions. The LEED-ND system creates higher expectations for the impacts of buildings

and multiple building projects, specifically for their impacts on the surrounding community. It encourages building projects that protect and enhance health, the environment, and quality of life. The rating system defines the criteria for which points are given for projects that protect and enhance the overall health, natural environment, and quality of life in a community. It promotes the location and design of neighborhoods that reduce vehicle miles traveled (VMT) and create jobs and services that are accessible by foot or public transit.

In its rating system, LEED-ND specifies points for projects that create mixed-income communities. It specifically states its goal is "to promote socially equitable and engaging communities by enabling residents from a wide range of economic levels, household sizes, and age groups to live in a community" (USGBC, 2012). While the way in which it seeks to create mixed-income communities is limited to requiring the building of housing for different income levels, this provision has the potential to make a significant contribution to community economic development through the provision of affordable housing in combination with its goal to reduce jobs–housing imbalances. LEED-ND is a notable effort that seeks to transform private development and was conceived by a private–public partnership of multiple organizations (see Figure 11.1).

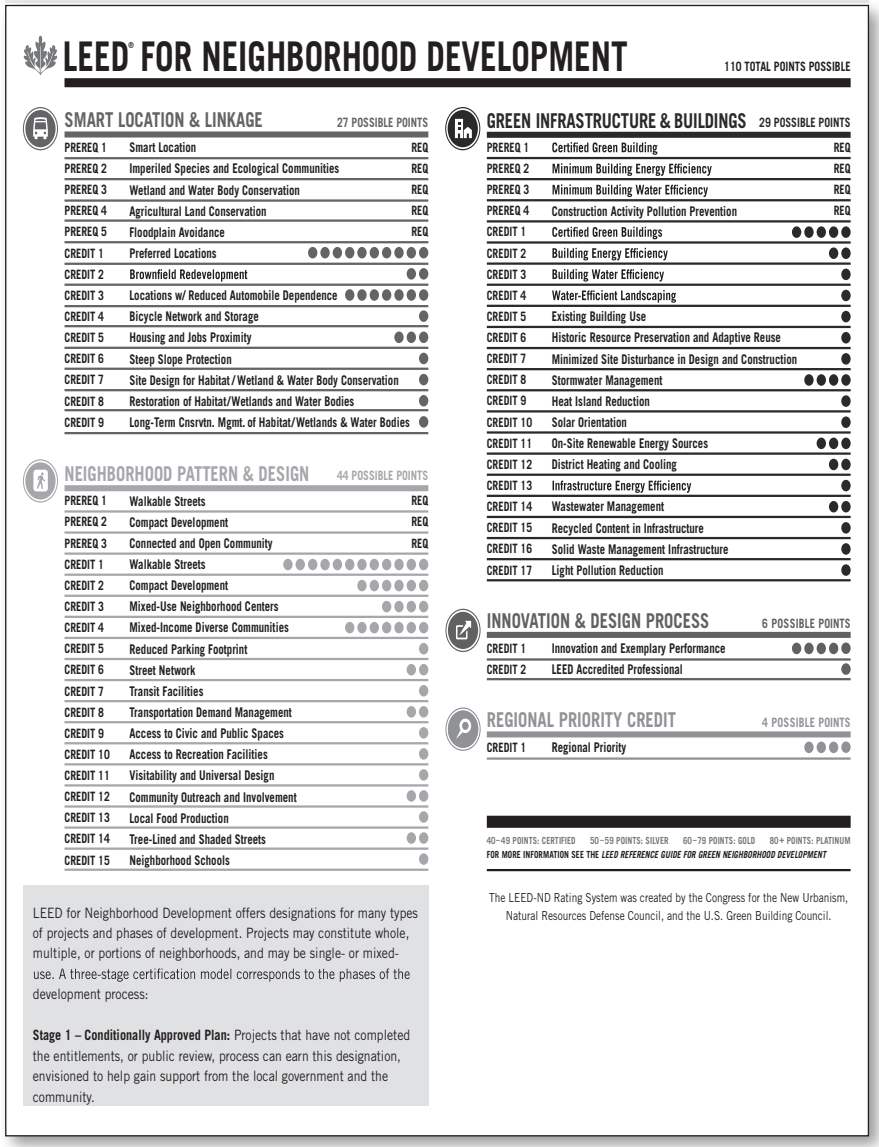
Targeting and Marketing Neighborhood/ Community Assets

Marketing a community is very much like marketing a product. Product and market research are employed to determine what type of assets a community has to offer, in what markets, and to what type(s) of clients. For maximum effectiveness, the community should be marketed only after determining the likely buyers of its resources—for example, tourism, where purchasers may be domestic or foreign. A community should develop knowledge of its marketing audience: What do they read? What appeals to them? How can they be reached? These questions are even more appropriate in industrial or commercial economic development. The market depends on who the community is trying to reach. This is true for individual projects, attraction efforts, and financial assistance for local projects. The fundamentals of target marketing are relatively straightforward. These are listed next.

Identification of the Community's Long-Term Goals

The level of long-term growth must be gauged with respect to overall population and/or jobs that a community is targeting. For example, to

Figure 11.1 LEED for Neighborhood Development



Sources: USGBC (2012).

produce a job growth of 3% per year, an international audience may be the most likely target audience. Smaller, growing firms, however, may be more appropriate for a community that prefers more limited or controlled development.

A balance among different segments of industrial, commercial, and community-based activities may be desired as well. This balance determines what types of marketing efforts are undertaken and how vigorously they are pursued. In addition, knowledge of the existing infrastructure will influence the development alternatives examined. In fact, it may be impossible to select certain targets without a long-range infrastructure plan.

One of the best examples of how a community has organized and projected its resource base is the emergence of Emeryville, California, as the nation's premiere biotechnology center. Emeryville, with a population of around 10,000, accomplished this by concentrating its infrastructure development on the requirements of the new biotech industries.

Marketing of the Community

Any marketing of the community must depict it as it is and the genuine opportunities it presents. Glossy brochures and rhetoric will not help market a community. Major manufacturing firms have their own in-house research staff, so they are not deceived by false advertising. Dissemination of misleading information will seriously damage an area's reputation.

The type of communication selected must appeal to the community's potential clients. If the prospective clients are Japanese businesses, information in one of the Japanese newspapers or magazines will reach this client base better than brochures written in English and hand-carried by the local mayor or community leader to the Japanese consulate.

Scientific or trade journals may be an even more important source for businesses than brochures or similar public relations efforts. If you want to get the attention of firms' managers, do it through the reading material of the senior executives. Whereas CEOs may read the *Wall Street Journal, The Economist,* or the *New York Times,* they seldom read brochures.

It is important to know the industry being recruited. Neighborhood or community leaders need to know some general details about the type of firm likely to visit the community. Many industrialists or would-be entrepreneurs have been discouraged by the seeming lack of interest in, or shallow responses of community leaders to questions regarding the industry and its requirements.

Manufacturing firms are not the only focus of community and neighborhood marketing and recruiting efforts. Many communities feel that to be competitive and perceived as offering a high quality of life, they need to offer strong services in the form of retail and health care businesses. For example, communities that have been overlooked by some of the major retail chains have developed specific recruitment efforts aimed at them. They may also target the recruitment of medical and health care professionals.

Incentives and Community Benefits Agreements

Incentives should be packaged to meet the needs of the firm or individual entrepreneur a community is trying to attract or encourage in the area. Financial incentives are seldom as important as a good business climate, strong retail potential, available research facilities, appropriate space at reasonable rates, adequate infrastructure, and a proactive local government with a flexible approach to incentives.

A community should list available assistance and resources as well as location information. Communities often publish promotional material with no information on who to contact for further details. As a result, they have missed sales simply because of poor communication. The entire community needs to be involved in promotion. (There are many stories about uncooperative staff giving a negative impression to visitors in casual conversations.)

At the same time, business being recruited to a community, or even just looking for a location to land, has come to see the offering of incentives as the norm rather than the exception. Many communities have found out the hard way that the incentives offered do not always warrant the benefits gained from the new business. The level of jobs promised may never materialize, or the jobs go to employees brought with the firm rather than to those in need in the community. The burden on existing infrastructure—water, energy, and transportation—may degrade levels of service for the rest of the community. In recent years, the use of community benefits agreements (CBAs) has begun to proliferate. These are legally binding contracts negotiated by the community with the new business that can spell out who gets the jobs created, who pays for infrastructure, and other contributions the new business or development may make to improve the overall community.

The Community Prospectus: A Means of Communicating the Qualities of Your Community

Many communities invest in general promotional brochures. Although these may be helpful, they seldom attract a firm. Because targeted marketing requires establishing the specific feature identification required by an industry or certain type of firm, the best means of communicating to firms is through the community prospectus. This material acts much like a firm prospectus and allows the buyer to know what the community is offering and what opportunities are available.

The prospectus should describe the community assets and business opportunities in terms of industrial and market potentials as well as community trends over the past few years and expected future trends in commercial and

industrial opportunities. It should also relate any national economic or social trends that may affect a venture's potential in the community. Moreover, it should include a section on the community's research and development (R&D) capacity, infrastructure plan, and financial assistance program.

The R&D capacity section is one of the most important components of any community prospectus. Access to higher education institutions, research laboratories, or facilities offering scientific knowledge and/or trained personnel is vital to almost all industries. It is important to describe the nature and extent of the scientific efforts in the area that relate to business, industrial, or agricultural products and services.

In addition, other private sector research or advanced facilities or equipment should be described as well as any major products, scientific breakthroughs, or well-known researchers resident in the area. Of course, very few communities have such resources within their boundaries, and most communities would benefit from projects that improve their R&D capacity in defined areas that complement their development strategies.

The *community infrastructure plan* section of the community prospectus should discuss the community physical infrastructure—location and buildings—along with specialized equipment and personnel (other than management) available to prospective businesses. It should describe what the community's industrial or retail or commercial space availability is in terms of specific venture requirements. For this to be effective, suitable building sites should already have been located and fully developed. If a site has been selected, describe it and how it meets the venture's needs, the businesses surrounding the site, whether the site and any buildings on it will be bought or leased, and the reasons behind these decisions.

The infrastructure discussion will cover slightly different topics, depending on whether the venture is manufacturing, retail, or service. Existing plans should be examined for the targeted businesses. Infrastructure descriptions for both retail and manufacturing should list the availability of water, power, and waste removal as well as any environmental constraints and existing transportation systems. Telecommunications is an especially important infrastructure component and needs to be assessed carefully. Today, optic cable, international switching, and data-transmission facilities such as teleports are as important as water and sewerage capacity. Manufacturing discussions should also address the availability of industrial space at reasonable rates and whether facilities are available on a short- or long-term basis.

The description of human resource availability should include what kind of labor can be obtained locally for the type of venture sought. This section should also discuss the executive and managerial skills available in the area, as well as the general labor supply. If training is required, there needs to be a discussion on how it will occur and the associated costs.

The *financial program* section of the community prospectus is the last section because it is based on the information in the earlier sections. It should offer plans to improve the critical gaps in the community infrastructure as well as offer specific financial assistance for the desired type of firm. This section should, of course, make note of the financial programs available; these include initial financial assistance, venture capital, debt financing, and other specialized funding. Additional community funding or special arrangements for access to local capital should also be described.

Local Government's Role in Community Economic Development

Local governments can take an active role in stimulating and supporting community economic development by doing the following (see Economic Developments 11.2):

- Developing revolving loan funds and similar financing as seed capital for community projects
- Examining means to subcontract to community groups the delivery of community services or the operation of community facilities
- Developing work spaces and facilities for community groups to commence enterprise activities
- Identifying surplus or underutilized local government equipment that might be used by community groups
- Establishing a network of people or service clubs that can provide technical assistance to community groups
- Making community-based initiatives a component of the overall local economic development strategy
- Helping communities negotiate CBAs

Conclusion

As we stated at the start of this chapter, community economic development focuses on the neighborhood scale of socioeconomic transformation in a distressed locality. The need for effective community economic development became even more acute due to the devastation the subprime mortgage crisis wreaked on neighborhoods throughout the United States. Local economic developers are called upon to improve the capacity for these smaller geographic areas and their populations to withstand the buffeting of national and international economic trends as well as local restructuring.

ECONOMIC DEVELOPMENTS 11.2
East Gateway District: Bridging the Gap Between Community and Economic Development

The East Gateway District is a neighborhood in coastal city Clearwater, Florida, located 30 miles west of Tampa. As seen in Figure 11.2, the neighborhood has 2,871 residents, or 2.6% of the city's population. East Gateway has a diverse population that is half White, one third Hispanic, and a little less than one quarter Black. Median household income is low at $31,038, and about half of the residents are employed. East Gateway lies in Pinellas County, which is known for its high concentrations of poverty. According to the 2012 Economic Impact of Poverty Report by the Pinellas County Board of County Commissioners, 11.6% of county residents live at or below the federal poverty level. The county's poverty rate costs an estimated $2.5 billion annually for funding for jails, hospitals, homeless populations, and lost wages due to high school dropouts (Warren, 2013). The county and city of Clearwater recognized that rather than reacting to the consequences of high poverty rates, investing resources into poverty prevention through quality education, stable employment, affordable housing, and accessible health care would be more socially cost effective over time, according to Geri Campos Lopez, director of economic development and housing for the city of Clearwater (2016).

Figure 11.2 East Gateway District and Extended Study Area Markets

East Gateway Community	Extended Study Area
MARKET SIZE	**MARKET SIZE**
Population: 2,871	Population: 11,703
Households: 1,219	Households: 4,669
MARKET BUYING POWER	**MARKET BUYING POWER**
Median Household Income: $31,098	Median Household Income: $39,417
Average Household Income: $41,115	Average Household Income: $46,019
Aggregate Income: $50,119,618	Aggregate Income: $214,860,000
Income per Acre: $205,501	Income per Acre: $133,678
Income of New Home Buyers (2009): $41,231	Income of New Home Buyers (2009): $46,280

Source: Lopez (2016).

Throughout the early 2000s, economic development in Clearwater primarily focused on redevelopment of the downtown and shoreline areas. The Economic

(Continued)

(Continued)

Development and Housing Department and the Community Redevelopment Agency (CRA) wanted to reprioritize funding and attention toward targeted neighborhood improvement, one of which was the East Gateway District. The city and CRA sought to address neighborhood issues of crime and safety, run-down appearance, weak business environment, economic growth and housing, and the need to integrate the Hispanic community. Outreach efforts were stymied by a lack of funding, low private sector involvement, the Hispanic residents' language and cultural barriers as well as general distrust of government. In 2008, the East Gateway District Task Force, made up of city staff from multiple departments, formed a Five-Year Action Program aimed at engaging residents and business interests, revitalizing to increase economic stability and private property reinvestment, and establishing a greater neighborhood pride and identity. The action program identified funding sources for projects, formed a steering committee, and developed regional partnerships (City of Clearwater, Florida, n.d.; Lopez, 2016).

The Five-Year Action Program has generated a number of revitalization accomplishments. The CRA Facade and Building Lot Improvement Program, seen in Figure 11.3, offers loans or grants to commercial property owners to improve the appearance of building exteriors. The Sidewalk Improvement Program is focused on identifying streets lacking pedestrian pathways and adding sidewalks to make neighborhoods more walkable. There has been strategic property acquisition and development of derelict property. The site of a previous rundown Economy Inn Motel is now a 15,000 square foot community garden (Leone, 2015). Funding has been allocated for increased police presence in the district. Finally, the incorporation of multicultural celebrations into the action program has increased involvement of residents and businesses in the revitalization process. Both the East Gateway Hispanic Festival and the Mexican Independence Day events have helped the task force to gain residents' trust of government efforts (Lopez, 2016).

Figure 11.3 Facade and Building Lot Improvement Program

Source: Lopez (2016).

The East Gateway District Task Force has identified several lessons for economic developers working to address similar neighborhood issues. Forming

partnerships, such as with the CareerSource Pinellas workforce board, the Mexican consulate, and the Hispanic Outreach Center, creates a more inclusive and holistic approach to economic development in the district. By gaining resident trust through these partnerships and various social events, the task force and partnering organizations were able to be more effective in outreach to address the needs of citizens. The task force successfully implemented programs by layering funding sources, such as Community Development Block Grants (CDBGs) for the facade program, tax increment financing (TIF) for community policing and land acquisition, a County Health Department grant for a farmers market, and a capital improvement program called "Penny for Pinellas" for infrastructure improvements (Lopez, 2016).

Following the implementation of the Five-Year Action Program, the CRA hired a firm to conduct a neighborhood market/economic analysis to define the financial basis for market-supportable revitalization efforts (Gensler and Social Compact, 2012). With this analysis, the city and CRA were able to tailor programs to the area's strengths and build on its existing assets. The study determined that the district has a population density twice that of both an extended study area and the entire city. Even though median household income was 27% lower in the East Gateway District than the extended study area in Clearwater, income per acre was actually 54% higher. East Gateway is also home to many entrepreneurs and small businesses: 81% of the 201 businesses have five or fewer employees. The concentrated population and income of neighborhood residents as well as the numerous wealth-generating microbusinesses generate a higher-than-average buying power in the district.

The amount of retail, grocers, and restaurants in the district, however, lags far behind neighboring districts in Clearwater. The analysis addressed this "under retailing" by recommending more mixed-use development and small businesses, such as local, unique apparel shops to fill potential retail space in walkable areas that could attract the rising number of visitors to the Clearwater area (Gensler and Social Compact, 2012). In its latest effort, the East Gateway Task Force is investigating the potential of developing a *mercado* (Spanish for *market*), a mixed-use building to house local vendors focused on the Hispanic market as well as a microbusiness incubator, commercial kitchen, and tourism-oriented attractions and retail (Lopez, 2016).

Clearwater's Department of Economic Development and Housing and other city agencies are proactively focused on reducing poverty and its associated high public costs through economic and community development. With careful analyses of economic and demographic characteristics and engagement of the East Gateway neighborhood, they were able to identify strategic initiatives for redevelopment. Applying inclusive collaboration and trust building since the beginning, East Gateway District's revitalization efforts started small and are slowly building to become a model for longer-term sustainable development.

Acknowledgments: The authors gratefully acknowledge Geri Campos Lopez for bringing this important case study to their attention and also the research assistance of Ashley Bozarth, Georgia Tech City and Regional Planning master's student.

PLED PROBLEM SOLVING 11.1
Workers as Owners

On a late autumn evening in northeast Franklin, a bookkeeper and a couple of stock clerks could be seen through the plate glass windows of the ComUNITY Sports store. For everyone else, work had ended. But for ComUNITY Sports' directors and stockholders, sitting on empty running shoe boxes and sports equipment crates, the day had only just begun. The president, Joe Offer, called the meeting to order, and soon the group was engrossed in a spirited debate on product mix. Some people advocated cutting the price of ski equipment early in order to stimulate sales in all of the city's ComUNITY Sports outlets. This had been a very successful tactic of the old management. Several people objected to this proposal simply because it was the old management's idea. "Who wants to be associated with management that was forced into near bankruptcy on a nationwide sporting goods chain?" Another hot topic was corporate directors' liability. Both topics were being pursued in heated debate.

At this point, Jim Schader, then board secretary, spoke up. "Dun & Bradstreet's asking for details on our financial status," he said. "What's our policy on giving out this type of data to investment services?"

No policy existed, but there were plenty of opinions both on the point and at some distance from the actual task at hand. When no consensus was forthcoming, Offer finally expressed what turned out to be the majority view. "Our credit's good," he said, "and we will provide it because it will be good for us to cooperate early in order to get the best credit rating possible when we need it. We are directors and the only stockholders of the company."

And an unusual company it is. Until last year, the store in which this meeting was held and 10 others in the city of Franklin were combined with a chain of more than 200 discount sporting goods stores. The company had prospered in the 1980s when discount consumerism was rampant, but the whole chain was in danger of collapsing by the time the employees made an offer to take over the entire West Coast division of the company and break it up into smaller city-based retail outlets separately managed by the workers at each store but under an umbrella corporate structure. Today, the ComUNITY Sports stores claim that weekly sales are 20% above those of other retail clothing and equipment chains; the Roslyn store sales are up 40%.

"It's *our* store," said Faith Mason, ski sales manager for all of the ComUNITY Sports stores. "We all feel that way about it. Owning the company gives us more incentive to make it a success. We're putting in about 80 hours a week—40 as workers, 40 as owners. And guess what? I actually *enjoy* coming to work. There will be more store systems like this one. It's a great program and too good an idea not to spread."

Yet support for employee ownership was not universal at the time it was proposed. In Franklin, for example, Cornell Young, a labor leader, encountered criticism

when he first explored worker ownership a few years ago. "An executive at ComUNITY once told me it sounded like socialism to him," Young said. "But I said we just wanted to organize stores the way he and his friends had originally started back in the late '60s when they were radicals at Berkeley—everybody pays into a kitty, you elect some directors, you hire a manager. What's socialistic about that; that's exactly what they did before they joined the country club set."

Young has served for years as president of Local 357 of the United Retail Sales Union (URSU). The membership of Local 357 peaked at about 9,000 in the mid-1970s, after which the depressed economy forced a string of sporting goods retail stores to close, which cost the union more than a quarter of its members. The crowning blow was when Pacific Tex, the conglomerate that spun off ComUNITY as part of its profit center in 1977, decided in 1981 and 1982 to shut down 14 of its West Coast–area stores, idling nearly 400 URSU workers as well as members of a smaller textile union. The Pacific Tex had closed more than 150 stores in 8 years—65% of its nationwide chain—and its losses in 1981 exceeded $30 million.

In many respects, it is a unique and unprecedented agreement. Workers obtain ownership of a segment of the company and the right to buy in the future as well as more authority and responsibility. It provides an avenue to learn management skills and provides a legal property claim—a right of first refusal to purchase stores from the company, so it cannot be bid up competitively and sold off to someone else. This arrangement creates an important source of worker-controlled capital—perhaps as much as $1.5 million a year at first, with more as time goes on—to finance incentives and investments in employee-owned enterprises.

Pacific Tex officials acknowledge that their main interest was and is in the stores they kept, not the ones they gave up. Without making judgments on the sales potential of the stores, they do characterize them as "experimental." According to one company official, the agreement reflects "a sharing of objectives with the union. U.S. business and communities have to find ways of working together and stop fighting with one another; that's the only way we can be internationally competitive."

Even while this experiment is underway, the directors of ComUNITY need to consider diversifying beyond sporting goods into men's and women's clothing lines imported from China. Since the union has gone on record as "Buy America," this is not an easy decision. But if a move is not made soon, the managers fear the ComUNITY experiment will disappear forever. This is a tough issue. The employer/owners feel that selling foreign goods will hurt local workers.

The board doesn't know how to raise this issue with the membership or the impact of failing to compete in a global marketing system.

The board has called you and your team as consultants, and they want your advice on how to keep their experiment going.

PLED PROBLEM SOLVING 11.2
A Community Finds a Business

Lakes Alternative Energy Board (LAEB), a community development corporation (CDC), is composed of three community action agencies (CAAs) involved in alternative sources of energy. This partnership will simultaneously bring in revenue to the community, create jobs, and provide low-cost fuel to area residents.

LAEB serves the Lakes area, which is known for its high unemployment rate and high percentages of elderly residents and families with incomes below the poverty line. The area has been hit severely by the collapse of the two traditional sources of employment and revenue: the iron mines and the lumber industry. Fuel is also a primary concern in the region, with its 120-inch annual snowfall and temperatures below freezing for two months of the year. Fuel costs are high: many of the Lakes' elderly clients spend about half their income on fuel.

The first venture is the use of wood pellets as a fuel source, which will eventually lead to the building of a wood-pellet-processing plant in one of the nine counties served by the four agencies. This mutually beneficial venture illustrates how CAAs can turn their nonmonetary assets into an effective base for the creation of community economic development projects.

Another project was to have been the construction of live-in demonstration models of energy-efficient houses: retrofitting existing housing, developing wood-based insulation materials, and producing low-cost stoves. At the time, though, the energy crunch was not a hot topic and the proposal was turned down.

LAEB has been incorporated by the three CAAs. It is investigating new, alternative energy sources with economic development potential.

The goals of LAEB included analyzing the use of wood refuse and small streams on farm property as an alternative fuel source, especially for low-income people; promoting the use of alternative fuel sources; and creating—and keeping—jobs in the wood industry through the private sector. The intent is to develop a low-cost fuel that can be used by both commercial and residential energy systems.

LAEB has stressed to Lakes residents that it is not in competition with the private sector; rather, it sees its function as a catalyst for local economic development. LAEB staff members define their role as helping private entrepreneurs get established in the alternative energy market. Possible spin-off ventures include maintaining storage facilities for bulk quantities of pellets, manufacturing the special stoves needed to burn the pellets, and running local dealerships to sell and service the stoves. LAEB also wants to establish a market for wood refuse that would generate income for loggers, truckers, and the struggling wood-processing plants in the area.

LAEB is attempting to involve all sectors of the community in its efforts. Representatives from the three CAAs sit on the board, along with representatives from the lumber industry, local universities, the U.S. Forest Service, and cooperative extension services in each county as well as low-income people from the area.

There are also a number of technical advisory groups and committees set up to bring in authorities on various aspects of the lumber industry.

Once LAEB established its board and narrowed its focus to the development of wood pellets, it turned its attention to finding a private partner with the necessary experience to establish a pellet plant. Asperal, Inc., a wood pellet manufacturer in Minnesota, approached LAEB when it heard that the board had capital to lend to a private partner in exchange for establishing a pellet plant.

LAEB evaluated the quality of Asperal's pellets and its collateral and then negotiated a loan agreement with the company. In exchange for a low-interest loan, Asperal will work to establish a market for wood pellets in the Upper Peninsula. If successful, Asperal will begin building a pellet plant in one of the nine counties covered by LAEB.

Capitalizing on their status as nonprofit entities and their access to federal funds, the three CAAs in LAEB used a government grant to cement a public–private partnership with Asperal. As the private partner, Asperal, Inc., benefits from the agencies' contacts in and knowledge of various sectors of their communities in gaining the support and cooperation of area residents. LAEB gains the business experience and technical knowledge of the private firm that will help ensure the venture's success.

The question before LAEB is what its next venture should be. The current energy crisis is over, and pellet sales will lag soon. How can all the energy and expertise be directed to creating jobs in the future?

PLED PROBLEM SOLVING 11.3
New Freedom House

New Freedom House was founded to set up a Native American jewelry distribution center on the Napahmoe Reservation in a state located in the southwestern United States. It markets products for four American Indian cooperatives—three that produce leathercrafts and one that makes garments. The cooperatives were the first ones established by the National Center for Native American Enterprise (NCNAE).

The initial distribution business via national sales catalog did well. People responded favorably to the products (design and quality), and the Christmas season brought substantial sales. After the holidays, however, sales slowed considerably. Freedom House responded by entering the walk-in retail business in Santa Fe, while continuing as a mail-order operation. The business also bought raw materials for all the worker cooperatives, many of which had been buying their supplies at excessive prices or were simply unable to purchase supplies in their local areas.

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It was then, too, that NCNAE decided to turn over ownership of New Freedom House to the reservation tribes who supplied it with its merchandise and those who worked in the various cooperatives. The resulting cooperative would market goods for individual craft co-ops, buy their supplies, and have as members all those who worked in established cooperatives.

New Freedom House Cooperative (NFHC) is a two-tiered organization. The first consists of the "unit members," or unincorporated associations of individuals organized on a cooperative basis who are engaged in the production and sale of handcrafted products. There are 13 unit members in the southwestern region, including jewelry, several leather co-ops, a clothing co-op, and a candle co-op. Each unit member is entitled to elect one representative (usually its president) to the NFHC board of directors. The board elects officers who, in turn, employ professional managers and a staff to operate the main office and warehouse.

Each unit member (workshop) is a separate entity, but all are organized on identical lines and their individual members sign identical articles of association. Any person may become a member of an association at any time by subscribing to its articles and paying dues. The members elect officers who function as a management committee. The number of partners ranges from 6 to approximately 25.

The bylaws and marketing agreement signed by each unit member are the two basic governing instruments describing the various responsibilities of the members and the directors and officers.

Each worker's co-op (unit member) is responsible for the production of particular items in the product line described in the New Freedom House catalog. These products include suede handbags, leather belts, cuff links, costume jewelry, dolls, stuffed animals and toys, children's clothing, canvas bags, candles, greeting cards, and numerous other items. Each workshop, moreover, is responsible for maintaining its own records of its total production and that of individual members. Every 2 weeks, an employee from the main office of New Freedom House collects the finished products and delivers raw materials and equipment that unit members have ordered.

Partial payment in the form of an advance is made for the products on the basis of a cost price that includes labor costs, costs of material, and overhead items for each unit member. The advance is distributed to workers on the basis of their weekly production.

After being collected from individual workshops, products are taken to the New Freedom House warehouse, where each item is tagged and inventoried by quality control personnel. Any item not conforming to established standards is tagged for return to the particular workshop. After clearing quality control, all of the products in a particular category are pooled and placed in storage bins or on racks for distribution through retail outlets or mail-order sales on a national level. Proceeds from mail-order sales account for most Freedom House income. Mail-order catalogs are distributed to an extensive mailing list throughout the United States, Canada, and England. This list is constantly augmented by trading with other organizations and by leasing lists from direct mail brokerage services.

NCNAE has organized several urban-based organizations, including six retail outlets plus Graphic Arts Southwest, Southwest Media, and Flute Publications. The latter are affiliated as craft workshops—that is, the publications and media workers are members of the NCNAE. Although their activities are conducted in an urban setting, their activities are directly related to the needs of the rural members.

New Freedom House has faced the future squarely, and the prospects are not good. The organization is large and too decentralized to compete with the better-capitalized mail-order firms tied in with the credit card companies. But New Freedom House has both a mission and a message. The board is now struggling with a proposal from a large New York mail-order firm to take over management and distribution of its products. Board President Chief Joseph reminded his fellow board members that neither the Anglos nor any other minorities were there when they needed them in the early days. Young Susan Windfall, another board member, said the chief's ideas are tired and racist. She believes it is time for Native Americans to show the way—and make big profits. Who is right? How would you go about setting up an agreement with an external retailer to work with the Native American community? Or would you reject the idea altogether and redesign the firm? If the latter decision were made, what would you do?

Community-based economic development and employment initiatives are important elements in a wider local economic development strategy. In general, these initiatives have strong social objectives underpinning economic ones. They are as much rooted in and motivated by needs (of groups, individuals, and localities) as they are in finding and exploiting economic opportunities. They offer a structure and resources to encourage economic activity at the neighborhood level. They provide access to job opportunities for local people who find entering the economic system difficult. (See Table 11.2 for a sampling of community-based employment development projects.)

Table 11.2 Community-Based Employment Development Project Idea Starters

Tool	Project Idea Starter
Employee/ ownership cooperatives	*Skilled trades cooperative:* A cooperative is formed of skilled people of various trades who offer advice on technical matters to local firms and provide a sales and repair service for all kinds of specialized equipment and machinery. *Worker acquisition of existing firm:* Industry workers agree to put up money of their own—and accept a "readjustment in their pay"—in a bid to save their jobs and buy a sizable share in their former employer's business through the formation of a new company owned jointly by workers and perhaps a state equity bank (e.g., metalworkers with the blessing of a union and the support of a new equity bank). *Cooperative government projects bidding service:* People with expertise in various aspects of fabrication come together as a cooperative to bid collectively for contracts (government and other) that they do not have the capacity to bid for as individuals.

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Community-based employment	*A home-energy auditing and retrofitting scheme:* The aim is to provide an energy auditing and efficiency test service to homeowners and prospective buyers to estimate energy costs and to provide quotes on retrofitting to reduce costs. The project also might supply a team of people capable of carrying out retrofitting activities.
Community-based service and employment development	*Recycling of waste as art and craft materials:* This project is to collect and redistribute industrial and other waste as art and craft materials from a shop or center that may be used by anyone in the community who pays a yearly subscription or a set fee per garbage-bagful. Also, lessons might be provided in making art and crafts with recycled materials.

The track record of community-based economic and employment development organizations has not always been good. Some of the reasons for this have been an imbalance in the mix of social and economic objectives, inadequate financing, and lack of skills and planning. Another major problem relates to the fundamental issue of ownership and control. In theory, community-based organizations for economic development and employment generation are democratically owned and controlled. In practice, however, problems have occurred when these organizations commence projects on a business basis. Finally, as Michael Teitz (1989) warned, these problems are mentioned here not to undermine the concept but to state the limitations clearly.

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12

Building the Implementation Plan

The successful implementation of any economic development plan is dependent upon three key elements: choosing the appropriate strategy, having the correct organizational structure, and garnering the necessary resources. The first element, choosing appropriate strategies, was the focus of Chapter 7 of this book. This chapter was followed by an exploration of common foci of economic development strategies: locality development (Chapter 8), business development (Chapter 9), and human resource development (Chapter 10). In Chapter 12, we focus upon creating the necessary organization structure and identifying and deploying the necessary resources for successful plan implementation. With few, if any, exceptions, the necessary organization structure will be made up of private and public partners. Consistently critical resources for economic development plan implementation are financing and marketing.

The initiation of economic development planning is fundamentally an effort to influence the market economy. Further, the impetus for this effort is always because there are acknowledged deficiencies in the outcomes that the market economy has generated for a community overall and/or for certain segments of that community. While the public sector is always involved—directly or indirectly—in economic development plan implementation, the point of any such plan is to strengthen the private sector and the benefits this will generate for all of the community. Thus, local economic development plan implementation is invariably a mixture of public and

private actions. For example, public provision of roads or mass transit and strong K–12 education systems are indirect but critical enablers for economic development. In response to market failures, the public sector needs to directly stimulate private capital formation and firm creation or location. In the next section, we discuss the use of public–private partnerships for implementing economic development plans or projects.

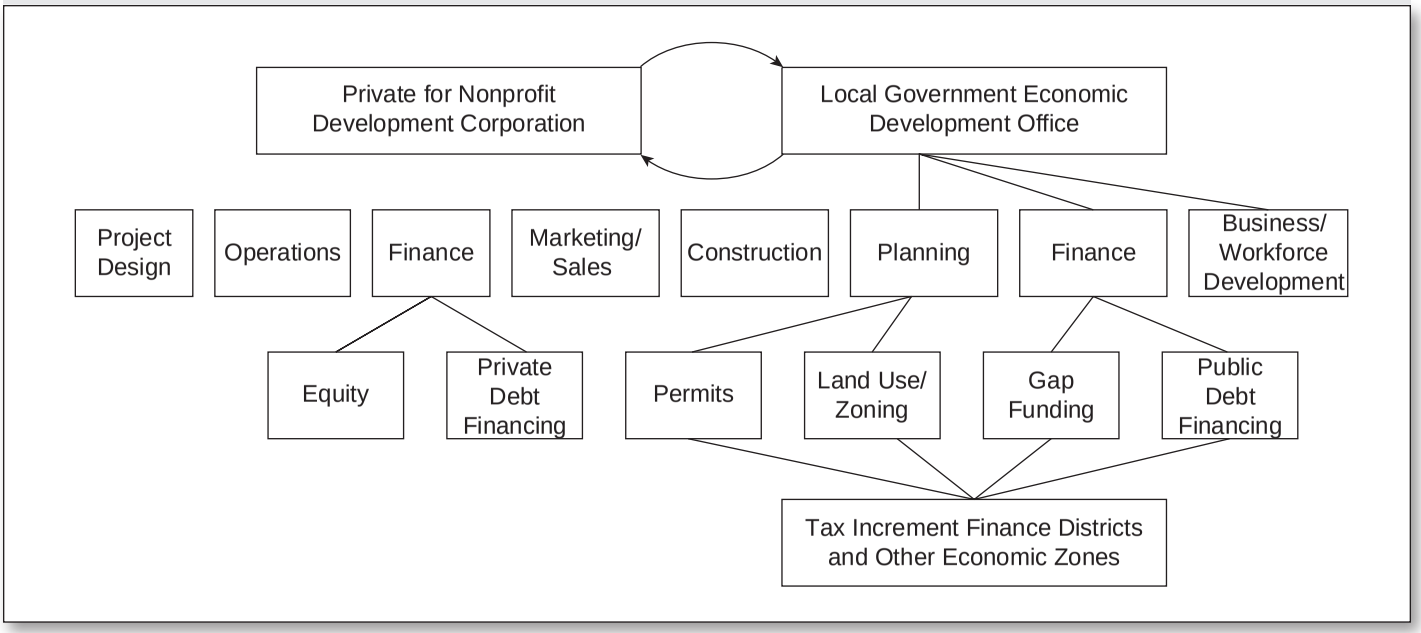
Public–Private Partnerships

Figure 12.1 is a stylized representation of public–private organizational relationships for plan or project implementation. The left side of the figure characterizes the public side of partnerships. It begins with a unit of local government (county or city level depending on the size of the area) responsible for economic development planning. The exact title of this unit varies across localities. Sometimes this entity is combined with a community development or other government department. Typically, the public economic development unit oversees planning, financing, and business and workforce development needs for strategic plans and specific projects. Some examples of public-sector activities it must engage in to realize plans and projects are creating land use and zoning supportive of economic development goals, identifying specific areas within the community that warrant designation as tax-increment finance districts or other types of economic zones because of their economic decline or underdevelopment, and providing an efficient permitting process for specific projects.

In one major city, Long Beach, California, the primary responsibility for economic development plan implementation falls to the Community Development Department through the Economic Development Bureau, along with the Workforce Development Bureau and the Redevelopment Agency. But the city recognizes the success of its economic development planning requires an integrated and coordinated effort that leverages resources of other city departments as well as external partners. The key city departments include Planning & Building, Financial Management, Public Works, and the public safety departments, fire and police (City of Long Beach Economic Development Bureau, 2007).

The right side of Figure 12.1 characterizes the private side of partnerships. Private partners can be in the for-profit or nonprofit sector. Included among for-profit–sector partners are trade and industry associations (e.g., chambers of commerce, a specific manufacturing association), banks, utilities, developers, and major locally headquartered companies. Nonprofit partners can include community development corporations (CDCs), medical

Figure 12.1 Organizational Relationships for Project or Plan Implementation



Source: Adapted by Nancey Green Leigh from Figure 3.3 in Giles (2011).

and educational institutions, and foundations, among others. When the focus is a specific project, private for-profit partners are looking for the best market opportunities, the highest and best use of land under consideration for development, and greatest profit-making opportunities.[1] Nonprofit partners typically are seeking to compensate for market failures and to address conditions in declining areas by taking on projects that are not in the best locations and for which high returns are not expected.

Public–private partnerships can be complex and require considerable effort to create and sustain. The basic premise behind public–private partnerships is that of cooperation for implementing a plan of benefit to the larger community or of risk sharing for developing a specific project. A public–private partnership example of a project is one that uses the assets of the public sector—for example, a building, air rights, a change in zoning, low-interest loans—combined with tax benefits for private enterprise, ranging from credits for hiring local workers to tax relief such as land or sales tax deductions.

For specific projects, the private sector provides the design and development capacity along with cash or equity for financing. An example of a project is a parking structure used by the public for a fee combined with a movie theater that might be incorporated into the base of the same building operated by a private firm. The profit or income is split between the public and private parties in a variety of ways.

When public–private partnerships are focused on implementing a broader plan rather than a specific project, partners from both sides are often called upon to help market the community or a plan or both.

Marketing Community

Traditionally, communities do marketing for economic development to highlight their attractiveness to new employers and investors. However, there is increasing recognition that communities need to retain businesses and residents that have contributed to the economy. Thus, marketing is also necessary to ensure that a successful business seeking to expand will do so in the community, and a resident who is retiring considers the quality of life of the community attractive enough to retire in place.

While much of community marketing activity has focused on tourism and visitor services, community marketing is becoming increasingly sophisticated in seeking to position local assets in the global economy. Community marketing in today's environment is based on an inventory of local resources (human, cultural, natural, and built), opportunities, and options. Combined,

these create a profile that helps the community determine the kinds of firms and institutions that "fit" best with its multidimensional resource base. Based on the profile, the community creates marketing messages for local and external consumption.

Communities have to develop a clear identity for their marketing to be successful. This identity needs to be authentic and capable of contributing to the base of the local economy. Over time, this identity may change in order to address long-term economic challenges the city has not been able to overcome as well as to take advantage of emerging opportunities in the economy. For example, it was noted in the city of Long Beach's economic development implementation plan that "Long Beach has shed its skin numerous times. It has been a resort town, an oil town, a Navy town, an aerospace town" (p. 2). Long Beach's stated goal was to become a more diversified city, less susceptible to large economic shifts (City of Long Beach Economic Development Bureau, 2007).

Components of Good Community Marketing Analysis and Designing a Marketing Plan

While each community has to develop interesting ways to present its assets, this presentation has to be based on real data for and indicators of the economic area that it represents. Typically, the local economy is part of a regional economic system or even a megaregion like Los Angeles, London, New York, or Shanghai, which requires setting the local economy (be it neighborhood, town, or city) within the larger regional context, even when local smaller-scale development is the goal. Next is a list of analysis steps that should be taken into consideration.

- *Market area context*. Determine what role the community has within the larger region and what resource(s) it contributes.
- *Local market capacity*. Determine the size of the local market area and its components with respect to demographic profile, met and unmet consumer demands, and product and service provision.
- *Resource assessment*. Conduct a meaningful assessment of the strength, weaknesses, and resource potential of the focus area or local economy.
- *Market scope and penetration*. Determine the degree to which the local economy offers the ability to meet some market demands using its locational and related assets.
- *Niche competitive advantage*. Because globalization has reduced the comparative advantages of location and even fixed natural-resource

assets, determine whether a combination of special attributes—cultural, social, educational, environmental, or equity performance that enhances community quality and stability—has the potential to create a marketing advantage for the local economy.
- *Cost factors*. Determine what the key cost considerations are for firms or projects expressing interest in the local area or for which the community wants to compete.
- *Sustainability*. Determine what hard and soft infrastructure support the community can supply to firms that are part of the green economy.

Community (City or Neighborhood) Marketing Plan

No matter whether it is a firm, organization, city, or neighborhood, if there is an intention to compete, then there is a need to market and present. Many people confuse marketing with sales. Sales are the best indicator of good marketing. But marketing is the envelope that helps introduce the place or product. Good marketing presents the place or product in such a way that the consumer recalls it for the intrinsic reasons of quality and reliability. In too many cases, however, places substitute slogans for genuine market assessment and presentation. A good motto confirms the quality or other aspects of the product or place, but it is not a substitute for providing the services of goods. In this respect, communities have to present what they have and not what they would like to have. So it is not convincing to present a nice poster with an ocean background and attractive man or woman in swimwear for a desert community. However, many communities make the equivalent of such poor choices. They present what they think the consumer or the local leaders want the place to be rather than what it really is. Places like Washington, D.C., can market themselves as "capital cities," but a small county seat would be foolish to use the same kind of presentation. Therefore, a city or community has to portray what is has and how it wants to position its attributes as the enabling factors for competing to serve, attract, or grow firms.

A basic checklist of requirements for designing a place-oriented marketing effort includes the following:

- *Identity*. Community has assessed its assets and come to a conclusion regarding the keys for its place identity—good transportation, strong universities, quality neighborhoods, specific firms, natural features or resources, and so forth.
- *Consolidated presentation*. The most successful communities have a consortium of partner organizations that present the community

through a coordinated, strategic message. These can include the following:
  - Site-selection consultants
  - Existing industry
  - Community stakeholders and leadership
  - State government
  - Legislative delegation
  - Greater-region development organizations
  - County commissioners
  - City council
  - Real estate community
  - Electric utility providers
  - Economic development organizations
  - Marketing mission and trade show contacts
- *Communications infrastructure*. Communities have a layered communications infrastructure that includes person-to-person, print, and various forms of electronic media. Competitive communities have well-designed Web presences that prospective firms or residents can explore. These include all pertinent information about the community and use a geographic information system (GIS) as well as video to describe the community. Competitive communities also explore additional ways to reach intended audiences such as holding conferences, seeking to place articles about the community in national and international media, and getting the city used as a set or backdrop for movies and television.

Economic Developments 12.1 lists the marketing actions the county of Lancaster, South Carolina, identified for its economic development plan implementation. Lancaster County is relatively rural but in the sphere of influence of Charlotte, North Carolina, and desired to create stronger economic development for itself.

Marketing can help to attract new business and residents to a community or retain residents and expand existing businesses. In many cases, however, communities find that it is necessary to help businesses and development projects obtain the financing they need to expand or locate to the community. This is most applicable when there is a market failure for the community or when the community is seeking to shift its economy to targeted growth sectors. The next sections present basic concepts of project financing that a serious student of economic development planning will explore further in classes on economic development finance.

ECONOMIC DEVELOPMENTS 12.1
Marketing Tools for Communicating a Community's Assets to the Marketplace

- After identifying target sectors, develop specific marketing materials for the sectors.
- Develop a business or industrial park brochure profiling all business park locations.
- Produce a transportation network flyer or promotional piece for all target sectors that includes pictures, maps, and quotes from existing companies.
- Develop existing industry testimonials.
- Develop an incentive (state and local) overview for business retention and new firm recruitment.
- Develop a list of all local "certified" rail-served sites.
- Create a community profile providing a general overview and utilizing regional demographics facts such as the following:
  - Education
  - Transportation
  - Labor force
  - Incentives
  - Utilities
  - Sites or buildings
  - Quality of life
  - Major employers
  - Cost of living
  - Target industries or sectors
- Develop a professionally bound package of information materials.
- Develop a retiree recruitment marketing piece.
- Create an economic development website that provides information on available incentives, community demographics, and available buildings and sites.

Source: Adapted from Lancaster County, South Carolina (2009).

Project Financing

Prior to securing the financing for an economic development project, the project idea must be determined to be viable within the environment it is designed to improve. Next, the project must be shaped to pass the viability test by building action plans specifying in some detail the project, outputs, resources, and support system requirements. For smaller, simpler, shorter-term projects, an action plan may itself be adequate to gain formal commitment for the project idea and thus claim materials, finance, and personnel to implement it.

As projects become larger, more complex, and longer term, however, action plans for the project design need to be fully detailed to claim resources. Detailed project plans are also required whenever a local government is considering acting on its own or if projects are submitted that invite local government endorsement.

The preparation of a detailed project plan has four traditional basic tasks (Items 1, 3, 4, and 5 on the following list) to which we add a fifth (Item 2). They are as follows:

1. Viability assessment
2. Sustainability assessment
3. Detailed feasibility studies
4. Organizational design and business plan preparation
5. Monitoring and evaluation program

The main difference between the detailed project plan and the formerly described action plan is the degree of detail required. In this chapter, we will concentrate on general standards for detailed project plans that can be adapted to any requirement.

Project Viability Assessment

Project development is the redefinition and determination of the potential of specific project ideas. During this stage, the decision must be made on whether to complete the planning phase and implement the project. In general, project development involves taking one or more attractive project ideas, shaping and specifying each precisely, and rejecting those that do not seem viable. To justify the project, the criterion of potential for economic development and employment has to be satisfied, at least preliminarily. In project development, viability is determined in relation to four interconnected bases: (1) community, (2) locational, (3) commercial, and (4) implementation (Malizia, 1985).

Community Viability

Because economic development is a community issue, the formulation and selection of local economic development projects constitute a communitywide political act. First, the local economic development process describes the necessary support base required to make a project viable. Then it decides whether the project has sufficient community support.

Caution is suggested when deciding whether a project has community viability. Many individuals and organizations may initially give casual support to project ideas but then withdraw their support when the project is likely to become a reality. To overcome this potential problem, local economic development planners should seek explicit oral commitments from other key actors. These informal commitments are required because to

proceed on any other basis is far too cumbersome. Formal commitments are sought only after the project is found to be viable, an action plan assembled, and important actors and their roles identified.

Locational Viability

For the locational/market viability analysis, the resources required by the project need to be identified and their availability determined. How the proposal harmonizes with other existing or proposed projects needs to be considered.

Next, planners should identify potential customers for the product or service provided by the project and answer the following questions: Who are they? Where are they located? Why would they buy this product? How frequently? Planners then need to step back and consider market size and trends. They should determine whether the product is in a growth industry, whether the market area is growing, and what the expected size of the market is when operations begin. The next step is analyzing the competition. What are the strengths and weaknesses of the product relative to the competition? What is the market capture strategy—that is, what will be done to gain customers?

The answers to the previously given questions will provide two valuable pieces of information: (1) whether to proceed any further with the project, and (2) what should be addressed in a formal market study and marketing plan by consultants at a later stage of the economic development process. If the project appears to pass the test of locational or market viability, its economic or financial and operational viability then need to be considered.

Commercial Viability

Based on the answers to the questions asked in the market viability analysis, the community or other sponsor must estimate the revenue-raising potential of the project and judge the likelihood of the project recovering its costs. Knowing the level of risk to capital is a precondition to determining whether investors will be readily available and whether the project will have reinvestment opportunities. The economic viability studies should consider each of these aspects. They constitute the initial pieces of a project cost plan to be made in the next step of the local economic development process.

Implementation Viability

Implementation viability is determined by considering who in the community has the skills and capacity to undertake the task. There is no real point in embarking on projects if the skills to organize or manage the project are not

present. In addition, the community has to consider how the services and goods are produced and the means of production, as well as whether the five *M*s (materials, [hu]man power, markets, management, and money) can be satisfied in developing and operating the project. On completion of this task, the financial feasibility must be determined before the project is undertaken.

Sustainability Assessment

Sustainability analysis of projects and firms is an evolving field. It can broadly be construed to focus on social and environmental issues. With respect to social issues, a community that is providing financial and other support to a private development or firm will want to know how workers will be treated: For example, will they receive fair compensation packages? Will safety standards and rights be adhered to? With respect to environmental issues, will the development or firm seek to minimize its carbon footprint and the waste it generates? Will it follow green building standards? And will the managers of a development or firm also expect its suppliers to adhere to sustainable social and environmental practices?

Detailed Feasibility Analysis

The purpose of the detailed feasibility analysis is to identify the critical issues affecting each project's potential for success, to specify what conditions or requirements are necessary, and to evaluate the possibility of achieving these requirements. The information previously gathered for the project viability analysis and the action plan forms the basis of the full-scale feasibility study. This study investigates in more depth any weaknesses identified in the earlier steps and does a more thorough analysis of each feasibility factor—especially the financial aspects. The research should result in an internal working document, which, in turn, forms the basis of the business plan. The business plan is a more formal document, designed for distribution outside the project planning committee. It incorporates much of the information in the feasibility study and also discusses how the conditions for success will be achieved vis-à-vis the operation of the business.

There is no standard format for a feasibility study, but there are a minimum of three special studies that should be undertaken:

1. Market analysis
2. Financial analysis
3. Cost–benefit analysis

These studies should be undertaken for project start-ups, business expansions and acquisitions, and community development projects. Research and evaluation methods may differ somewhat in each case, however. The scope of each study will depend on the size and complexity of the prospective venture. If any major problems or weaknesses are identified, they must be examined thoroughly, increasing the study's length and complexity. Although the precise nature of each of these analyses will differ according to the venture under investigation, certain factors should be addressed in each of them. These will be discussed next, and sources for gathering information will be given throughout.

Market Analysis

At earlier stages in the planning process, we looked briefly at the overall market for a project's potential products or services. We also roughly defined the project's potential customers and estimated their numbers based on general research. The market analysis component of the feasibility study is more specific and detailed. It defines the project's primary and secondary markets and determines the total size and share of the market that the venture can be expected to capture. To do this, the market analysis must closely examine three factors: (1) the project's product, (2) the total potential market, and (3) competition.

Products

The first step in assessing the feasibility of all possible projects is to specifically define the product or service, or the mixture of goods and services, that the activity or business will produce and/or sell. As discussed earlier, all other factors in the feasibility analysis will relate to this definition. If the venture will manufacture a product, this part of the analysis may include a technical study, covering such topics as the following:

1. Crucial technical specifications, such as design, durability, and standardization
2. Engineering requirements, such as equipment, tools, and work flow
3. Product development, such as laboratory and field test results or plans

If the community does not have the capacity either to pay for or to carry out a technical product analysis, the venture is not a feasible one for that organization. If the venture will sell but not manufacture the product—as in

retail or wholesale undertakings—the product analysis may consist of comparing products available to determine the type or model to be sold. At a minimum, the product or products to be sold should be described as specifically as possible.

Necessary or desirable location specifications may be part of this section for manufacturing, wholesale, and retail ventures. Site characteristics, such as proximity to raw material suppliers, customers, transportation, educational institutions, and other directly related resources, should be specified for manufacturing and wholesale projects. For retail ventures, store location is an important factor in the success of the business. The store location or possible locations will probably not be specified until the business plan is prepared. Retail store location will be addressed under market analysis, because location profoundly affects the market for most stores. For existing businesses, the feasibility study should review what its product and/or service has been. If any changes are to be made, these should be noted and explained.

Total Market

Having specified what products or services will be provided by the venture, the market analysis must answer the following two questions: (1) Who will buy the venture's product or service? (2) What are the characteristics of its potential customers? The answers to these questions will define the venture's primary market, which are those who will be its major purchasers or users, and its secondary markets—that is, its other potential customers. Trade journals and suppliers, community surveys, or surveys of local business may provide much of this information.

The geographic limitations on the venture's market must also be assessed. If it is a retail store, for example, it may be limited to a few blocks or the surrounding community. A manufacturing project may have a regional or perhaps even national market. Trade associations and other knowledgeable sources can help define the market area. Also, check with business schools, libraries, and the chamber of commerce.

Once the characteristics of potential customers and the geographic limitations have been outlined, the size of the total market can be estimated by determining how many people (or firms) with those characteristics are located within the specified geographic area. Population statistics (e.g., population census) and various business censuses (e.g., census of manufacturers) should be helpful sources for these figures. This information, along with the information gathered under the competition analysis, will allow the

community to determine how many buyers in the market will become customers (the market share). Suppliers, trade associations, the chamber of commerce, state and federal agencies, and other business owners in the area can assist in making these projections.

It is important to remember that many factors affect the size of the total market and the size of the market share that the venture can expect to capture. There are many factors beyond the control of the community (e.g., demography, economic conditions, and competition). On the other hand, items like price, product, product mix, and location are within their control. Location has already been discussed, concerning its influence on a venture's potential market. The price of goods or services is another important element over which the community has little control. Even though the price must have, as its base, the cost of providing the good or performing the service, the price is also determined by what market the seller is targeting.

The venture can be designed to target customer groups in which the market analysis shows the greatest or most feasible demand. If, for example, the venture is based on expanding a nutrition program into general food services, it can investigate the size of several markets or market segments that exist for the same product. Examples would be senior citizen centers; child care centers; and institutions such as schools, hospitals, and businesses. It can then determine whether enough demand exists in any of these segments alone or in several combinations to support the venture. (Remember that demand means not only need for the product or service but also the ability to pay for it.) The organization can then choose which market segments to target for the highest possibility of success.

Conducting the total market analysis, the organization should be asking what choices exist and which ones will make the venture the most feasible. Once this is determined, how much competition there is for that market should be researched.

Competition

When defining the competition, one must look at not only who sells the *same* product but also who sells substitute or alternative products. The local chamber of commerce and state and federal business censuses can help competitors and provide vital information about them. Ideally, the following information on each competitor should be compiled, if available:

- Location
- Products

- Customers
- Market share
- Sales and market percentage
- Competitive advantages
- Analysis of how they compete
- Growth potential
- Community cultural dimensions

The significance of location depends on the type of business being analyzed. If the venture is a grocery store, it should probably not be located next door to its major competitor. Retail clothing stores, on the other hand, often benefit from being grouped near each other, as the group can attract more business than each store alone. The state development department, the chamber of commerce, and business schools and libraries should have information on the location needs of various businesses. Be careful not to eliminate competitors outside the venture's defined geographic market area. Customers may go out of their area to shop if their alternatives are limited or if the more distant store has better products or lower prices.

Under the heading of "products," one should try to define what similar goods and/or services competitors sell. One should determine what kinds of customers competitors attract—for example, does one childcare center in the area attract mostly parents who have the time and inclination to volunteer? Does another serve single-parent families or families in which both parents work full time? What market segments are served by each competitor?

Competitors' market shares relate to how much, numerically, of the total market each has been able to capture—that is, the volume of the business. The market and sales percentages tell how significant the market share figures are. If a business serves 2,000 customers in a year, is this 5%, 10%, or 20% of the total market? Keep in mind that a single product or firm seldom captures a market.

Sales percentages can be determined by establishing how much consumers in the defined market spent on the product during a given period (total sales) and how much was spent buying the product from each competitor. The chamber of commerce, local business schools, and library may have resources that specify these figures by individual firms.

Competitive advantages are the keys to a firm's success. How does each business attract its customers? Is it in a convenient location? Does it offer free parking or generous credit terms, free delivery, or installation? Are its prices lower, or does its product have a marketable difference in quality?

To determine the competitive advantages of different firms, try calling directly and take note of their advertising. What image are they projecting? What services do they offer? Learning about the competition is the first step in determining how the venture can compete. In addition to the kinds of advantages included in these questions, a venture may also be able to capitalize on its relation to the community as a whole.

Under competitive advantages, one should also analyze how competitors may respond to the venture. Are they likely to cut prices, increase advertising, or expand certain product lines? How much additional risk do competitors' possible responses impose on the venture? What competitors do will probably relate to how they currently market themselves.

A competitor's growth potential does not necessarily mean the possibility of expansion in the physical size of the store or facility but its potential for increasing sales and market percentages. This can be assessed from an analysis of its competitive strategy or advantages and the projected growth of its market segments or buying power. If accessible, the growth patterns of the business over the past several years can also be analyzed.

The previously given information will provide a realistic assessment of the venture's total estimated market share. Once this has been determined, it is possible to project the sales volume, a critical element in its financial feasibility.

Financial Analysis

Numerous publications, such as Seidman's *Economic Development Finance* (2004) and Giles Bischak's *Fundamentals of Economic Development Finance* (2011), go into depth about different aspects of financial feasibility. White and Kotval's (2012) *Financing Economic Development in the 21st Century* also offers a useful compendium specifically addressing local economic development. Accountants may also be able to provide valuable assistance in understanding and completing various financial statements. We focus here on six important financial analysis tools:

1. Estimates of initial financial requirements
2. Break-even analysis
3. Financial scenario development
4. Profit and loss (P&L) presentations
5. Financial cash flows
6. Return on investment (ROI) projections

The first five of these tools are used to determine the financial profitability and debt service capacity of the project. The last tool is a measure of the

project's ROI capability, a measure often compared with that of other projects in investment decision making.

Each of these financial projections is sensitive to the assumptions and projections made under the other feasibility factors. For example, if the venture requires an engineer or manager (who will probably command a high salary), that salary requirement will increase the venture's start-up and operating expenses. There may be many alternative ways of operating the business that could alter its financial standing. A business may, for example, have the choice of either manufacturing some parts itself or purchasing them. Financial feasibility could depend, to a large extent, on the alternatives selected for starting the undertaking. It may be beneficial to make several projections based on different alternatives so that they can be compared and the most feasible option chosen.

Estimates of Initial Financial Requirements and Financial Sources

The first step in determining a venture's financing requirements is to calculate all the expenses to be incurred before the business brings in money to cover costs. This includes three categories of expenses: start-up and initial operating costs and a reserve for unanticipated expenses. But the investors from whom funds are sought have to be considered as well. Good, straightforward financial presentations are excellent. However, some investors want to see other items, such as the following:

- *Leverage*. How will the start-up capital be used to gain other resources from third parties—donors, government, and the like? This needs to be built in to financial spreadsheets for the donor, lender, or investor.
- *Return to community*. A new criterion for many investors who realize that if the community is not part of the project, there may be costly delays. Projects that demonstrate community participation and sense of ownership are more likely to persevere, so the investor can be assured of realizing the anticipated return.
- *Sustainability contributions and returns*. How adoption of best practices for material and energy use as well as waste handling will contribute to the financial performance of the company while creating a lower environmental footprint and other benefits to the community.

Standard Financial Requirements

Start-up expenses are the costs associated with developing and setting up the business. They include market research, technical feasibility studies, cost

of hiring employees, purchasing equipment, deposits on premises, remodeling, and initial inventory. Start-up costs also include the salary or living expenses of the people starting the business. Although some of these costs may be subsidized initially, all expenses should be recorded carefully so that the true costs can be calculated.

Initial operating expenses are the costs of running the business until it reaches the break-even point, where income equals expenses. These expenses include fixed costs, such as rent, insurance, and other payments that do not vary according to sales, and variable costs, which are expenses that do vary with regard to sales, such as advertising and wages. Precisely which costs are categorized as fixed or variable depends in part on the type of business.

A *reserve for contingencies* is required to cover unexpected contingencies and changes in the venture development plans. These costs are extremely variable—although, as a general rule, they are projected at 10% of total project cost. A worksheet that can be used to estimate the venture's financial requirements is set out in Table 12.1. It may be adapted to match the venture being started. The estimates for each expense category should be as detailed and accurate as possible, though start-up costs can be filled in immediately. To estimate the initial operating expenses, however, the venture's break-even point must also be calculated.

Break-Even Analysis

The break-even analysis shows the relationship between total income and expenses at varying levels of production, sales, or provision of services. It

Table 12.1 Opening Financial Requirements

Start-up requirements
Financial analysis
Legal costs
Initial staffing
Contractors (architects, engineers, etc.)
Office (rent, purchase, use home or coffee shop)
Refurbishments of home or facilities to operate enterprise—short term, long term
New or used machinery
Cost of products

Marketing
Environmental and waste handling fees
Community contribution(s)
Borrowing costs
Utilities options—generate energy and use recycled water
Taxes or tax breaks
Insurance
Contingencies (at least 10% above total budget calculation
Total expenses

indicates at what level, given certain conditions, sales will reach the break-even point. At that point, income exactly equals expenses. Prior to this, the venture operates at a loss and must be subsidized. Subsequently, it generates a profit.

A venture could have several different break-even points, depending on the conditions under which it is operated. Such conditions, for example, are the number of employees or whether the business has its own delivery truck or hires a deliverer. Changes in these factors can cause variations in expenses and income.

For the break-even analysis, expenses are calculated as total fixed costs plus total variable costs over a certain period (e.g., 1 month):

$$\text{Total costs} = \text{Total fixed costs} + \text{Total variable costs}$$

Income is calculated as the number of units sold (either products or services) multiplied by the price of the unit:

$$\text{Total income} = \text{Number of units (products or services) sold} \times \text{Price of 1 unit}$$

Break-even analysis establishes whether the level of sales income will cover expenses. Once this is known, it is possible to calculate how long it will take to achieve the necessary sales level or whether it is possible for the venture to capture that particular amount of sales. This evaluation is made in conjunction with the information gathered in the market analysis. Based on how many months it will take to meet the projected break-even point, the

operating expense portion of the initial financial requirements of Table 12.1 can be estimated.

Development of Financial Scenarios

Once all the project's initial financial requirements are known, the local development organization should develop a series of financial scenarios based on Figure 12.2. Each scenario should be developed using realistic projections of the costs involved. Several need to be constructed using best-case to worst-case possibilities. Each component of the scenario should have a carefully developed narrative that explains how this form of funding can be obtained and the chances of obtaining it. In planning a new project, the necessary type of financing must be defined clearly. Failure to do so results not only in wasted time and effort but also in unnecessary confusion and, occasionally, failure.

From the community's point of view, a project's financing requirements are clearly defined by the purpose for which the funds will be used. The capital market institutions, however, define financing requirements by an entirely different set of criteria. To succeed in financing a project, financing needs must be defined using the criteria of both the project and the capital market.

The criteria used by lenders to analyze a financing package reflect six basic concerns:

Term. When and at what rate will the invested funds and interest be repaid? How does this correspond with the supplier's source of funds and stability?

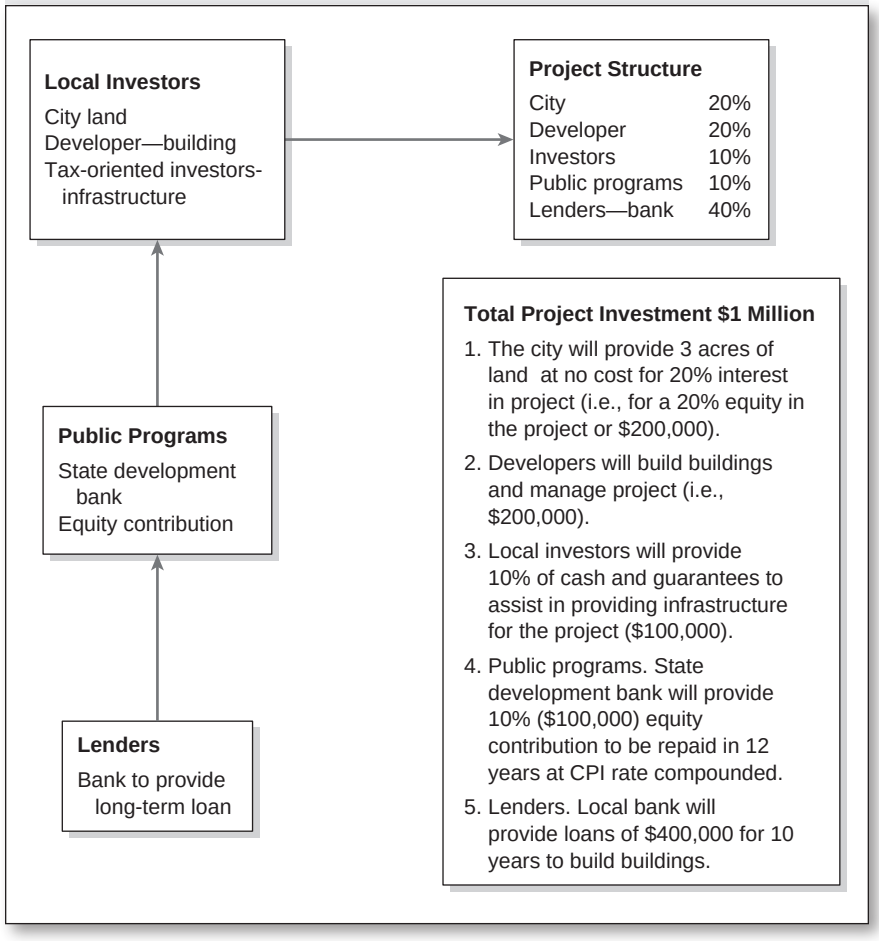
Risk. What is the primary source of repayment, and what is the probability that the invested funds will be repaid from this source? Is there a secondary source of repayment, and what is the probability that the funds will be repaid from that source if the primary source of payment fails to materialize?

Administrative cost. How much time and effort per dollar lent or invested will be required to ensure proper repayment and adequate control?

Return. What is the rate of return to the lender?

Community benefits. Will the investment result in the investor receiving additional deposits or make a contribution to new jobs, related business, goodwill in the community, or other tangible or intangible benefits?

Figure 12.2 Finance Development Scenarios



Portfolio assessment and expertise. Banks, insurance companies, and other lenders specialize in different areas of expertise, such as home-loan banks or industrial banks, and tend to keep their money in those sectors. Does the investment fit the institution's geographic, financial, sustainability, and professional involvement?

As we show, this is an entirely different set of criteria than that used in defining earlier financial requirements; it will therefore generate very different definitions. The following example of the financing requirements for a hypothetical community business venture demonstrates the differences in definitions. A community wishes to fund the industrial estate discussed in

the financial scenario. In a given project plan, it has been determined that approximately $2 million of finance will be required, to be used as follows:

1. Purchase property—1,000,000
2. Purchase equipment—$400,000
3. Carry receivables and inventory—$400,000
4. Early losses and contingency—$200,000

Total—$2,000,000

When viewed by potential financiers, however, this same financing package will look quite different, as shown next:

1. Real estate loan, 20-year, minimal risk, low administrative cost, low return, no secondary benefits, good portfolio fit—$400,000
2. Secured equipment loan, 5-year, fair risk, fair yield, low administrative cost, will receive sustainability offsets, fair portfolio fit—$200,000
3. Accounts receivable factoring, annual renewal, acceptable risk, high administrative cost, high yield, no other benefits, good portfolio fit—$200,000
4. Required equity to secure above—$1,000,000
5. Additional required equity—$200,000

Total—$2,000,000

To successfully prepare a realistic project plan, financial requirements need to be marketed. To avoid wasting valuable time and goodwill in locating the right financial sources, the project's financing must use the market's criteria.

Cash Flow Analysis

The Profit and Loss Statement

The venture's break-even point is determined by calculating its income and expense projections. These can be laid out graphically, in a quarterly time frame, on the venture's projected P&L statement, sometimes referred to as an "income and expense statement." A sample P&L statement is provided in Table 12.2.

Table 12.2 Project Profit and Loss Statement

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Total net sales				
Cost of sales				
GROSS PROFIT				
Variable expenses				
Human resources				
Taxes				
Security				
Marketing				
Digital information and information technology (IT)				
Legal Accounting				
Office supplies				
Telephone				
Utilities				
Miscellaneous				
Total variable expenses				
Fixed expenses				
Depreciation				
Insurance				
Rent				
Taxes and licenses				
Loan payments				
Total fixed expenses				
TOTAL EXPENSES				
NET PROFIT (LOSS) (before taxes)				

The P&L statement is a quarterly projection of operating expenses, combined with a quarterly projection of income (sales minus the cost of sales). Cost of sales includes the costs directly incurred by the business in producing the goods sold. In a manufacturing operation, this includes the cost of converting purchased materials into the finished product—raw materials, direct labor, equipment repairs, and so on. In a retail operation, cost of sales may simply include the purchase cost of the inventory that was sold. Trade journals and associations provide an average cost of sales for many industries.

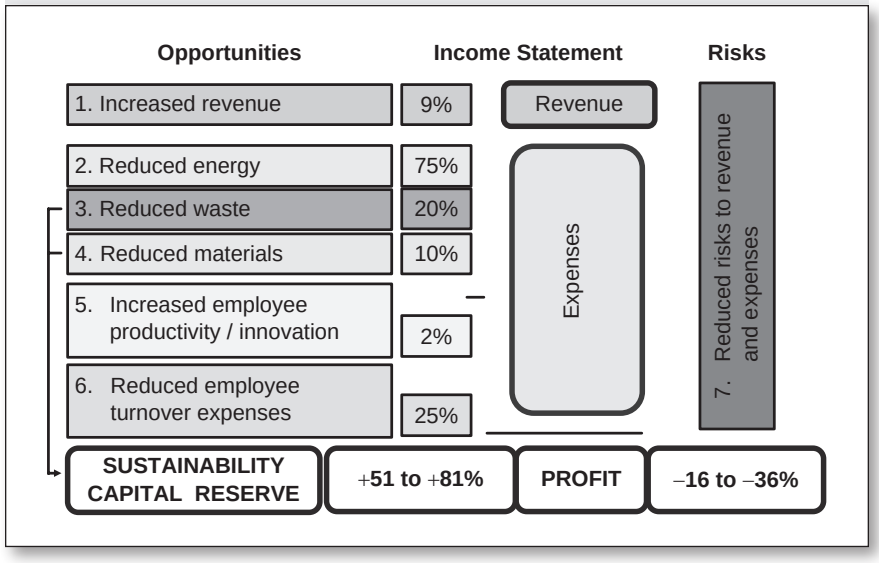
These can be used for comparison or rough estimation but should be adjusted to reflect the venture's specific circumstances.

The P&L statement should be accompanied by a statement of the assumptions used in making the projections. This is especially important if several variations of the venture are being tested within the financial feasibility study. It is also a good idea to develop several P&L statements for each variation on the venture: an "upside" projection that shows what it will look like if everything goes perfectly, an expected statement based on reasonable assumptions and projections, and a "downside" statement that shows what it will look like if the venture runs into a lot of problems or if circumstances vary a great deal in unexpected and negative ways. Once all the categories are filled in with projected figures, the total expenses are subtracted from the gross profit (sales minus cost of sales). The resulting figure is the venture's projected monthly net profit before income taxes.

The Corporate Shift to Sustainability

A 2010 worldwide survey of 766 CEOs documents the increasing adoption of sustainability practices in firms (Lacey et al., 2010). The survey identified three key drivers for the shift to sustainability: (1) 72% of CEOs saw the incorporation of sustainability practices as a way to enhance the firm's brand or reputation, (2) 44% saw it as an opportunity to grow revenue and reduce costs, and (3) 31% saw it as a way to recruit and engage quality employees. Bob Willard (n.d.) has developed a number of tools to help firms analyze the business case for adopting sustainability, including spreadsheets that estimate the profitability gains when data for a specific company are entered. Figure 12.3 depicts Willard's seven areas of concern to the firm, which can be mitigated through the adoption of sustainable practices: (1) revenue generation, (2) energy costs, (3) waste generation, (4) materials use, (5) employee productivity and innovation, (6) employee cost and turnover, and (7) the risk of not meeting revenue and expense projections. Based on firm research, adoption of sustainability practices mitigates all seven areas of concern and can increase profits from 51% to 81% while reducing risk by 16% to 36%.

Figure 12.3 Sustainability Business Case



Source: Willard (n.d.).

Traditional economic development implementation plans and specific analysis tools such as P&L statements are as applicable to sustainability-focused strategies as to traditional strategies. The need to make the business case for sustainability is imperative—and all the more so because of the deep recession that began in 2007 that has been followed by such a slow recovery. As more firm experience and data for those making the sustainability shift become available, however, economic developers are finding that making the case becomes a lot easier.

Project Sustainability

Project sustainability depends on how well the project does financially as well as meeting the social and environmental needs of the community. Cash flows reflect one aspect of sustainability, along with the returns on investment for the project in both financial and social terms.

Cash Flow Projections

Cash flow projections are similar to P&L statements except that they deal with the cash a business will actually have on hand and the bills actually due each quarter rather than all of the income (some of which may be in the form

of sales made on credit) and all of the expenses (some of which will not be paid during some months). The projected quarterly cash flow indicates whether the venture will have enough cash to pay its expenses each quarter or whether it will need short-term financing during some periods. A sample cash flow worksheet is provided in Table 12.3. "Cash flow cumulative" equals the cash flow quarterly for that quarter of the column plus the cash flow quarterly from the previous quarter. As with the P&L statement, you may want to make several projections based on how different circumstances, such as leasing or purchasing equipment, will affect the venture's projected cash flow.

Table 12.3 Cash Flow Projections

Start-Up Prior to Loan	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
Cash (beginning of month)				
Cash on hand				
Cash in bank				
Cash in investments				
Total cash				
Income (during month)				
Cash sales				
Credit sales payments				
Investment income				
Loans				
Other cash income				
Total income				
TOTAL CASH AND INCOME				
Expenses (during month)				
Inventory or new material				
Wages (including owner's)				

Start-Up Prior to Loan	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Taxes				
Equipment expense				
Transportation				
Loan repayment				
Other cash expenses				
TOTAL EXPENSES				
CASH FLOW (end of month)				
CASH FLOW CUMULATIVE (monthly)				

The Projected Return on Investment Ratio

The ROI ratio estimates how much money a project will make compared with how much money was invested. It allows potential investors to compare whether the rate of return on one venture will be greater than the rate of return on the same money invested somewhere else. The ROI ratio is considered one of the best criteria of a venture's profitability and a key measure of management efficiency. Once the venture is operational, its actual ROI can be compared with industry averages as a measure of monitoring the venture's performance.

The ROI ratio is calculated by dividing net profits (before income taxes, if any) for a certain period by net worth at the end of the period. Projected net profit can be obtained from the P&L statement. *Net worth* is defined as the owner's equity, or the owner's investment; it is simply the business's assets minus liabilities. It does not include long-term debt, although in some cases it can include subordinated debt.

ROI is expressed as a percentage. As a simple example, if net profit before taxes for a 3-month period is $5,000 and net worth at the end of the period is $20,000, then the ROI ratio is 25%.

$$\frac{\$5{,}000}{\$20{,}000} = 25$$

In general, a ratio of between 14% and 25% is considered a desirable return for investment and possible future growth.

Cost–Benefit Analysis

Cost–benefit analysis is a complex subject beyond the scope of this book. Thus, we will deal with it only in general terms. The following review of the basic notions of cost–benefit analysis should be supplemented by more extensive and detailed discussions.

A cost–benefit analysis examines a proposed project's net contribution to the local economy and community. It compares the local community's potential success at achieving fundamental objectives by pursuing a particular project against opportunities lost because resources were committed specifically to that project.

There are various techniques of cost–benefit analysis. The three most commonly used, however, are (1) the net present value (NPV), (2) the benefit–cost ratio (BCR), and (3) the internal rate of return (IRR). Each of these techniques—and in fact the entire concept of cost–benefit analysis—has basic limitations. Before mentioning these limitations, however, the various techniques will be outlined briefly.

The first step in preparing the cost–benefit analysis is to estimate the project costs. These estimates should include all capital and operating costs calculated on a yearly basis for each of the years in which the project is expected to operate. The projected financial statement discussed in the preceding section will be a good starting point for identifying these costs. It must be appreciated, however, that these calculations reflect the project costs to its sponsor or operative entity, not the project's economic cost to the community. To determine the project's economic cost, changes must be made to the financial cost calculations. In determining economic costs only, those payments that reflect the actual use of a societal resource must be charged against the project. Payments that simply represent the transfer of control over resources from one segment of society to another should be deducted. These transfer payments include project costs such as taxes, loan repayments, and interest repayments on loans.

Sunken costs are defined as those that have been incurred on the project before the cost–benefit assessment was initiated. They should, of course, also be excluded from the cost of the project for the purpose of deciding whether to proceed with it. Only resource costs that can still be avoided are relevant. For example, the economic merit of a project designed to complete another project does not depend on the costs already incurred but only on the cost of completion.

The next step is to estimate the benefits generated by the project for each of the years for which it is expected to operate. These benefits will include revenues from the sale of the goods and/or services generated and also money from the sale of any remaining equipment at the end of the project's lifetime. Contributions to society should also be added into the calculation of project benefits. To reflect these social contributions, the project's wage payments to previously unemployed workers and the price of its services must be weighed more heavily than their actual market value. This would signify in economic terms the project's contribution to the local economy and community. It must be noted that wages are counted as project costs; therefore, in charging costs to the project, the wages paid to previously unemployed people are reduced by an appropriate amount. The price of services, on the other hand, is counted as project revenues. Therefore, in assigning benefits to the project, the revenues gained from it are increased by an appropriate amount.

The process of identifying project costs and benefits is difficult. Table 12.4 presents an overview of the complexity of the issues described. The process of adjusting cost and benefit items to reflect the relevant community values and objectives is known as *shadow pricing*. How shadow prices are determined is a question best answered by an experienced cost–benefit analyst. Once the cost or revenue (benefit) items have been adjusted to reflect the relevant social or community values, we can proceed to calculate (1) the NPV, (2) the BCR, and (3) the IRR.

The NPV is, quite simply, the amount remaining after subtracting the present value of all project costs from the present value of all project benefits. The key term is *present value*. This concept can be explained as follows: Because the project's operations occur in the future, it will incur costs and produce benefits at different points in time. Hence, it is necessary to express future costs and benefits in terms of their present worth—that is, in a chosen base year. This can be accomplished by using a social rate of discount, which is a specified percentage that devalues future project costs and benefits.

The BCR is the present worth of all project benefits divided by the present worth of all project costs. The decision rule is simply that a project contributes to society if BCR is greater than 1. The IRR is the discount rate that will make the project's NPV equal to zero—that is, the project's net present benefits equal to its net present costs over a given period of time.

There are limits to cost–benefit analysis. First, only those project impacts that can be quantified in economic terms can easily be incorporated into the analysis. Using cost–benefit analysis cannot adequately assess social projects, which may produce benefits such as teaching a community how to organize or instilling a sense of pride and self-worth in the community. Second, the definition of certain benefits must be conceived very narrowly.

Table 12.4 Assessing Project Impacts

Direct Impacts	**Possible Indirect Impacts**	
Employment	**Employment**	**Income**
Construction	Multiplier effect creating other jobs	Multiplier effect
Permanent	Reduction in other jobs	
	Education and training	
Income	**Revenues**	**Land use**
Wages and salaries of employees	Sales	New developments around project such as housing and businesses
Low-income/ disadvantaged groups	Property tax	Increased property values
Profits	Business permits and so on	Housing requirements
Land use	Service costs	Environmental/social costs
Changes in land values	Sewer	Transportation/traffic congestion
	Water and so on	Community amenity
	Schools	Increased air pollution damage and less "room" for additional industrial development because of air-quality standards
		Community social programs

Finally, in determining weights by which to value a project's contribution to society, or in determining the social rate of discount, there is too much room for discretion and arbitrary decisions. Given this flexibility, a cost–benefit analysis can be manipulated to show a social profit.

Put in perspective, cost–benefit analysis allows one to compare competing projects and alternative approaches to the same project. It is not, however, a precise measure of its actual value to society. Because the analysis can consider only some of the social consequences of quantitative project measurement, many important "community spirit" and attitudinal values are lost. In most instances, therefore, it is necessary for the decision maker to

take the calculations of cost–benefit as an approximate measure of the project's actual worth. To improve the cost–benefit assessment, the previously given calculations could be supplemented with a descriptive analysis of the project's nonquantifiable costs and benefits.

Organizational Design

In making a choice of organizational form for the project, a development organization should carefully consider a number of factors:

- Economic development goals
- Amount of control the organization wants over the project
- Internal management and staff capacity
- Impact of potential liability to the local development
- Organization or government associated with the economic risk
- Image in the community
- Ability to obtain outside sources of public and private capital
- Requirements of tax, securities, and business law

Some of the most common organizational forms are nonprofit-related in-house ventures, for-profit subsidiaries, joint ventures, and franchises. These forms will have different tax, business, legal, community, and organizational factors. The local development organization should first decide on its goals for the venture and then work with a knowledgeable lawyer to find the most appropriate form to achieve those goals legally. Selecting the most appropriate legal structure for a project is not a one-time decision. As it grows and changes, both it and the local development organization may have different needs. The project's structure and its relationship to the local development organization can be altered to reflect the changed needs.

Using the Feasibility Study

Once feasibility studies are completed for each of the prospective projects, it is helpful to have each one reviewed by an independent expert and also by members of the local economic development advisory committee. The reviewers will provide different perspectives and valuable expertise. Their evaluations and recommendations for improvement will strengthen the feasibility study and also confirm that its findings are valid.

The reviewed feasibility studies should then be assessed by those responsible for determining whether to proceed with the venture. The evaluation of the feasibility studies should be spread over several meetings of the community or citizen group reviewing them. The first meeting could explain the function of

the feasibility studies to the decision makers, as well as what they should be looking for in evaluating them. A second meeting could be used for the presentation and discussion of the results of the studies. A third meeting could be a community briefing session explaining the project's potential for the community and exploring other hidden costs and benefits. The last meeting would be for the final decision. Once a project has been selected, it is recommended that only one venture be started at a time. This will minimize risks to the implementing organization. The next step is the preparation of a business plan, if appropriate, or a project monitoring and evaluation program.

Business Plan Preparation

The venture's business plan will be closely related to its feasibility study, which will provide most of the data necessary to prepare the business plan. There are important differences between the two documents, however. The purpose of the feasibility study is to explore options for operating the venture in order to assess the possible success of the activity. The business plan will lay out, in detail, how the venture will operate and the assumptions upon which the operation is based. The feasibility study discusses different ways that the business might operate; the business plan describes the way that the business will operate. The business plan is a final check on the venture's feasibility. It is more detailed than the feasibility study and is often longer, especially if technical specifications are involved.

The format of the business plan is another variable. Like feasibility studies, business plans have no standard method. What the plan looks like depends on the type of business and how the plan will be used. Regardless of the format chosen, most business plans should discuss at least the following points:

- The industry and the business (including general industry trends and the history of the business, if applicable)
- The product and service that the business will sell
- The market (including market size, trends, competition, and market share projections)
- A marketing plan (including pricing, distribution, and promotion)
- Prestart-up and start-up plans and schedules
- Manufacturing or operating plans
- Organization and management (including job descriptions, personnel needs, lines of authority, wages, and skills and experience of key personnel)
- Community and sustainability benefits (including economic impacts, environmental, human development, and other social impacts)

- Financial plans (including initial capitalization, proposed financing, and projected financial statements such as balance sheets, P&L statements, and cash flow and break-even analyses)
- Control and feedback systems (including monitoring plans)
- A discussion of critical risks and assumptions associated with the business and the business plan

Most of these issues were at least touched on in the feasibility study, although they are covered in greater depth and detail in the business plan. These basic topics can be covered in a variety of ways. What is important is that they be discussed somewhere in the plan. Seek advice from experts who can help decide what format to use and who understand the business project and the financing.

Monitoring and Evaluation Program

Project evaluation is important for economic development plan implementation or specific projects. It can lead to more efficient and effective projects as a result of systematic, careful analysis of project consequences and costs. It is an ongoing activity, beginning when a plan or project is in the design stage and continuing through implementation. It should also include a full review of the project once it becomes operational. In short, project evaluation begins right at the planning stage, and project evaluation procedures must be evident in the planning process itself. Indeed, the feasibility and business plan documents should include a separate section on the evaluation plan. This section should explicitly identify the following.

Criteria to Be Used in Evaluation

For a project, if the main body of the feasibility document is done properly, evaluation criteria will naturally emerge out of the time schedule, cost and budget limits, and productivity output targets. Key result areas, specified in measurable terms where possible, will be the criteria for evaluation. This is as true of concrete technical projects as of social projects, though the latter are admittedly harder to quantify. The final benefits or effects the project intends to achieve, as defined by the project's both explicit and implicit objectives, should also be included among the evaluation criteria. These benefits may include such items as the following:

- A specified number of job opportunities for low-income members of the community

- Opportunities for management skill development and job upgrading
- Income redirection, given the flow of money in the community
- Venture self-sufficiency
- Facilitation of community development
- Infrastructure development
- Provision of quality goods and services
- Community education opportunities
- Community ownership, control, and decision-making opportunities

Strategic economic development plans for communities are also frequently evaluated by stated goals. For example, the city of Portland, Oregon, established goals for creating 10,000 jobs in four industries: (1) clean technology, (2) activewear, (3) software, and (4) advanced manufacturing in its 2009 *Economic Development Strategy* (Portland Economic Development Commission, 2009).

Evaluation Techniques

This section identifies the evaluation techniques to be used as well as the points in time when they are to be employed. In postproject evaluation, the evaluator's task is to measure if the planning stage did, in fact, reflect what actually occurred. This could mean a recomputation or remodification of costs and benefits in light of changing government priorities. The resulting figures would give developers a more realistic perspective of the project in relation to community objectives. Thus, this section should lay out the cost–benefit premise as the basis for future evaluations to be set.

Other approaches or evaluation techniques include the use of control groups for comparative analysis, baseline measures, sampling, and various data-gathering methods such as field surveys, questionnaires, and interviews. These techniques, again, largely occur at the beginning of a project if a study or research design is planned. If this type of study is done, an experimental test group of consumers and a control group may be determined. Furthermore, baseline measures such as size and number of jobs to be created can be set. Tests or interviews conducted can reveal certain critical aspects or situations prior to the start of the project.

At the time of postproject evaluation, the comparisons made would be the experimental group before and after the project, the control group before and after the project, and an evaluation of results based on the critical aspects studied. Other techniques used would be financially oriented, such as variance analysis, where a study of the budgeted versus actual financial performance is made. If the project did not utilize a budget, however, such analysis would be very difficult, if not impossible.

Time Schedules for Conducting the Evaluation

Aside from scheduling implementation, proposals should schedule evaluation so that it is not indefinitely postponed or indicate an acceptable lapse time in instances in which a project's desired results—especially social—are not evident immediately after project completion.

Budget for Evaluation

This section should include, aside from the total amount and the program breakdowns, the promised or possible sources of funding and the schedule of budget releases.

Organization and Staff Requirements for Evaluation

This section should outline the size of the evaluation team, its qualifications, the reporting relationships, and access to project information and staff.

Those responsible for post-project evaluation must, by definition, assume a comprehensive point of view. Whereas the project's components may be worked on individually during implementation, the evaluator looks at the project as a package. Success or failure is determined by the achievement of the whole venture measured against its objectives.

Often, a team of project evaluators is composed, at a minimum, of both a technical and a project-management expert. The group may consist of three to five individuals from various disciplines with recognized expertise in the line of the project. They are sometimes from universities or research agencies as well as from various government offices. Their expertise and experience are of primary consideration in their selection, however, as the quality of the evaluation work will only be as good as the evaluators themselves.

Opinions differ on the relative merits and demerits of a preponderantly external evaluation team over an evaluation from within the project-operating agency. External teams have objectivity, possibly at the cost of lack of understanding, perspective, or access to background information, both hard and soft; internal teams enjoy familiarity and access at the expense of possible subjectivity.

Conclusion

As we noted at the outset of this chapter, initiation of economic development planning is fundamentally an effort to influence the market economy

when there are acknowledged deficiencies in market outcomes for the community. The public sector is always involved—directly or indirectly—in economic development plan implementation for the purpose of strengthening the private sector and resulting benefits for all of the community. This chapter has focused on the mix of public and private sector partners, considerations, and tools for economic development plan and project implementation.

Significant attention has been given to marketing a community to achieve its economic development goals. This marketing is not just to outsiders but also to those within the community who make valuable economic contributions that the community does not want to lose but rather hopes to strengthen. Significant attention has also been given in this chapter to financing economic development projects and to their evaluation. A well-chosen project implemented through a strong public–private partnership can be a highly valuable catalyst for realizing the goals of a community's economic development plan. The chapter's overview of project viability and financial analysis was intended to give the reader a sense of the effort and complexity involved in creating and implementing an economic development project.

In contrast to the well-accepted steps for project development and analysis, the reader should be aware that the details of implementing an overall economic development plan will vary considerably depending on the size of the community (e.g., a small town or major city or county), the time frame for the plan (e.g., 1 year or 5 years), and specific economic goals (e.g., target specific industry sectors, grow small business, increase the skills of the labor force). Local governments often hire outside expertise when implementing their economic development plans or projects. This expertise, however, augments but does not supplant the public–private partnership that is required for successful economic development implementation.

Note

1. "Highest and best use" of a piece of property generally means a use that is legal, reasonable, and physically and financially feasible as well as provides the greatest return.

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13

Institutional Approaches to Local Economic Development

Institutional approaches to, or structures for, local economic development have received considerable attention in recent years. One reason for this is that more local, regional, and state economic development institutions are being formed. The structure of the economic development program varies according to whether it is a state, substate, regional, or local city or county-wide organization. In some instances, these organizations merely coordinate activities in the public or private sector, and in others the development organization is the de facto project developer. There needs to be a clear distinction between a plan for economic development and a plan for short-term measures, no matter how urgent, to meet immediate community needs. Planning for economic development intends to bring about a lasting and continuing change in the local economy so that it will better serve social objectives. Economic development is an institution-building process. As a result, it requires the establishment of *planning systems and institutions* that can manage the development process over extended periods of time. The planning process, not the plan or document, is significant.

An institution with specific responsibility to coordinate each step of the local economic development process is essential. The development strategy plan, as well as the process itself, requires fiscal resources, technical expertise, leadership, and imagination. Some type of fully staffed, locally based institution must be available to assist in identifying and mobilizing all these resources in order to carry out strategic planning. Matt Kane and Peggy Sand

(1988) summarized the essential characteristics of an economic development organization:

> People and organizations with vested interests in an area's economic development must be drawn into the formation and policy processes for an economic development organization. Different stakeholders will have different goals that must be made explicit and considered. The city government and private businesses certainly need to play a role. But so, too, do downtown and neighborhood representatives, labor unions, city residents, utility companies, environmentalists, other area governments, and officials from local universities. The list of stakeholders will vary from city to city. Some of these stakeholders may be important in setting general directions for an organization, while others may be needed for its day-to-day operations. A community's economic development organization may involve stakeholders in a formal or informal manner. But one way or another, involvement itself is important. Without it, an organization may find it lacks political support to rally the community behind its objectives and programs. (p. 22)

The planning model or approach is as important as the process. This chapter reviews the basic organizational requirements for economic development planning. In addition, case studies of various development organization types are presented.

Organizational Requirements for Local Development

There are several basic ingredients for any local or regional economic development organization. Table 13.1 describes these components and the activities associated with each of them.

The coordinating organization for economic development is best thought of as a set of functions within a structure rather than as a single institution performing all tasks itself. (That is, the activities associated with each of the columns in Table 13.1 can be performed by staffing the organization or by the staff of another existing organization.) For example, the board of directors' function might be performed by the existing city council or a subcommittee of the city council. Alternatively, a group of local governments across a region could form a combined board.

Similarly, the executive director might be a full-time position held by a second staff member of a local government or regional organization. Of course, a full-time professional director would be best. The marketing and

Table 13.1 Components of Economic Development Organization

	Leadership Board Director	
Economic Analysis and Planning	**Marketing and Finance**	**Human and Community Resources**
Assessment	Promotion	Profiles
Forecasting	Project development	Education and training
Strategy	Financial planning	Community services
	Financial packaging	Regulation analysis
		Local government coordination

finance functions, on the other hand, might be provided by the local chamber of commerce or a consortium of local businesses and financial organizations.

A local university or college may provide ongoing business and economic analysis, and the existing employment services agency might assist with human resource and community assessments.

Clearly, there is a wide range of effective organizational designs. The type of organizational form chosen depends on the size of the community and the level of sophistication of its institutions with respect to economic development. The specific form should be based on an analysis of the potential roles various institutions might play in the development strategy decided on by the community. Regardless of what form the development organization takes, the essential point is that it should have sufficient *authority* and *resources* to undertake at least the following activities:

- *Research*. To provide background information on the area's needs
- *Information provision*. On identified target activities
- *Marketing*. Customized according to specific development strategies
- *Coordination of activities of other groups*. Important to the achievement of the overall development strategy

Funds should be balanced between those devoted to staffing and those provided to staff for work-related costs. Too much funding devoted to salaries can, for example, result in staff not carrying out important tasks because they cannot provide project funding. A well-developed local coordinating body for economic and employment development will have a clearly written definition of management and staff roles and responsibilities. The essential responsibility for overseeing the planning and venture selection process in

the organization must be set forth clearly. The person in charge of analysis must be responsible for preparing and monitoring reports of analysis. Any new roles and responsibilities should always be explicitly identified and added to the workload of a particular staff member.

A well-developed local economic development organization also has strong financial planning controls and a forward-looking financial planning system. The financial system must not only be able to look back and describe what happened in the past—as is necessary in grant reporting—but also to look forward and make predictions so that the organization and its ventures can accommodate and react quickly to changes. The financial system should be structured so that overhead and administrative costs are not hidden but are allocated fairly and openly among the various programs. Strong financial controls enable the organization to keep accurate records of its finances and pinpoint trouble spots quickly.

The local economic development organization should also have a strong economic and employment planning component. This will enable the organization to look to the future and place current and short-term community interests and needs in the context of a long-term perspective on community revitalization and independence. The planning component also allows the organization to systematically increase the capacities of both the community and the organization for economic development activities. Effective targeted marketing programs for development activities are also crucial for success.

A well-developed organization will have a strong connection with the private sector and good relations with all the social groups within the community. This helps ensure that the organization meets the needs and expectations of these groups and enables the organization to make use of the community's resources to create healthy ventures. The support of the private sector is essential for obtaining business advice, financing, and also possible contracts. In addition, the support of the wider community can strengthen the organization's ability to obtain public and other grant funds and can demonstrate that the organization is involving the disadvantaged in the local development process. An appropriate legal structure should form the basis of a well-developed local economic development organization. Appropriate legal structures that reflect the needs and goals of the organization or venture are as simple as possible. This means that the economic development body has no external structure for its venture but houses it internally or that it sets up its venture as a separate subsidiary. Legal structures should allow the organization the amount of necessary control to monitor its investments effectively without interfering in their internal operations. Legal structure should follow function and therefore should be selected after the venture in order to ensure that the structure is appropriate.

Leveraging the nonmonetary resources (e.g., goodwill of the community and political connections) allows the well-developed local economic development organization to make the most of its resources. Indeed, the support and cooperation of local, state, and federal officeholders is essential. The organization identifies and develops additional ventures through vertical and horizontal integration, such as starting a laundry to service an already operating nursing home. The organization may also spin off ventures, when appropriate, to free resources for the support of new ventures.

Public–Private Partnerships

The term *public–private partnership* has permanently entered the lexicon of local government. What is a public–private partnership? Why is it important to consider it as a component of economic development?

Public–private partnerships are not a new phenomenon. They are the legacy of more than 50 years of federal urban policies. In 1938, the federal government embarked on a set of housing assistance programs by chartering the Federal National Mortgage Association (FNMA), now commonly known as Fannie Mae, to create a secondary market for home mortgages. This program created a partnership between the public sector and the private market to produce housing in urban areas. The cities benefited from this national partnership. It was so effective that in the 1960s and 1970s, this concept was extended to rebuilding the inner cities through the Model Cities Program and later the Urban Development Action Grant (UDAG). UDAG was the most powerful stimulus for downtown restoration ever devised. Most of the nation's large cities cleared large portions of their downtowns to open them to revitalization projects crafted at the local level but supported through federal government transfers and loan guarantees. The UDAG program established the framework for local partnerships between government and local private sectors.

In the mid-1970s, local officials began experimenting with a new set of relationships with the private sector in order to complete the projects launched a decade or more earlier under more generous federal support. The lessons learned from UDAGs were adapted in the 1980s, when federal support was withdrawn at the height of local fiscal distress.

City officials became deal makers by the late 1970s. These deals included the provision of essential infrastructure at little or no cost with promise of a return on the city's investment through a soft loan or a portion of the profits from the project. In many instances, cities built public garages for private developers or sold or leased back facilities to retailers. In essence, cities

moved from their traditional role as regulator to one as coinvestor. "This new role marked a change," as Sagalyn (1990) said the following:

> In expectations about the public sector's separateness from the private sector. . . . These strategies placed a high premium on public entrepreneurship and private market feasibility. . . . And increasingly, in bargaining with developers, cities negotiated direct financial stakes in a project in the form of public profit-sharing arrangements, a practice very unlike the usual behavior of cities. (pp. 429–430)

As a result, most local governments entered the 1990s with considerable experience as entrepreneurs in the development process.

No matter what organizational structure is selected, public agencies and private firms have to enter into new relationships to make the development process work. This approach is much more than the public sector merely offering cooperation to the private sector to facilitate economic activities for private gain; it is also far more than occasional meetings between the municipal council and local business organizations, such as the chamber of commerce. Although these activities are important—and perhaps integral to good business–government relations—they do not constitute true partnerships among the sectors. Partnerships are shared commitments to pursue common economic objectives jointly determined by public, private, and community sectors and instituted as joint actions. Analysis of successful partnership efforts suggests the following guidelines:

1. *A positive civic culture that encourages citizen participation and is related to the long-term employment concerns of the community*. The goals for the development process must be shared among the community. Civic institutions that help create jobs and stimulate the economic base can form real partnerships, whereas self-serving business promotion or traditionally insular government—without a development role—cannot find any common ground for a partnership.
2. *A realistic and commonly accepted vision of the community based on the area's strengths and weaknesses as well as on a common conception of the area's potential*. This is the most important area for partnership formation. Without a common understanding of what the community has or what it can become, it is impossible to build a better community. Furthermore, unless there is a realistic vision of the area's potential, the community will never come together to achieve its goals.
3. *An effective civic organization that can blend the self-interest of members with the broader interests of the community*. Enlightened self-interest is undoubtedly the spark that lights the most action. If the

interests of civic leaders, both individually and collectively, can be channeled through some structure in order to achieve what is in the common interest of the total community, the development process will work.

4. *A network of key groups and individuals that encourages communication among leaders and facilitates mediation of differences among competing interests*. This network builds respect and confidence in the community. It allows business, labor, and government to work out their differences in private rather than in public, thereby allowing the focus of public discussion to be on the areas of agreement rather than on the problems of poor relationships.
5. *The ability and desire to nurture civic entrepreneurship—that is, to encourage the risk takers and build their confidence*. Nothing is more damaging to the notion of economic development than communities that dismiss the work of effective people. It takes a few active and motivated persons and bold action to move an area or community into new job-creating ventures. If these people are not rewarded and encouraged, then the development process will stop and the community will suffer the loss.
6. *Continuity of policy, including the ability to adapt to changing circumstances and reduce uncertainty for business and individuals who want to take economic risks*. Too frequently, government, in the absence of any consistent goals, pursues ad hoc policies disruptive to the development process. There are steps that can be taken to minimize this. First, the community should work on a set of development policies that act as a frame for their actions in the development arena. For example, a community might adopt policies that promote labor-intensive developments. Subsequent projects, as well as regulations, have to be examined to see whether they fall within the framework. Second, local government and private enterprise, along with unions and community groups, should try to determine what kind of community they really want and build social and physical infrastructures accordingly.

These six guidelines form the basis for any organizational structure the community decides to adopt. Essentially, public–private partnerships are bridges of trust based on similar objectives but mindful of differences in roles.

Achieving public–private cooperation is the first step toward engaging in actual projects. The projects will follow easily if the structure is there to facilitate the relationships.

Finally, a key aspect of the well-developed local economic development organization is its aggressive identification of new areas for growth. For continuing success, the organization must constantly move forward, identifying new ventures and activities that will help it to meet its goals. Local government authorities and/or neighborhood associations must, in order to create new development initiatives, employ expert officers to act as project

coordinators, economic development specialists, or persons working under similar titles. These individuals will in the following pages be referred to as economic development specialists.

The Economic Development Specialist

The appointment of a local economic development specialist to plan and/or direct the local development program has numerous benefits for the community, irrespective of whether a decision is made to form a new organization to guide the development process. This position helps bring both focus and commitment from the total community. The position also brings visibility for the community in wider economic and political circles. The duties of development officers vary according to the sophistication of the development system in a community. In some instances, development officers are executives who direct other specialized staff or large regional development organizations. However, most communities are likely to require an individual who cannot only guide the development process but also accomplish the following tasks:

- *Research*. To assess community economic and social needs
- *Planning*. To organize people and information and set goals and priorities
- *Management*. To develop and promote specific projects involving public–private partnerships
- *Leadership*. To facilitate the effective functioning of the local development board or commission as well as lead staff

Institutional Approaches to Local Economic Development

As mentioned previously, the actual structure of a local development organization is dependent on community circumstances. It is, however, extremely important for everyone to understand the old management principle: "Form must follow function." Too frequently, communities adopt a structure based on reading about the experiences of other places. The correct procedure is to design an institutional form that fits the political and economic situation. First, however, a community must appreciate that, regardless of the form the development organization takes, it is ultimately an "enterprise" and must have sufficient capacity to perform. There are two important characteristics that development organizations must possess:

1. *Authority*. The legitimate power to act on behalf of the local government, community, unions, businesses, and other constituent groups

2. *Resources*. Staff, financial access, technical assistance, information, and other resources required by local economic and employment development projects and programs

For a development organization to be successful, it must be able to use a combination of authority and resources to facilitate work. If an organization exists in name only and has only nebulous coordinating responsibilities, it is unlikely to gain the respect of the business community. The community organization has the responsibility of specifying the limits of such authority at reasonable levels. The absence of delegated responsibility will mean that the organization cannot operate effectively and that the development officer spends too much time obtaining permission to function effectively.

A Typology of Development Organizations

There are three general types of development organizations. First, there are *government or public* development organizations. These are components or complete delegate agencies of city or county government. Second, there are *private development associations,* which are sponsored by local or regional businesses and operate with the permission or endorsement of local government. These are private bodies usually affiliated with or a component of chambers of commerce, manufacturers, or other similar bodies. Finally, there are *local development corporations* that are a form of public–private partnership. They act as semi-independent bodies that coordinate and actually manage development projects for or with local government. These organizational approaches are seldom observed in their pure form; nevertheless, they will be described here as "archetypes." Each has its advantages and disadvantages.

A major advantage of the public agency is its connections to the political system; as such, it has access to the political resources of local as well as state and federal governments. Its chief disadvantage is the persistent delays of government bureaucracy. In local development planning, where responsiveness to the market and opportunity is essential, this may be a fatal flaw unless local government genuinely supports the agency through city council actions. There are other important advantages associated with public economic development organizations that the International Economic Development Council (IEDC) *Managing Economic Development Organizations Training Manual* (2011) lists as the following:

- Use of finance tools to leverage private investment such as public grants and revenue sharing funds

- Municipal powers that can be utilized for economic development initiatives such as "taxing authority, eminent domain, ownership of land, rights of ways, zoning and regulatory powers, and the ability to construct and operate public facilities and services" (p. 90)
- Use of other local government resources (planning, research, public works)

On the other hand, the disadvantages of public organizations for economic development include the following:

- Economic influence is essentially limited to their political boundaries.
- The ability to finance initiatives is subject to municipal debt limitations.
- Prohibitions may be given on lending money to the private sector, participating in profit-making activity, and building or operating non-public facilities.
- There may be elected official turnover or weak commitment of officials.
- There may be private sector mistrust as well as public disclosure laws that "prevent private negotiations with relocating businesses or developers" (p. 91).

Private development organizations can act quickly, but they are bound by limited interests. Generally, they are concerned only with the promotion of existing private business and with the real estate and investment opportunities associated with new firms. Private organizations seldom involve themselves in wider employment and community welfare activities. Private groups, however, can function far more effectively than government bodies in economic sectors such as tourism and retail development. Private economic development organizations also have advantages and disadvantages (IEDC, 2011). Their key advantages include the ability to do the following:

- Make decisions quickly and not be accountable to a broad constituency.
- Raise funds, invest equity capital, and make profits.
- Insulate individual investors from risk.

Their key disadvantages are that they:

- Lack municipal land powers such as eminent domain
- May have less public sector support
- May have to pay taxes on investment income
- May sometimes shift efforts away from economic development because they are self-supporting

Development corporations, or "joint power" organizations, that involve government as well as business and community are the most used form of organization because such organizations continue to enjoy government and

private support. In some instances, however, the organization is given too little power or responsibility from either the private sector or government agencies. Key advantages of public–private economic development organizations include the following (IEDC, 2011):

- Are less subject to politicization of their work
- Can incur greater risk and make bolder decisions because their board is unpaid and unelected
- Augment government powers with "functions and powers of legal, private subsidiaries and affiliates" (p. 100)
- Can draw on the expertise and resources of the public and private sector
- Protect decision makers from financial risk via incorporation
- Can be self-supporting through assessing fees and dues

Compared to solely public or private economic development organizations, the public–private form has one key disadvantage. While limited accountability to the public sector can create greater flexibility and provide access to more tools, it also can lead to eroded public support if the public–private economic development organization's goals are not perceived to serve the public interest appropriately.

When considering the three forms of economic development organizations (public, private, public–private), the following questions should be kept in mind: What role is the organization to perform? What resources are available for the organization? What are the capabilities, interests, and needs of the locality?

Economic Development Agencies as Units of Local Government

Some local governments consider economic development a regular responsibility of government that should be incorporated into its organization structure. A development department is a very comprehensive organization, and the staffing required to run such an organization is effectively out of reach for most small local government authorities. Large cities have fully staffed economic development departments. This structure has the advantage of close communications, as shown in Figure 13.1.

Independent Private Development Agencies

This type of agency has existed for some time in various local government areas. In many instances, the tourism or retailer associations have evolved from more elaborated development bodies. The chamber of commerce or some existing business group usually acts as the nucleus for this

Figure 13.1 Model Structure of Development Organization That Is a Unit of Local Government

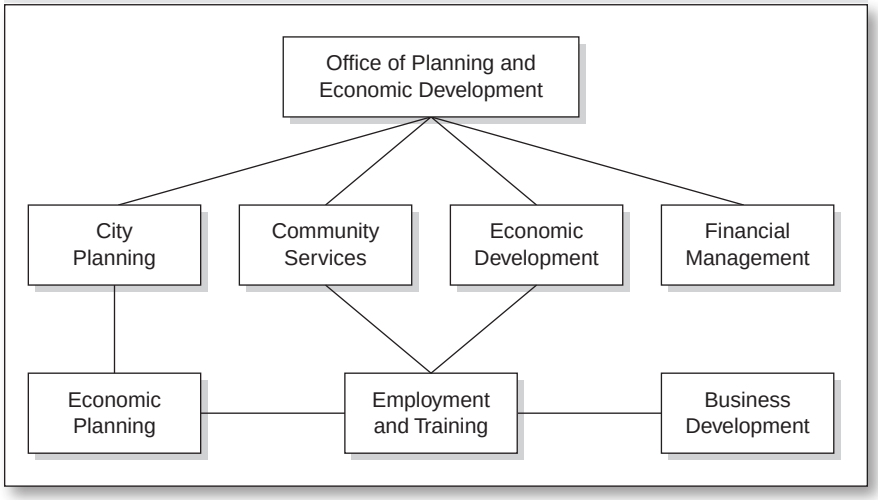
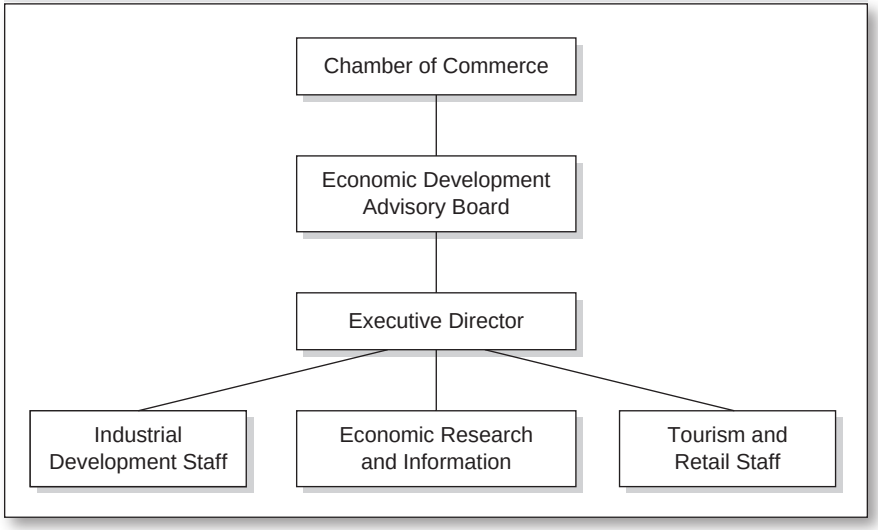


Figure 13.2 Private Development Organization Model



organizational framework. These organizations are effective as lobbyists for local interests with the local government. They may also raise private funds and become involved in high-risk ventures because of their status. The major benefit to the community of such a body is that it puts peer pressure on businesspeople to get things done for the community. Some smaller communities have decided that this is the best approach because the local government can assist these organizations by providing land or facilities, but it

does not risk taxpayer revenue since it cannot (by law) be directly involved in deal making (see Figure 13.2).

Economic Development Corporations

The economic development corporation (EDC) is an excellent vehicle and should enjoy strong support from both the public and the private sectors, although there are instances where this support is lacking. Nonetheless, this institutional approach makes it possible to bring together the complete resources of the community if the public and private sectors have equal stake in the corporation.

The structure of a local development corporation can be very sophisticated or relatively simple. Many EDCs have moderately complicated structures. The most important feature of this institutional form is that it can perform all of the tasks local government delegates to it while acting as a private body. For example, it can do the following:

- Administer development funds from both public and private sources.
- Manage industrial estates or commercial facilities for the government.
- Operate parking facilities and other services as joint public–private ventures.
- Enter into contracts and borrow funds for various development projects.
- Engage in marketing and promotion activities.
- Provide a "one-stop" business service.
- Act as a small business assistance center.
- Provide marketing and technical assistance for local firms.
- Sponsor industrial and commercial attraction efforts.

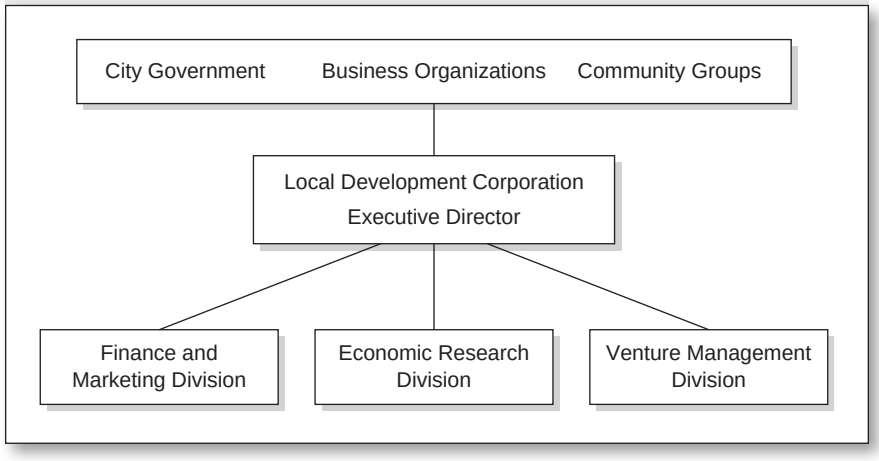
Clearly, a community development corporation (CDC) is the most flexible structure for carrying out the multiple development tasks of dealing with poverty and social maladies in distressed communities. Nonetheless, we need to be mindful of the following:

> We're not going to undo in ten years what it took 200 years to create. . . . If every CDC accomplished its goals, we would still not see the end of poverty. Poverty is the creation of the institutions we live in. . . . CDC can be important to a larger agenda that addresses economic injustice. (Bauen and Reed, 1995, p. 15; see Figure 13.3)

Summary of Institutional Approaches

Communities, regardless of their size, need to select an organizational form that meets their requirements. None of these forms is set in concrete:

Figure 13.3 Local Development Corporation Model



They can evolve over time, with components and functions being added or deleted as the need arises. There is no point in "reinventing the wheel," however. Adequate institutional development experience is available nationwide for communities to select a development framework to meet their needs. After the type of structure is selected, civic leaders can then tailor it to local circumstances.

Conclusion

Developing the correct organizational form is just as important as determining an economic development strategy. The form as well as the staffing will depend on the resources as well as the situation. Almost all economic development depends on public–private coordination and cooperation.

No matter what original forms of local economic development organization occur in a locality, it is likely that there will be pressures for them to change and adapt over time. In a 2012 report, "New Realities for Economic Development Organizations," Nourick (2012) observed the following: "EDOs of all sizes have been analyzing their strategic priorities and the practitioners' role in the community in order to be more effective and competitive in today's erratic economy" (p. 5).

In the aftermath of the Great Recession, economic development organizations have reduced funding from the traditional locally invested banks, utilities, and newspapers. They are turning to such disparate but locally vested entities such as hospitals, universities, cable companies, waste management companies, law firms, and auto dealerships (Nourick, 2012).

As public revenue has diminished, private funding of economic development has increased. The share of private-sector funding of economic development has grown from 30% in 1998 to 70% in 2011. As a consequence, economic development organizations must respond to increased pressure to track their performance in order to show what the return is to their investors. The trend toward private investor funding has also created greater pressure to demonstrate financial and organizational efficiency. This, in turn, is leading to more consolidations and mergers of economic development organizations (Nourick, 2012).

While more efficient use of resources is an important objective of economic development, a key question will be how well the multiple interests of local economic development (workers, firms, real estate, etc.) are met in the variations of consolidations and mergers that are taking shape.

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14

Local Economic Development Planning's Response to a Global Economy and Climate-Challenged Planet

By now, it should be clear to students of local economic development planning that their field is complex and multifaceted. Local economic development may have been practiced in a simplistic manner in the past, but no locality can afford to make that mistake now nor hire local economic developers who do so. The ability of a local economy to thrive is contingent upon many factors, and those over which economic developers can and should have domain have been highlighted in this book. However, economic developers may also have a role to play in coordinating or facilitating responses to locality aspects that are not specifically their direct responsibility. For example, while disaster management planning is not specifically the responsibility of the local economic developer, if such planning is not in place, all of the economic developer's and the locality's hard work can easily be wiped out through hurricanes, roaring fires, earthquakes, or other natural disasters. Without excellent transportation systems (surface and air, private and public), efficient movement of goods and people cannot occur and economic development activity is stifled. Thus, economic developers often have to be advocates for transportation improvements. Likewise, they need to be advocates for an adequate supply of workforce housing in order to attract a

competitive labor force. And they need to be advocates for quality health care and prekindergarten through high school education. These are essential building blocks for creating a quality labor force and a high quality of life that increases the community's attractiveness. In particular, a strong education system is a key requirement for economic development strategies that are focused on advanced technologies and processes.

In the final chapter of this book, we discuss technology and innovation economic development strategies that are an essential response to the global economy as well as economic development strategies necessary to cope with extreme weather events. We also discuss other essential strategies for protecting, growing, and even reinventing local economies.

Finding Solutions Through Innovation and Technology

It is important to note at the outset that while innovation and technology are essential components of the response to climate change and maintaining competitiveness in the global economy, they will by no means be the sole solution. Changes in lifestyle and ways of doing business that reduce dependence on carbon-based resources are required to minimize climate change and do not necessarily require new technological solutions. For example, it is essential to shift the predominant mode of transportation away from petroleum-fueled private automobiles and trucks by using existing mass transit technology and the lowest of technology (bicycles and feet!).

High technology became the "it" strategy of economic development during the final two decades of the 20th century and continues as the accepted economic engine for the 21st century but is now referred to by the more meaningful term *advanced technology*. Further, this advanced technology is developed within a knowledge economy. The literature on attracting and retaining advanced technology firms reveals mixed results. The precise methods, as well as the factors that lead advanced technology firms to select one community over another, are debated widely (Blakely and Nishikawa, 1992; Lowe, 2014; Luger and Goldstein, 1991; Saxenian, 1987; Willoughby, 2000). Public officials at every level enthusiastically support efforts to attract, retain, or encourage advanced technology firms. Nearly every urban region in the Western world has a technology park and an advanced technology strategy. Urban regions in growing economies throughout the rest of the world are adopting the same approaches. Typically, these use university resources and public facilities to create or incubate innovative firms with specialized technologies that can penetrate global markets. In the global economy with high firm mobility, localities have not abandoned firm attraction strategies—especially of advanced technology firms. However, they are

placing increasing emphasis on creating the conditions for new advanced technology firms to take root and make their corporate headquarters in the community à la Silicon Valley, the most powerful metaphor in the knowledge economy. In this region of California, just south of the San Francisco Bay Area, firms and multiple advanced technology subsectors were not attracted but created. Further, as the Twitter case study of Chapter 9 shows, these firms and subsectors have transformed the Bay Area region and are most recently responsible for downtown revitalization of San Francisco.

In fact, most Western-style economies have embarked on advanced technology strategies that emphasize both specific technologies and specific locations. For example, France, Sweden, Germany, Italy, as well as China, Japan, Korea, and India are key examples of nations embarked on ambitious regional technology development programs that pinpoint technologies as well as tailored human and physical infrastructure for specific localities. Within the United States, San Jose/Silicon Valley, Emeryville-Oakland, and San Diego in California; New York City; Cambridge, Massachusetts; Ogden, Utah; Austin, Texas; and the North Carolina Research Triangle were the original technology success stories. The Japanese Technopolis and Sophia Antipolis in France are the best examples of non–North American *technopoles*. These special environments are the focus of many copycat policies aimed at stimulating new advanced technology firms. However, Luger and Goldstein's observation back in 1991 still holds true:

> Research parks will be most successful in helping to stimulate economic development in regions that already are richly endowed with resources that attract highly educated scientists and engineers. This is not to say that regions with less rich endowments cannot have a high technology future, but more basic long-term investments in improving public higher education, environmental quality, and residential opportunities will be needed first. (pp. 183–184)

Empirical evidence has long suggested that advanced technology development is nearly impossible to produce or purchase by traditional industrial incentives such as free land or low taxes (Lowe, 2014; Luger and Goldstein, 1991). Rather, the evidence indicates that advanced technology firms are induced by the region's character. The economic development question is: Is it possible for a community that currently does not have the correct environment to create or stimulate one? In this chapter, we cannot answer this question categorically; however, we can suggest what communities will need at the various stages of technology development to examine and nurture their *innovation and entrepreneurial capacity* to start, retain, and sustain an advanced technology firm environment.

The Technology Development Process

The range of support systems needed to encourage and foster advanced technology development are many and complex. Only a broad list of essential support structures is addressed in this chapter. The basic orientation we take is that the *soft infrastructure* (living amenities, cultural and educational institutions) sustains the *hard infrastructure* (money and physical) rather than the reverse. To plan for advanced technology, one must first understand how the technology process works. There are four stages, and the failure to provide the necessary supports at any one stage may ultimately inhibit the development of new products and industries.

Advanced Technology Regional Choice Model

In what follows, we describe a four-stage advanced technology model. The technology process is cyclical and interactive. Each stage in the process may revert back to or interact with a previous stage. For example, product failure spurs new research or a new phase of innovation. The process has its own support system requirements. In too many instances, the regional policy or program fails to recognize these distinct stages and consequently fails to create the right environment at the right time. The first stage of the technology-based economic development strategy begins with establishing a research base that leads to invention, as described in what follows:

1. *Research base*. Research identifies the basic scientific principles on which new technology industries or products are based. Research may be applied (designed to solve specific problems or have an application for a field of technology) or generic (nonspecific research in areas of continuing pertinence for a business enterprise). Targeted research may be market driven, guided by the knowledge of market requirements, or technology driven, guided by perceived capabilities of specific technology. Each field of research will also have its own peculiar support system. Most generic research is performed at national universities or laboratories, mainly with government funding. Most applied research is performed at large industrial labs. Many university communities have a set of research institutions with both the generic and applied/firm-based institutions. The communications or networks among research firms serve as the real incubators in economic development (Blakely and Nishikawa, 1992).
2. *Invention*. Inventions are products that may or may not arise directly from research. Often, they result from ideas that help to improve an operation's efficiency. In many cases, gadgets, devices, or programs

are the result of invention. These are eventually developed and refined as new-technology products. A technology milieu creates an environment that stimulates more invention. Moreover, it is important to have in place organizations to assist in patent handling as well as creative financing in the community. It is no accident that Silicon Valley developed near San Francisco. The San Francisco area has a very strong venture capital base and excellent legal services for scientists.

3. *Adaptation and development.* Adaptations result from research or invention modifying or improving existing technology. Modifications of software, for example, improve the operation's efficiency. During product development, ideas, research principles, inventions, and adaptations are translated into an actual product. Prototype tests or models are built to evaluate the performance, application, and feasibility of developing the product to a commercial level. More detailed feasibility studies and some market research will be undertaken. Communities and regions can assist in the adaptation and development process by providing actual incubator facilities and creating technology or manufacturing zones so that firms can find suitable space for their initial operations.
4. *Innovation and dissemination.* The fourth stage in the process involves the commercialization of a new product or process. A firm will decide to develop the product to manufacture or sell the design to another firm for manufacturing. If it decides to manufacture, the firm may enter into a joint venture or other production arrangements. Marketing, venture capital finance, and entrepreneurs will be important in the innovation and dissemination stage.

These first three stages in the technology process all represent investment costs. Through the manufacture or sale of new technology, a company should produce a return and recoup the cost of the product's creation. Production is the fourth and final stage of the process. Larger companies that have purchased or developed a high-tech product will manufacture and distribute it. Other companies will disseminate the production of components to subsidiaries to produce, for instance, chips and circuits. Constant marketing and monitoring of the product are essential during the production stage. Regular feedback to research and development (R&D) and marketing is essential in order to continue to improve a product or terminate the production before it reaches the end of the technology life cycle.

To facilitate the development process, a community has to provide "places to meet." These places range from convention centers to restaurants and theater areas. This soft infrastructure can be as important as physical roads, sewers, and special industrial parks.

Fostering the Advanced Technology Community

Creating an environment that maximizes information exchange, face-to-face communications, and the formation of strategic relationships is key to successful advanced technology development. These networks or channels of both information and exchange of capital and expertise form the nucleus for the other physical, social, economic, and environmental systems needed to support advanced technology industrial development.

Human Resources

Human resources, in terms of skills, know-how, and entrepreneurship, are essential for advanced technology development. Most people involved in the research phase of development will have postbaccalaureate degrees and often will have multidisciplinary skills.

Social skills in dealing effectively with people from a variety of cultures and foreign languages are essential in globally based enterprises. These skills develop as the result of peer group association and interaction during forums of scientific and social interest. One of the hallmarks of Silicon Valley has been the high level of social interaction that naturally developed between scientists in one locality. Local economic development efforts to replicate this innovation-nurturing social interaction have been widespread in the public and private sectors. For example, Microsoft is partnering with cities to create the Microsoft Innovation Center (MIC), which provides training to the technology community and hosts networking events. In Atlanta, MIC is colocated with flex working space, a women's entrepreneurship organization, and a university innovation center.

During the development and dissemination phase, a critical resource is the marketing department. Social entrepreneurial skills are an essential link between product development and production capital. Trained financial marketing depends on a human resource support system that can promote the products and bring in the venture capital. Special marketing, finance, and management skills are required in the final stage of the technology process, when a product is manufactured.

Advanced technology regions have been characterized by a high degree of employment mobility. This is partly due to the rapidly changing nature and high failure rates of technology enterprises. In addition, many individuals do not want to be bound to companies and prefer contractual or project-based employment. Many businesses look upon this favorably, as it reduces problems with staff retrenchments in economic downturns or at the end of technology life cycles. This mobility also supports the transfer of ideas and innovation.

Education and Research Facilities

Another important support system for advanced technology development is the presence of a university or technical institute of international standing that provides STEM (science, technology, engineering, and math) education and research. Evidence from studies carried out in the United States and elsewhere suggests that universities play a direct role in generating advanced technology research. Further, their affiliated research institutes, often with a specialized focus, emphasize applied research and can be major catalysts for advanced technology development. Stanford Research Institute, for example, was one of the important ingredients in propelling the original high-tech development in Silicon Valley, California. Such institutes might be privately or publicly funded and may consist of one or more centers.

Just as important as these institutes are research laboratories and incubator establishments like Bell Laboratories and the Wang Research Institute, which can be tied to major companies. There is a tendency for major companies to form, or parcel out, work to subsidiary companies whose activities specifically involve R&D. Government research centers are also important in this process. Many are involved with basic research leading to new discoveries.

Although universities, research institutes, and laboratories perform an important educational function in the process of technology development, strong support is essential at the secondary education level to ensure a supply of future research scientists, innovators, and technical workers. Students at high schools require strong basic math and science skills, digital literacy, and some training in research methods to gain employment in technology-based enterprises (Leigh and Walcott, 2003).

Environmental Quality and Community Amenities

The quality of the environment and its natural resources can have a significant effect on whether an individual chooses to live in one locality or another. Experience throughout the world indicates that personnel involved in R&D choose to live in high-quality residential environments with good amenities as well as cultural, commercial, and educational facilities.

Business and Support Institutions

Although universities and research institutes play a significant role in promoting new advanced technology–based enterprises, major corporations and institutions that have R&D sections attached to their operations also can stimulate growth and clustering of technology industries. Many large

American companies have defense contracts, which have been the principal stimulus behind numerous advanced technology developments. Other companies in the pharmaceutical, medical, chemical, bio- and nanotechnology fields have generated spin-offs of advanced technology enterprises.

Many state and local governments recruit technology branch plants as the basis for forming an advanced technology economic base under the (mistaken) belief that new firms will emerge from these branch operations and establish headquarters in their locality. Research indicates there is very little spin-off of new firms away from the research headquarters' locations (with the exception of software development). If a company moves its headquarters or a major division and product lines to a community, it usually continues to use its own internal support systems for servicing the branch operations.

However, a community that successfully implements a strategy of incubating or starting small tech firms may be able to create an agglomeration of technology industries within the region or locality. When this occurs, the multiplier effect of technology development is significant since R&D businesses pick up contracts from these larger companies.

Small companies are part of the technology life cycle of product development. Many never survive to grow into large firms and instead become part of larger operations. This has been a fundamental growth strategy of many information technology (IT)–based firms, including Amazon, Apple, Google, and Microsoft.

There is a trend in recent years to establish innovation centers to encourage the development of small-scale businesses involved in advanced technology. Many of these have failed partly because they were too far removed from the major businesses they served. Innovation centers are more likely to succeed when located close to major users or developers of advanced technology products and research institutions.

The importance of institutions as catalysts for advanced technology development has often been overlooked in the belief that the greatest spin-offs come from corporations. Medicine is one of the sciences in which research is expanding rapidly; hospitals are a base for much of that research. As hospitals become more specialized, there is a greater need for more precise instruments, drugs, vaccines, and equipment. Advanced technology firms have considerable opportunities to take advantage of these institutions' needs.

Government institutions that are catalysts for advanced technology are telecommunications, government science laboratories, agriculture and marine research centers, defense, and administrative services. The last group is becoming increasingly dependent on substantial data storage and retrieval systems and processing. The obvious benefits of defense institutions are well documented, but the opportunities to develop advanced technology industries that serve the special requirements of other government institutions are numerous.

Enterprise or Incubator Facilities

Enterprise facilities describe the buildings, areas, or estates necessary to carry out business associated with advanced technology. Some of these can be developed as part of other support systems—for example, universities, research institutes, research laboratories, and innovation and conference centers.

There are five specialized development areas that can house new businesses: (1) research parks, (2) science parks, (3) technology parks, (4) business parks, and (5) high-quality industrial parks. Their typical forms are described next. Historically, these forms have been located in suburban areas, but increasingly, they are also locating within revitalized areas of cities.

1. *Research park*. A high-quality, low-density physical development in a parklike setting, there is significant interaction between academics, researchers involved in research and product development, and commercial organizations and entrepreneurs.
2. *Science park*. An innovation center containing R&D enterprises, a science park can also include light industrial production relating to scientific research and appropriate ancillary services.
3. *Technology park*. This is a collection of advanced technology industries concerned with both research and production, located in attractive, well-landscaped surroundings and situated within a reasonable service area of a STEM university or major institute.
4. *Business park*. A prestigious environment, suitable for a wide range of activities, including manufacturing, assembly, sales, and other office-based activities. There is no requirement for these parks to be close to academic institutions.
5. *High-quality industrial park*. These parks have attractive features for certain forms of contemporary light industry.

There are many benefits to be gained by new industries being located in specialized, well-marked facilities—namely, good services, shared facilities, a high-quality environment, and flexible planning conditions.

Advanced technology workers expect quality entertainment, dining, and retail outlets. These outlets are also important in developing associations between people involved in R&D and advanced technology industries. These associations allow ideas to be expressed on an informal basis and help circulate knowledge.

Because many people involved in the fields of science, research, and development are generally highly paid, most of them expect higher levels of service and are prepared to pay for it. Their demand for high-quality housing and schools is very attractive to communities seeking to raise their level of economic development.

Not all localities can expect to become centers of innovation and advanced technology development. However, every community can better prepare its human resources and incorporate new technologies such as superfast fiber optic networks into its public infrastructure. In so doing, it maximizes its ability to stay competitive in the New Economy.

With broader acceptance of climate challenges and smart growth goals, we can expect the typical greenfield location and low-density development patterns of the four types described previously to be altered in the future. Indeed, in the future, the most innovative research and business activities may be expected to seek out parks and facilities that meet the physical standards of sustainable development. For example, a June 2008 joint conference of the Association of University Research Parks (AURP) and the Biotechnology Industry Organization (BIO) Council of Biotechnology Centers featured a session titled "Innovation: Green From the Ground Up," which focused on creating LEED (Leadership in Energy and Environmental Design)-certified green research parks (AURP, 2008). The LEED rating system developed by the U.S. Green Building Council (USGBC) for the research park infrastructure and research centers requires the use of construction materials that are renewable, do not harm the environment, and use less energy than those found in conventional construction. Auburn University, the University of Virginia, Boston University, and many other universities have adopted green building and infrastructure for their research parks and buildings.

Globalization is rapidly changing the prospects for advanced technology local economic development strategies in the United States and other advanced industrialized nations. The outsourcing of tech jobs to India and elsewhere that was discussed in the opening chapter of this book has been viewed as a significant threat to these strategies. At the same time, "reshoring," or the bringing back of jobs to the United States, has been occurring in a number of firms because of dissatisfaction with outsourced performance or conditions becoming more competitive in the United States. What the long-term balance between outsourced or reshored (i.e., domestic) jobs will be is unknown—and so are the impacts on U.S. local economic development. However, what is clear is that strong school systems from prekindergarten through university are essential to maintain a competitive position in the global economy. The reason U.S. firms can outsource research and analytical jobs to India is because India has a large supply of well-educated research scientists and other professions who receive a fraction of the compensation of their U.S. counterparts. Of course, it is technology in the form of advanced communications and logistics systems that allows the export of some of the most advanced employment for developing technology and new innovations.

Advanced Manufacturing and Clean Technology

In recent years, advanced technology is increasingly being deployed to transform manufacturing and to shift all sectors of the economy to cleaner or greener production and processes. The federal government has taken concerted steps to promote advanced manufacturing, which it defines as the following:

> A family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting-edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies. (www.manufacturing.gov)

One of the more notable U.S. presidential policy shifts for economic development has been the Obama administration's stance that "the nation's long-term ability to innovate and compete in the global economy greatly benefits from co-location of manufacturing and manufacturing-related R&D activities in the United States" (www.manufacturing.gov). This leadership at the national level can be seen as a clear rejection of the idea that advanced economies are postindustrial or service economies. Going back to the fundamentals for local economic development planning that contribute to stability and resiliency (the latter to be discussed in detail later in this chapter), an advanced economy should have a diverse composition of leading industrial and service sectors.

To remain globally competitive, it will also be necessary for advanced manufacturing to contribute to the growing expectations of the international green economy. The U.S. Department of Commerce has a "sustainable manufacturing" program that encourages industrial processes and products that conserve natural resources and generate less pollution. The national network of Manufacturing Extension Partnerships helps smaller manufacturers with innovation and competiveness in emerging sustainable industries.

The Organisation for Economic Co-operation and Development (OECD), made up of 35 countries, including the United States, has developed a sustainable manufacturing index and guidebook to help firms become more sustainable. The index and guidebook are also useful to economic developers seeking to promote more sustainable production activity in their communities. There are 18 indicators identified that are grouped into three key areas of manufacturing: (1) inputs, (2) operations, and (3) products (see Table 14.1).

Table 14.1 Sustainable Manufacturing Indicators Specified by the Organisation for Economic Co-operation and Development

Inputs	Operations	Products
Non-renewable materials intensity	Water intensity	Recycled/reused content
Restricted substances intensity	Energy intensity	Recyclability
Recycled/reused content	Renewable proportion of energy	Renewable materials content
	Greenhouse gas intensity	Non-renewable materials intensity
	Residuals Intensity	Restricted substances content
	Air releases intensity	Energy consumption intensity
	Water releases intensity	Greenhouse gas emissions intensity
	Proportion of natural land	

Source: OECD Sustainable Manufacturing Indicators. http://www.oecd.org/document/48/0,3746,en_21571361_47075996_47855728_1_1_1_1,00.html.

The move toward the green economy will naturally have an impact on the workforce, and local economic development efforts are increasingly focusing on creating green jobs. The U.S. Department of Labor defines green jobs to be those "in businesses that produce goods or provide services that benefit the environment or conserve natural resources."

Manufacturing typically offers above-average pay and benefits to workers with a wide range of skills and job titles. This should particularly be the case for advanced manufacturing jobs. However, the U.S. industrial workforce has significant skill gaps and is also rapidly aging, making it difficult for employers to fill jobs in emerging advanced and/or sustainable industries. Compounding the problem are surveys that found parents generally do not want their children working in manufacturing. Unless this is corrected through workforce strategies that promote manufacturing as a career option, local economic developers will have great difficulty helping their community either grow an advanced manufacturing firm from a local invention or attract one from elsewhere (Hoelzel and Leigh, 2012).

An additional critical challenge for local economic developers seeking to foster advanced and sustainable industry in their communities stems

from what has often been a contentious relationship between industry and communities as well as pressures to convert existing industrial land to residential and commercial uses. The negative image of industry held in many communities is largely associated with traditional industry, which, for good reason, was kept separate from residential and commercial development. Today's industry is cleaner and has a lighter imprint on the land, but attitudes and land use regulations are slow to take this into account. Consequently, opportunities for economic development are being missed. However, there are some forward-thinking cities in the United States (notably Brooklyn, New York; San Francisco, California; Seattle, Washington; Chicago, Illinois; Minneapolis, Minnesota; and Philadelphia, Pennsylvania) that are adopting proactive policies to retain industrial land that economic developers can learn from (Hoelzel and Leigh, 2012; Leigh et al., 2014).

Resiliency in Local Economic Development

The economic and environmental crises of U.S. cities in recent years have generated a growing planning and policy focus on resiliency in economic development as well as other aspects of city systems. The increasing use of phrases such as *the resilient economy* or *resilient city* or *resilient region* may give the impression that this is a term and a movement that supercedes efforts to create the sustainable economy or city or region. We take the view that these are not competing terms or efforts; rather, resiliency is a framework nested within that of a larger framework of sustainability. That is, recalling the definition of sustainable local economic development (SLED) upon which this book is based, we pursue SLED to preserve and raise the standard of living through a process of human and physical development based on principles of equity and sustainability. This requires achieving a minimum standard of living for all that increases over time while reducing inequality and fostering environmentally benign resource use and production. *Resiliency* has been defined as "the capacity of a region to respond effectively to a shock, such as the effects of realigning or declining industries, a national economic recession, or a natural disaster" (U.S. Department of Housing and Urban Development [HUD], 2012). If the local economy or region is truly resilient, then its standard of living, levels of equality, and environmentally benign resource use and production will not be diminished by any major economic shock or extreme weather event.

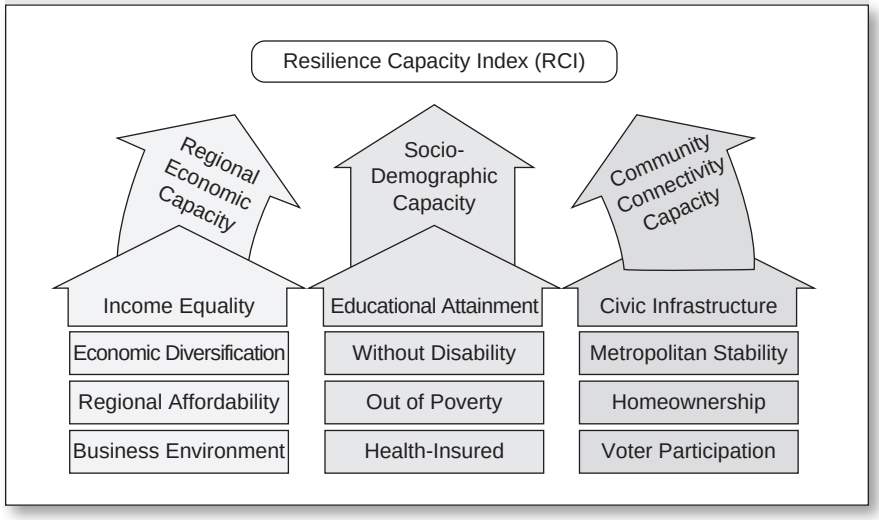
In a major initiative focused on building resilient regions funded by the MacArthur Foundation, significant analyses have been made of the kinds of shock that can occur and how specific characteristics of regional or local

economies affect their ability to recover. Hill and colleagues (2011) delineated three causes of economic shock. They can be due to (1) downturns in the national economy, (2) downturns in particular industries that constitute an important component of the local economy's export base, or (3) other external events (i.e., natural disaster, military base closure, exit of a major firm). Hill and colleagues (2011) defined whether an economy demonstrates resilience or nonresilience to a shock as follows: "A region is *resilient* if, within four years of the onset of the downturn, its annual growth rate returns to the eight-year growth rate prior to the year the downturn occurred. If it does not do so within four years, we term it *nonresilient*" (p. 7).

Hill and company's (2011) analysis of metropolitan regional economies yielded a number of important findings for local economic development—four of which are highlighted here. First, while economies with a higher proportion of employment in durable goods manufacturing tend to experience more downturns and to be less shock resistant, they also demonstrate resilience more quickly. Second, economies are more shock resistant when they have greater numbers of major export industries and when they have greater industrial diversity. Third, economies that are less shock resistant have lower average education levels (high school degree or less). And fourth, economies with higher income inequality experience more downturns and take longer to recover.

In other research associated with the Building Resilient Regions initiative, Kathryn Foster, author of Figure 14.1, developed a Resilience Capacity Index (RCI) that ranked 361 metro areas using 12 indicators in three capacity categories: regional economic, sociodemographic, and community connectivity. Of the three categories depicted in Figure 14.1, we will explore in more depth those under the *regional economic capacity* category: income equality, economic diversification, regional affordability, and business environment. Income equality is included in the index because regions that have more equal distribution of economic resources are hypothesized to respond more cohesively to shock (Cutter et al., 2010). Economic diversification is included because having economic activity spread more widely across industrial sectors means that business cycle impacts or industry shocks are lessened. The regional affordability indicator measures the proportion of an economy's households that pay more than 35% of their income on housing. Housing cost exceeding 35% of income is typically thought of as excessive (e.g., homebuyers generally cannot obtain mortgages when payments would exceed 35% of their income) and suggests the household would have less spending and investment flexibility during a crisis. The business environment indicator seeks to capture how economically dynamic an economy is,

Figure 14.1 Resilience Capacity Index (RCI)



Source: Kathryn A. Foster, University at Buffalo Regional Institute and MacArthur Foundation Research Network on Building Resilient Regions. *Graphic design by Beuving Creative, Inc.*

with greater dynamism associated with factors such as higher proportions of small businesses, high levels of business churn (starts and stops), and residential high-speed Internet connections.

Having discussed economic development characteristics associated with resiliency, the next section focuses on what local economic development planning can do to promote resiliency after an environmental or economic crisis.

Local Economic Development Planning for Resiliency

A key role for economic developers is that of helping communities adjust to the economic changes that are causing or may cause serious structural damage to their underlying economic base. These changes may occur overnight or over a long period of time and result from industrial or corporate restructuring, new federal laws and regulations, reductions in defense expenditures, and depletion of natural resources or natural disasters. On top of this, as the recent past showed, local economies can be negatively impacted by institutional and international monetary missteps well beyond their control. For

example, as was discussed previously in this book, the U.S. Federal Reserve's loosening of oversight and requirements for the home mortgage industry caused a subprime mortgage crisis that became international in scope while deeply affecting individual homeowners, local finance institutions, entire neighborhoods, and cities.

Because of the national dependency on oil to run the United States and other national economies, jumps in its price can raise the cost of doing business and moving goods and people in the economy to hardship levels in many communities. As petroleum is the basic input into the plastics and related industries, it is an essential input to much of what modern society consumes. Hence, unprecedented inflation in the basic consumer basket also began to accompany the subprime financial market collapse when fuel prices were also rising. While oil and gas prices subsequently fell due to growth in U.S. oil shale resources, supported by shifts in federal policy ($3.62 in 2013 compared to $2.45 in 2015, constant prices), the decline in prices is temporary. Communities should not lose sight of the fact that substantial increases in the cost of oil and gas threaten the middle-class lifestyle and create particular hardships for working-class families. Shifting to a greener, less petroleum-dependent economy now will ensure that the preview of what rapidly escalating prices can do to our national and local economies won't turn into a long-running nightmare.

If local communities have not already created a resiliency plan, let us hope the Great Recession and recent environmental disasters around the world will motivate them to do so, thereby helping to protect them from negative impacts of future economic and societal changes.

The Centre for Community Enterprise (2001) defines a resilient community as one that "takes intentional action to enhance the personal and collective capacity of its citizens to respond and influence the course of social and economic change" (p. 5). It has identified 23 characteristics of resilient communities that fall into four major categories: (1) people, (2) organizations, (3) resources, and (4) community process (see Table 14.2).

That local businesses have a great stake in creating community resiliency is persuasively argued by David Honour, editor of *Continuity Central* (see Economic Developments 14.1). Continuity planning is an activity in which businesses engage to enable the resumption of critical functions when a disaster or other disruption is experienced. Businesses should see community resiliency planning as an extension of their continuity planning because much of their success is dependent on a well-functioning community. Thus, businesses and local government and other economic development actors should view each other as important allies working together to create and implement community resiliency plans.

Table 14.2 Characteristics of Resilient Communities

People
1. Leadership is representative of the community. 2. Elected community leadership is visionary, shares power, and builds consensus. 3. Community members are involved in significant community decisions. 4. The community feels a sense of pride. 5. People feel optimistic about the future of the community. 6. There is a spirit of mutual assistance and cooperation in the community. 7. People feel a sense of attachment to their community. 8. The community is self-reliant and looks to itself and its own resources to address major issues. 9. There is a strong belief in and support for education at all levels.
Organizations
10. There are a variety of community economic development (CED) organizations in the community such that the key CED functions are well served. 11. Organizations in the community have developed partnerships and collaborative working relationships.
Resources
12. Employment in the community is diversified beyond a single large employer. 13. Major employers in the community are locally owned. 14. The community has a strategy for increasing independent local ownership. 15. There is openness to alternative ways of earning a living and economic activity. 16. The community looks outside itself to seek and secure resources (skills, expertise, and finance) that will address identified areas of weakness. 17. The community is aware of its competitive position in the broader economy.
Community Process
18. The community has a community economic development plan that guides its development. 19. Citizens are involved in the creation and implementation of the community vision and goals. 20. There is ongoing action toward achieving the goals in the CED plan. 21. There is regular evaluation of progress toward the community's strategic goals. 22. Organizations use the CED plan to guide their actions. 23. The community adopts a development approach that encompasses all segments of the population.

Source: Reprinted with permission from Centre for Community Enterprise, The Community Resilience Project, http://www.globalfacilitators.org/VirtLib/Resilience/CommunityResilienceGuide.pdf.

ECONOMIC DEVELOPMENTS 14.1
A Path Toward More Resilient Cities*

In 2012, Superstorm Sandy came barreling across the Eastern Seaboard, devastating large portions of coastal New York and New Jersey. Approximately 305,000 housing units in New York City were either damaged or destroyed, and total costs to the city were estimated at $19 billion. The New York City neighborhoods most impacted by the hurricane were in southern Manhattan, southern Brooklyn, South Queens, the East and South Shores of Staten Island, and the Brooklyn-Queens Waterfront, many of which had already experienced economic decline prior to the storm. Floodwaters forced approximately 18,000 businesses to close their doors either temporarily or for good, affecting more than 200,000 employees (New York City Economic Development Corporation [NYCEDC], 2013).

In 2013, the NYCEDC initiated the "Neighborhood Game-Changer Investment Competition" that would award up to $18 million to individual neighborhoods for innovative capital-intensive projects. The award money, funded by federal Community Development Block Grants (CDBGs) for Disaster Relief, encouraged private businesses and nonprofit organizations to submit project ideas that would spur long-term economic growth, while being tailored to a specific neighborhood's needs.

Applications were submitted and the NYCEDC spent over a year reviewing them. Then Mayor Bill de Blasio took office in January 2014 and announced that the game-changer competition was not the most effective way to spend federal relief funds. Part of the money was reallocated toward "Resiliency Innovations for a Stronger Economy" (RISE), a new NYCEDC competition to entice companies and organizations to apply resilient technologies to the city's more vulnerable areas (Boyle, 2015). In May 2015, $30 million was divided among 11 winning teams to install their technologies in small businesses impacted by Hurricane Sandy.

The winners represented three technology sectors: (1) energy, (2) telecom networks, and (3) building systems. Indiana-based Go Electric will implement an Energy Resiliency System that provides continuous electric power during outages. The Red Hook Initiative will expand its mesh wireless network to small businesses impacted by Hurricane Sandy in the Brooklyn-based Red Hook neighborhood. Young adults from Red Hook designed the project and now train and employ others from the neighborhood to retain financial resources and jobs within the community. A consortium of firms headed by F. William Brown in Connecticut will install Sandwich Plate System flood panels that prevent water infiltration in small businesses. The RISE program comes from Mayor de Blasio's larger plan to retrofit public and private buildings with green and innovative technologies that reduce New York City's large carbon footprint (NYCEDC, 2015).

Seven years prior to Sandy, in 2005, Hurricane Katrina's destructive force relocated 1.5 million residents and created $100 billion in damage. Today, New Orleans and the Louisiana Gulf Coast region have been become models for climate change adaptation planning thanks to several innovative and collaborative strategies. First,

federal funding has provided more than $14 billion to rebuild the levees and other flood resilient technologies. This has resulted in 133 miles of new construction and 100-year flood protection against flood levels that have a 1% chance of occurring in any one year (Sheppard, 2015).

In December 2005, the state of Louisiana created the Coastal Protection and Restoration Authority (CPRA) to unify coastal storm protection efforts under one agency. CPRA submits publicly and privately funded flood resiliency and restoration plans to the state legislature each year. Perhaps the most important collaborative project of the CPRA thus far is the "state coastal master plan," first created in 2007, and updated every 5 years. The 2012 update includes 109 coastal protection and restoration projects totaling $50 billion over 50 years.

The 2012 redevelopment update also includes "nonstructural" flood mitigation projects as alternatives to traditional systems such as levees designed to keep water out of an area. The nonstructural approaches, labeled "Living With Water" by New Orleans architects, are based on Dutch methods to adapt buildings and other infrastructure to accommodate water. Accommodations, including home elevation, flood and storm proofing, flood insurance, and public education about storm safety and response, are thought to be more cost effective than the traditional structural approaches (Jackson, 2012) and to be more beneficial to resource-stricken rural coastal regions. For instance, Terrebonne Parish in southern, rural Louisiana applied for and received grants from the Federal Emergency Management Agency (FEMA) and elevated more than 1,000 homes (Sheppard, 2015). However, leveraging state and federal funds to pay for these projects is not always feasible, so these types of successful nonstructural mitigation projects have been piecemeal so far.

The state coastal master plan also includes wide-scale wetland restoration efforts. According to a U.S. Geological Survey (Schleifstein, 2011), Louisiana's coastline is losing more than a football field of wetlands every hour and has one of the world's highest rates of rising sea levels. However, as a result of the Department of Justice's $18.7 billion settlement with BP for the devastating 2010 oil spill in the Gulf of Mexico, Louisiana will see a portion of that money go toward coastal wetlands restoration (Sheppard, 2015).

A joint effort between the city of New Orleans and the Rockefeller Foundation's 100 Resilient Cities Initiative has generated funding to hire a "chief resilience officer" and create a recently released policy agenda aptly named "Resilient New Orleans." The multifaceted plan depends on public and private partnerships to fund and develop 41 proposed strategies related to the environment, city services, and social and economic equity. Proposals include developing a new regional transit system, establishing a savings-matching program for low-income citizens to maintain emergency funds, and improving the city's storm water drainage system. The plan also proposes opening a Resilience Center as a research and innovation hub for flood mitigation technologies. The Resilient New Orleans plan will support efforts underway over the past decade to build up the region's resiliency through

(Continued)

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nonstructural approaches such as home elevation, flood insurance, and targeted planning and zoning measures (Jackson, 2012). For instance, the Network for Economic Opportunity, which connects unemployed residents to training and job opportunities, also will benefit from the plan's resources (Kinney, 2015). The plan promotes the goal of the region becoming a global business hub for water and environmental services firms (City of New Orleans, 2015).

Both RISE : NYC and the state of Louisiana's regional efforts have resulted in innovative programs where the goal of resiliency is more than protecting against future natural disasters. Instead, resiliency includes strengthening communities and business through strategies that prioritize equity along with social, economic, and environmental sustainability.

*Research assistance provided by Ashley Bozarth.

The 2005 devastation of New Orleans and the Gulf Coast by Hurricanes Katrina and Rita; the 2011 tornado-driven havoc that Joplin, Missouri, and many midwestern and southern communities experienced; and Hurricane Sandy, which hit New Jersey and New York City in 2012, illustrate the difficulties and complexities of the disaster-recovery process. They also show how much better prepared for recovery communities could be by engaging in predisaster or resiliency planning. Plans need to be tailored to the nature of the disaster that one may reasonably foresee for a community—that is, a plan for a possible tornado in the Midwest may look very different than for a possible hurricane on the Gulf Coast. Further, there is a range of disasters for which the community should proactively plan to minimize impacts on economic development, for example, water shortages, company closings, or terrorist attacks.

The economic portion of the plan will also vary significantly from community to community, because it should be developed to address the specific needs of the local economy as defined by area businesses and infrastructure assets of critical importance to the economy. For example, by building into the local business retention and expansion database information about suppliers and distributors, the local economic development organization has the needed information to facilitate employers rebuilding these networks in the aftermath of a disaster.

Having the ability to do so brings to the forefront one of the key preparedness factors to facilitate recovery: availability of data and contact information. In addition to encouraging their local businesses to do so, part of disaster preparedness is the economic development organizations themselves backing up all data to a site outside of the immediate area—recommendations have been made for distances as far as 500 miles away, which can be accomplished

by using an Internet cloud data-storage service—so that this information can be accessed in the immediate aftermath. Included in the economic development organization's off-site data backup should be local businesses' contact information and physical addresses. Even when using a cloud, redundancies in backup locations provide even greater protection.

Joplin, Missouri, was hit by an EF5 multiple-vortex tornado on May 22, 2011, with winds over 200 miles per hour. It left 161 dead and destroyed more than 7,000 homes and nearly 550 businesses as well as key institutions. A year after the tornado hit, 429 of the businesses that were either destroyed or damaged were up and running. The Joplin Area Chamber of Commerce partially attributes its community's successful reopening of about 80% of its businesses to the organizational continuity planning the chamber engaged in prior to the May 22, 2011, tornado. Within 3 weeks of the tornado, the chamber staff was able to make contact with all 530 employers by walking the streets (facilitated by added capacity from volunteers from other chambers in the region). This provided businesses with a sense of someone being in charge and committed to their individual business and overall community economic recovery, fueling the optimism needed to rebuild. Further, part of the chamber's planning included designating emergency meeting locations, which it used along with SMS text messages to reconnect to employees and key local business owners. By being accessible to area businesses, the chamber could be a source of reliable information regarding utilities, cleanup and rebuilding, and business services, which reinforced confidence for rebuilding. If the chamber had not planned for its own organizational continuity, it may not have been as well positioned to facilitate that 80% rebuild rate (Wellemeyer, 2012).

The impact of having a positive, unified voice of leadership for rebuilding can be highly effective, as Charleston, South Carolina, found in the aftermath of 1989's Hurricane Hugo. The decision by President Harry Lightsey to open the College of Charleston just 7 days after the hurricane was met with skepticism but soon thereafter—and over 25 years later—continues to be cited as having had an important positive psychological impact for rebuilding (Graham, n.d.).

The International Economic Development Council (IEDC) was an early entry in the growing awareness of predisaster planning, specifically with regard to planning for economic recovery, as it immediately stepped in to provide support to its members and peers in the Gulf Coast in 2005 (see www.restoreyoureconomy.org). What began as a peer-to-peer volunteer effort evolved into a wider effort of educating economic development professionals regarding the importance of advancing disaster preparedness and postdisaster economic recovery planning. Additional organizations engaged in supporting predisaster planning activities include Community and Regional Resilience

Institute (CARRI), the National Association of Development Organizations (NADO), Business Civic Leadership Center (BCLC), and the Association of Chamber of Commerce Executives (ACCE).

The efforts of both the IEDC and its partners have resulted in the outline of a framework for predisaster planning. Not just the plan but the process itself should be tailored to the community and inclusive of all the relevant stakeholder groups for economic development—that is, representatives of local government; employers; business service providers; economic assets (e.g., the local airport and prominent tourist destinations); infrastructure (roads, water, sewer, electric, telecommunications, etc.); workforce development (K–12 and higher education); hospitals and other large health care providers; and local lending institutions, foundations, and other organizations that can be a source of loans or grants for planning or recovering activities.

As outlined by the IEDC, the planning process for preparing for disaster is best focused on the following:

1. Clarifying roles and responsibilities both in the planning and recovery phases
2. Developing an understanding of economic assets and their potential vulnerabilities and strategic actions to shore up those vulnerabilities predisaster and address them postdisaster
3. Writing a clear communications plan and contact information backed up in an Internet cloud or other off-site location
4. Identifying and then making available a list of identified funding and support systems at the federal, state, regional, and local levels
5. Integrating this plan with other relevant community plans and regularly revisiting and updating the plan, contact list, and funding and support system list. [1]

Through the RestoreYourEconomy.org website, IEDC has also provided recommendations in the areas of engaging businesses in their own continuity or disaster-preparedness planning, building capacity to support recovery, and developing business-recovery financing options as well as redevelopment planning (including land use and building code considerations) and workforce planning (including housing, training, retention, and transportation considerations). These activities could also be built into a predisaster planning process.

There are so many business recovery needs to address in predisaster planning—for example, capital, infrastructure, workforce, customers, technical assistance, and insurance—that the process can be overwhelming. With limited funding and time capacity to engage in proactive planning, it

PLED PROBLEM SOLVING 14.1
Community Resilience: The Next Stage in Business Community Thinking?

Companies and entities that are new to business continuity often focus their efforts solely within the boundaries of their organization. As their business continuity arrangements mature, their horizon expands to include supply chain vulnerabilities and any threats posed by the activities of other companies located close by. This is where many business continuity managers stop. But there is a further dimension to business continuity planning that the profession's innovators are starting to consider: the importance of community resilience.

No business exists in a vacuum; it has dependencies on its local community. Employees, suppliers, and customers may all come from the local area. The availability of all critical infrastructures is dependent on the local "last mile." If the community is impacted, then the business is also impacted. Good business continuity planning, therefore, needs to take into account dependencies in the local community and, for self-preservation rather than for altruistic reasons, needs to become involved in helping enhance the resilience of the local community.

There is a temptation for businesses to see community resilience as solely the role of the local authorities and emergency services. After all, these bodies have the statutory responsibility for emergency planning and disaster response. However, in a wide-area disaster, your company will be just one of many voices clamoring for help, and you will have no guarantee of assistance in time to meet your recovery time objectives. For an initial period, at least, communities often need to support themselves in times of disaster, and such self-help is much more likely to be effective if some level of planning has taken place.

The first step is to determine what makes up the local community for your organization. This will have different layers, each layer presenting different risk levels and therefore requiring more or less input and effort.

For example, if a business leases an office in a tenanted building in a business park on the outskirts of a town, it may have the following layers to its local community:

- *The building layer.* The community of other businesses that share the premises with it
- *The business park layer.* The community of other enterprises that are located in the immediate vicinity
- *The surrounding suburb*
- *The town*

The next step is to determine the stakeholders and community groups that you will need to work with within each layer.

(Continued)

(Continued)

After this, you can begin to take positive measures. These could include the following:

1. Working alongside local authority planners to support business continuity awareness and education among other businesses in the community
2. Creating a local business resilience group and inviting other local businesses to join. Joint activities could include the following:
   - Having regular forums to discuss business continuity and share ideas
   - Conducting tests and exercises
   - Carrying out a community risk assessment and building inventory assessment. This may bring up new threats that you were previously unaware of.
   - Making a group subscription to work-area recovery space
   - Agreeing to share a mobile recovery facility in the event of a disaster
   - Jointly funding a business continuity consultant to provide services to the group members or to provide group training sessions

   On a more ambitious level, the local business resilience group could do the following joint activities:

   - Building and managing its own local recovery center
   - Being an effective forum to liaise with local first responders about emergency credentialing, agreeing in advance which staff can enter a police cordon, and providing appropriate ID and training for these people
   - Developing a joint local business continuity information and emergency communications portal. See http://www.continuitycentral.com/news03449.htm for an example of this from the United States.
3. Working with employees in their community setting—for example, making work-area recovery choices based on commuting zones rather than the main office location and enabling resilient home working to prevent transport disruptions from affecting business continuity. This could also include being aware of local incidents, which, while not impacting any company premises, have affected homes and communities of employees. Support could be offered to help with areas such as transport, child care, and rehousing to ensure the well-being of the employees and to enable a rapid return to productivity.
4. If you are a larger company, it may be appropriate to offer the services of your business continuity team as volunteers to support local authorities' business continuity planning activities. These are likely to be stretched for time and budget, and your support may be well received.

As well as making sense from a business continuity point of view, community resilience also fits well into the current trend for companies to take corporate social responsibility (CSR) seriously. CSR is a growing requirement of good reputation management, and, in many countries, medium and large companies are now expected to have a CSR policy. To include community resilience activities within the remit of CSR could be a win-win situation, ensuring that the business is seen to

have the community's needs at heart while at the same time bringing tangible benefits to the business itself.

Source: Adapted from "Community Resilience: The Next Stage in Business Community Thinking?" 2008. *Community Central,* June. © Continuity Central Portal Publishing Ltd.

unfortunately often takes a disaster to motivate predisaster planning for the next one. An economic development organization can take the lead in encouraging preparedness by engaging in its own organizational continuity planning, like the Joplin Area Chamber, and by educating stakeholders and businesses about the much more substantial economic loss that can occur without the preparedness activities.

Conclusion: The Future of Local Economic Development Planning

As stated at the outset of this book, the United States and other advanced nations are enmeshed in the global market system as leaders, followers, and participants. Smart local economic and political decision makers are not surrendering their communities' fate to chance, the marketplace, or unsupportive governmental policies. Growing concern over widening inequality and global warming that accompanied past economic development is galvanizing those who seek sustainable economic development planning, as well as bringing converts from those who engaged in traditional economic development planning and practice. Indeed, the need to focus on equity and inclusivity in economic development has seemed to enter mass consciousness. Why is this the case now?

A recent report from the World Economic Forum offers some insight into our question:

> Since the onset of the financial crisis, the question of how to unlock new sources of productive employment and translate economic growth into broad-based progress in living standards has preoccupied political and business leaders in developed and developing countries alike. (Samans et al., 2015)

But we have to ask what it will take to ensure that the "unlocked" new development translates into broad-based progress. The United Nations Development Programme (2015) argued the following:

> Development can be inclusive—and reduce poverty—only if all groups of people contribute to creating opportunities, share the benefits of development and participate in decision-making. Inclusive development . . . integrates the standards and principles of human rights: participation, non-discrimination and accountability.

However, to ensure that all groups of people are included in the development process requires significant institutional change that, in turn, requires transparency and accountability.[2] Further, achieving this change necessitates convincing a broad public that explicit efforts to reduce inequality actually foster economic growth and development.[3]

The final chapter section of this book discusses four local economic development strategies that practitioners can pursue to foster structural change while promoting greater equity and inclusion. We call these the fundamentals for local economic development planning: entrepreneurial, green, culturally adaptive, and knowledge-based strategies.

Four Strategies to Foster Structural Change in Local Economic Development Planning and Practice

The four strategies to foster structural change can go a long way toward fostering the characteristics of resilient communities that were identified in Table 14.2.

The entrepreneurial strategy focuses on forming local businesses and job creation from within the local economy. This can occur across the wide spectrum of industries within the economy from manufacturing to advanced services to retail. It requires a critical mass of entrepreneurs, strong support networks, and a community ready for change, seeking innovation and willing to take risks (Lichtenstein, Lyons, and Kutzhanova, 2004). The strategy relies on the creation of social and professional networks. These networks connect business owners with service providers as well as grant access to resources, materials, labor, financing, and new markets.

The second local economic development strategy is based on ecofriendly or green development. There are a number of elements that can be found in the ecofriendly strategy, including green business, green building, waste management or diversion business, brownfield redevelopment, greenspace development, ecotourism, and eco-industrial development. These elements provide opportunities for new firm and employment creation, create demands for innovation, and use traditional marketing and recruitment skills aimed at attracting those who prioritize sustainability.

The third economic development strategy focuses on creating a culturally adaptive community. This type of community is one that sees its changing population as a source of assets to capitalize on or seeks to use the arts and culture as an economic development tool. These scenarios are not mutually exclusive. Despite the lack of community support, high housing poverty, poor English skills, and underemployment, ethnic populations have managed to build businesses and communities throughout rural and urban America. They are becoming an essential part of rural communities and central cities, adding children to declining schools, businesses to decaying main streets, and arts to dying towns. The culturally adaptive strategy requires economic developers to tailor traditional small business development approaches to meet the needs of different groups. This can include providing translation of business support materials into appropriate languages, or linking ethnic and minority business to corporate networks that can buy their products or services. Providing targeted workshops, training, and venture capital are other fundamental steps.

The final economic development strategy is the knowledge-based strategy. This strategy prioritizes the development of human capital from early childhood education on, the creation of a skilled labor force, and the fostering of innovation and creativity to spur new businesses and sources of employment. Knowledge-based communities are defined by the specific resources at their disposal. These can include businesses or private sector community members and other community development organizations as well as educational or research institutions, such as universities and colleges. Public–private partnerships are common. A distinguishing characteristic of knowledge-based communities is that they view the educational system not only as a vehicle for labor force development but also as one that can improve equity (School Communities That Work, 2002) and lead to "shared growth" where there is a "broad distribution of opportunities for meaningful participation in the economy and enjoyment of the benefits of an increased standard of living" (Schweke, 2004, p. 3).

The Way Forward

In concluding this book, we cannot overemphasize that these are challenging but exciting times for local economic development planning and practice. Economic developers have a critical role to play in helping communities to respond to the flatter, climate-challenged world. Traditional economic development practice will not be adequate to create sustainable economic development and to counter widening trends of inequality.

In order to serve their communities well, local economic developers will need a deep understanding of the major forces impacting local economies. They will need to hone analytical skills and take advantage of new sources of data and evidence that are rapidly becoming available from nongovernmental sources.[4] Further, local economic developers must direct their efforts to helping communities implement innovative and thoughtful strategies for creating sustainable and resilient economies. To advance SLED, practitioners should use the new data and evidence to evaluate any strategy or project under consideration by three questions: (1) Can it lead to a rising standard of living? (2) Can it reduce inequality between people and/or place? (3) Does it do no harm or, even better, repair the environment? Past evidence clearly shows that we cannot advance from traditional economic development to SLED unless the objectives represented by these questions are explicitly incorporated into our plans, policies, and actions.

Notes

1. This bullet list is adapted from the IEDC manual *Economic Development Strategic Planning*, revised November 2011.

2. We discussed in Chapter 9 one notable institutional change: the GASB Rule 77 that requires reporting of state and local tax incentives. See page 308.

3. See Samans et al. (2015) for a discussion of research evidence showing "that reducing inequality can enhance and strengthen the resilience of growth" (p. 2).

4. For example, real-time labor market data that is being created by private vendors from continual collection of job advertisements or improved business data from online surveying.

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Edward J. Blakely, PhD, is a professor of urban policy in the United States Study Centre at the University of Sydney, Australia. He has held academic positions in teaching, research, academic administration, and economic development policy for more than 30 years, including Dean of the Robert J. Milano Graduate School of Management and Urban Policy and Dean of the University of Southern California School of Policy, Planning, and Development. He is a leading scholar and practitioner in the fields of planning and local economic development. Dr. Blakely served as a policy adviser to the mayor of Oakland and adviser to the Los Angeles Public School District. He was appointed by President Clinton as vice chair of the Presidio Trust, where he played a key role in the development of the former army base into a profitable civic facility. He has served on the board of directors of the American Planning Association, the Nature Conservancy, and the Fulbright Association. In January 2007, Dr. Blakely was appointed by the mayor of New Orleans to head the recovery effort following the devastation of Hurricane Katrina.

Opportunities to Leverage Program Effectiveness via Partnerships
Interagency Network of Enterprise Assistance Providers
April 2012 Meeting Summary

Host
Small Business Administration (SBA)

Purpose of INEAP
Monthly forum where business and technical-assistance program-partnership catalysts meet in support of small businesses to initiate relationships and exchange information across organizational boundaries for the purposes of leveraging public-private resources and promoting innovative activities that accelerate domestic economic development.

Welcome and Opening Remarks

Speakers: Heidi Sheppard, Manufacturing Extension Partnership, National Institute of Standards and Technology, Department of Commerce
Michael Chodos, Office of Entrepreneurial Development, Small Business Administration

Attendees were welcomed to the April 2012 INEAP meeting convened at SBA located at 409 3rd Street, S.W., Washington, D.C. Exchanging information on new Federal program initiatives that support small businesses is a major goal of INEAP. Through this exchange of information, INEAP-member agencies can collaborate on each other's programs.

Small Business Administration, Office of Entrepreneurial Development
Michael Chodos, Associate Administrator for SBA's Office of Entrepreneurial Development, heard about INEAP 2 years ago from Antonio Doss, of SBA and one of the founders of INEAP. Since then, INEAP has come up again and again within the Office of Entrepreneurial Development during conversations involving all levels of collaborations, from grass roots to the Administrator levels within the Federal government. Most importantly, INEAP fosters non-political, directed, real collaboration among dedicated INEAP members in support of small businesses. Mr. Chodos commends INEAP members who are going over and beyond their normal responsibilities:

- To voluntarily be involved with INEAP,
- To share awareness of what is needed and what works within their programs, and
- To determine the most effective way to collaborate with each other's programs.

Mr. Chodos acknowledges the accomplishments and success stories that have evolved from INEAP interactions and looks forward to hearing the collaborative outcomes that result from April's INEAP meeting.

Feature Presentations
The April meeting featured presentations on:

- Employment and Training Administration's (ETA's) New Business Engagement Strategy,

- Access to Capital, a study by Booz-Allen for National Institute of Standards and Technology, Manufacturing Extension Partnership (NIST MEP),
- Small-Business-Assistance-Program Metrics Project, a study by American University, Kogod School of Business, for INEAP's Metric Subgroup, and
- *Supporting Entrepreneurs and Small Businesses: A Toolkit for Local Leaders*, National League of Cities (NLC).

The meeting continued with Sharing and Discussion and concluded with Announcements.

Employment and Training Administration's New Business Engagement Strategy
Speakers: Gina Wells and Megan Lizik, Employment and Training Administration, Department of Labor

Department of Labor (DOL), ETA, has developed a 2012 workforce-investment workplan to provide technical assistance to businesses across the country. The nation's workforce-investment system is Federally funded and supports workforce-development activities through the States and local communities, who operate one-stop career centers. These centers are designed to provide a full range of assistance to job seekers either in person or online (www.careeronestop.org).

The focus of ETA's 2012 workplan is to help businesses become more engaged in developing the nation's workforce through four areas: credentials and skills attainment, job fairs, small-business and entrepreneurship support, and communicating workforce-system successes.

- Credentials and Skills Attainment (1st Quarter)

ETA has sought input from national employers and the academic community to discuss highly valued credentials and skills to determine industry-recognized credentials that employers value and seek when recruiting. Through these efforts, ETA's certification-finder tool (www.acinet.org) has been enhanced and highlights credentials that are endorsed or accredited by third-party organizations such as the American National Standards Institute and the National Commission for Certifying Agencies. The certification-finder tool can be searched by industry, occupation, or keyword to find relevant certifications to help an individual qualify for employment or advancement.

- Job Fairs (2nd Quarter)

By hosting job fairs, businesses can promote the services and raise awareness of ETA's one-stop career centers. ETA has developed a Business Services Leadership Website (businessengagement.workforce3one.org) that provides training materials for businesses on how to hold virtual career fairs as well as resources for employing youth, veterans, and persons with disabilities. ETA has designated June as American Job Fair Month and hopes businesses will help ETA promote the nation's job-center network to new employers and jobseekers across the country by hosting local job fairs.

- Small-Business and Entrepreneurship Support (3rd Quarter)

Through roundtable discussions with small businesses and entrepreneurs that have been involved with programs sponsored by SBA, Economic Development Administration, and ETA, ETA's goal is to find ways to best promote local, integrated, public/private partnerships to better support small businesses and entrepreneurs. ETA's Small Business Toolkit (businessengagement.workforce3one.org/news/view/small-business-toolkit) is designed to help business-services representatives build strong partnerships between the workforce-development

system and business-serving organizations in an effort to support entrepreneurship and self-employment at the community level.

- Workforce-System Successes (4th Quarter)

ETA is gathering information from employers, the National Association of Workforce Boards and their best practices, and the National Association of State Workforce Agencies' conference on *Bridging Business and Workforce Development*, to determine what is working with the workforce system. ETA's Business Services Leadership Website (businessengagement.workforce3one.org) contains information and resources for business-services representatives to become more effective in partnering with and serving their business customers.

Gina Wells (well.gina@dol.gov) and Megan Lizik (lizik.mega@dol.gov) welcome comments and feedback on ETA's workplan to better engage businesses with workforce development.

Discussion

- It was emphasized that jobseekers need to know an employer's certification needs. ETA's tool should allow for employers to input their certification requirements.
- A major national concern is employing military personnel returning home.
- www.myskillsmyfuture.org helps jobseekers find career matches.
- Detroit is hosting the annual National Veterans Small Business Conference and job fair in June 2012 (www.nationalveteransconference.com/welcome).
- ETA's O*NET (www.onetonline.org) is the nation's primary source on occupational information and allows jobseekers and workers to explore and search occupational opportunities and find those occupations that are most in demand.
- SBA has many programs to help veterans become business owners (www.turbotap.org/portal/transition/lifestyles/Entrepreneurship/The_US_Small_Business_Administration_Programs_Reserve_Component).
- It was noted that only 7% of small and medium-sized manufacturers are aware of ETA's efforts on certifications. ETA is working on a communications plan.
- In ETA's Career Pathways Initiative (https://learnwork.workforce3one.org/), State and local teams work collaboratively to develop a career pathway system at the local level.
- Certifications need to be standardized from industry to industry. ETA and NIST MEP (stacey.wagner@nist.gov) will work together to look at certification-standardization issues.

Access to Capital

Speakers: Clara Asmail and Doug Devereaux, Manufacturing Extension Partnership, National Institute of Standards and Technology, Department of Commerce

A major goal of NIST MEP is to promote and motivate innovation and growth among the nation's small and medium-sized enterprises (SMEs); however, a barrier for SMEs is capital. A report on access to capital, *Connecting Small Manufacturers with the Capital Needed to Grow, Compete, and Succeed* (www.nist.gov/ineap/related.cfm), developed by Booz-Allen for NIST MEP, looks at current capital accessibility and its impact on SMEs.

The most common reasons SMEs need capital are for:

- Working capital (to cover inventory and accounts receivables and to meet supply-chain demands of larger manufacturers),

- Purchasing machinery or equipment,
- Expanding or remodeling a facility, and
- Refinancing/restructuring their balance sheet.

Gap analysis reveals weaknesses and strengths in the availability, awareness, and accessibility of sources of capital for SMEs. Bank-loan activity has been recovering since the recession hit in 2007; however, small-business-loan approvals by big banks dropped during the month of March 2012. While there is money available through various Federal programs designed to help SME access capital, many of the programs are underutilized. Loans from $150,000 to $500,000 are especially underutilized and represent the amount a small business would most likely pursue. However, small businesses are too busy to take on the paperwork and banks feel that loans from $150,000 to $500,000 are too much work.

MEP, in coordination with other Federal, State, public-private partnerships, and private-sector stakeholders, is looking at ways to address the availability, awareness, and accessibility of capital to SMEs. Recommendations from the study fall into three areas:

- Business assistance, including developing new or enhanced business-assistance offerings, such as providing guidance to MEP Centers on how to identify and establish relationships with local business-assistance organizations,
- Partnership and collaboration, which would focus on building relationships with key stakeholders who also have an interest and role in serving SMEs through their services, and
- Federal strategic and programmatic activities, which would focus on integrating capital-access strategies into existing Federal programs and plans, modifying existing Federal program requirements, developing communication products to raise awareness, and enhancing current MEP activities.

MEP continues to work with its Centers to better engage local Community Development Financial Institutions, banks, private-equity investors, and other sources of capital to build relationships and help direct local manufacturers to relevant sources and to the right products. MEP has an inventory of sources of capital (Prototype of Capital Sources Inventory) that was developed during the study and is planning to adapt the listing into a web-based diagnostic tool for SMEs.

NIST MEP will continue to develop a comprehensive set of solutions that addresses the availability, accessibility, and awareness gaps related to both the supply of, and demand for, capital. NIST MEP will be developing a pilot "MoneyTech" tool that will incorporate Federal, State, and private programs that provide loans, grants, and equity-based financing for SME growth and extract financial information relevant to specific funding sources that will help build and represent the fundability of manufacturers.

NIST MEP welcomes ideas from INEAP-member agencies (clara.asmail@nist.gov and douglas.devereaux@nist.gov).

Discussion

- *Connecting Small Manufacturers with the Capital Needed to Grow, Compete, and Succeed* and resulting toolkits should be posted on business.USA.gov.
- Should credit unions address the sweet spot and loan to SMEs? Credit unions are not-for-profit organizations; therefore, allowing credit unions to provide greater than 9% of their

business to businesses (versus consumers) would give credit unions an unfair advantage. Small banks could syndicate with larger banks, where small banks would work together and re-package their loans to sell to larger banks (much like the mortgage industry).
- More comprehensive listings of capital sources have been compiled by such organizations as Kenneth Poole's Council for Community and Economic Research.
- The Minority Business Development Agency (MBDA) (icunnaro@mbda.gov) has found that medium-sized businesses face unique challenges. An example is that minority-owned medium-sized businesses are vulnerable to takeovers.

Small-Business-Assistance-Program Metrics Project

Speakers: Beth Torres, Office of Small and Disadvantaged Business Utilization, Department of Veterans Affairs

Ralph Kirkpatrick, Lee Brindle, Raashi Binjrajka, Andres Bu Soto, Anthony Frazier, and Adrian Montgomery, Kogod School of Business, American University

Introduction

At the April 2011 INEAP meeting, a round-robin discussion was held on metrics. Three questions were posed:
- How does a Federal agency measure how well Federal investments are affecting the nation?
- How does a Federal agency measure a program's success?
- How does the Federal government measure the benefit of small-business programs?

It was determined that metrics for small-business programs within the Federal government must be better defined. Beth Torres took the lead to develop an INEAP special-interest group on metrics.

From that initial round-robin discussion, the INEAP Metrics Subgroup was formed. After several meetings, the Metrics Subgroup developed a memorandum of agreement with American University, where the Kogod School of Business would help produce a suite of small-business metrics through its practicum course for 2nd-year Masters of Business Administration students.

After initial discussions with the INEAP Metrics Subgroup, it was decided that the ultimate measure of success for small-business programs is job creation.

INEAP Metrics Report – Small Business Job Creation Analysis

Metrics are needed to determine whether Federal-government programs are creating jobs. These programs fall into three categories:
- Advocacy, through awards, partnerships, and research,
- Financial assistance, through grants, loans, subsidies, infrastructure, and contract awards, and
- Technical assistance, through advising, training, counseling, hiring, information dissemination, and education.

Traditionally, impact is measured after the fact. The power of metrics is to be able to determine impact in real time, to measure progress, and to then make adjustments.

To effectively determine the impact of a program, it is essential to:
- Define metrics properly,

- Standardize the metrics, and
- Communicate the metrics.

It is crucial for metrics to tell the story:
- Communicating mission success is critical for Congressional and agency oversight,
- Sharing successful programs and implementation approaches is critical for an effective government, and
- Attracting businesses to take advantage of agency programs will help small businesses create jobs.

Project Process

The goals of INEAP's Metrics study are to:
- Identify agency programs through Performance and Accountability Reports, agency websites, and General Accounting Office reports on program effectiveness,
- Catalogue agency programs and metrics,
- Analyze metrics as leading (programs need leading indicators to help justify program continuance and to steer the direction of a program), lagging (which confirm long-term trends, but do not predict them), and "but for" (what would the outcome be "but for" this program),
- Review industry best practices,
- Identify strengths, weaknesses, and opportunities (such as developing a composite index) of current metrics, and
- Develop a Federal dictionary of terms, which will standardize terms used in small-business metrics across the Federal government.

Summary

Thus far, the Metrics study has shown that:
- Standardizing metrics across job-creation efforts allow for evaluation across programs; continuous improvement as strong programs stand out and gaps are easier to identify; collaboration and sharing of resources, which allow for greater impact; and strengthening of the metrics base/stronger connections.
- Developing clear goals, metrics, and targets communicates the efforts of a program/illustrates a program's story.
- Developing a composite index, which is a combination of indicators intended to measure overall impact over time, will provide a gauge on a program's effectiveness and can therefore enhance a program's credibility.

Discussion

- The next phase of the study will look at specific elements, develop new methods for data collection, and propose new analytical tools and methods.
- The template being developed for the Federal government and manufacturers should be useful for other organizations and associations.
- Reports generated from the Government Performance and Results Act are silo/vertically based. The Metrics report is a study across the Federal government.
- The Federal government represents silos within silos. The approach of the Metrics study is across agencies.

- The Metrics report is unifying the message. Every agency is currently writing its story; however, with standardizing metrics and developing a dictionary of terms and a composite index, there is strength to having one message.
- An audience for the Metrics study should be elected officials.
- Whether a program is sustainable is important; what is the long-term life of a program after the funding ends?
- How jobs creation is defined is critical. Was a job created through funding or through best practices? How is return on investment determined?

Supporting Entrepreneurs and Small Businesses: A Toolkit for Local Leaders
Speaker: Christy McFarland, National League of Cities

NLC (www.nlc.org/) has conducted a multi-year study to better understand how local governments can support entrepreneurial and small-business growth. NLC researched literature and interviewed and conducted roundtable discussions with experts, city leaders, and practitioners involved with economic and regional development. At the national level, small businesses are a key to the U.S. economic recovery. At the local level, small businesses employ local residents and create a sense of place that enhances a community's quality of life.

The study focuses on four areas: understanding small-business development, roles within city hall, partnerships, and programs developed in cities across the country. The toolkit includes examples of support programs that range from regulatory improvements to university partnerships. Common themes across the programs are leadership, communications, and partnerships.

Understanding Small-Business Development
- As small businesses grow and develop, they face the same management, technical, and financial challenges.
- As small businesses grow and face new challenges, they need different resources and relationships to support them.
- Understanding the different stages and challenges a small businesses faces as it grows allows local governments to provide policies to support them.

Roles Within City Hall
- To support entrepreneurs and small businesses, local governments must first examine the policies and actions that lie within their powers. These include leadership, communication strategies that create avenues for local businesses to engage with local government, and an efficient regulatory environment.
- Strong local, elected leaders are needed to prioritize issues and show that entrepreneurs and small businesses are important to a community.
- Communication between the entrepreneurial/small-business community and the municipal government is needed to improve processes and to better respond to needs.
- Unclear regulations are especially burdensome on new and small businesses. Efforts must be made to communicate the availability of regulatory-assistance services.

Partners
Cities and local leaders can create meaningful partnerships because they can:

- Bring together service providers and business groups who may not be connected to each other,
- Identify gaps in the types of services being provided, and
- Serve as a centralized source of available services for small and new businesses.

Key partners include colleges and universities, small-business development centers, community-based organizations, business groups such as local chambers of commerce, and financial institutions.

City Examples

- To encourage local businesses to begin and continue greening their operations, the City of Austin, Texas, started a program called Austin Green Business Leader, which supports sustainability activities throughout the city.
- In an effort to spur economic development along Boston's waterfront, the Mayor developed a strategy that focuses on nurturing new and growing industries. A key component of Boston's Innovation District is that it offers entrepreneurs networking opportunities and business-development accelerator services.
- Instead of approaching economic development by attracting large companies with tax and land incentives, Littleton, Colorado, has developed its economy from within, known as economic gardening.
- New York has developed a program that supports immigrant small businesses by helping businesses build capacity, link businesses with customers, and connect businesses with resources.
- Scottsdale, in partnership with Arizona State University, has established the SkySong Center, a one-stop shop designed to incubate and accelerate startups.
- Seattle, Washington, recently focused its economic-development activities on facilitating connections, providing on-the-ground services to businesses needing assistance, and advocating policy and service changes to improve Seattle's business climate.
- Wichita, in collaboration with the Kansas World Trade Center, has developed a number of services to help small businesses achieve greater profits through trade. These services include consultation and research, education and training, translation and interpretation, and global credit reports.

Next Steps

- NLC is sharing the strategies and lessons learned from the study to help city leaders 1) better support entrepreneurs and small businesses in communities across the country and 2) shed additional light on how local governments contribute to business growth.
- NLC hosts bi-monthly Economic Development Network webinars. A webinar on Wednesday, May 23, at 2:30 p.m., Eastern time, will focus on small-business financing and support services.

Discussion

- NIST MEP Centers (www.nist.gov/mep) and MBDA's Minority Business Enterprise Centers (www.mbda.gov/main/offices) are good resources for NLC's toolkit.
- NLC's bi-monthly Economic Development Network webinars should be placed on business.USA.gov (contact dennis.alvord@sba.gov).

Sharing and Discussion

Appalachian Regional Commission

The Appalachian Regional Commission (http://www.arc.gov/) is helping local communities to form angel-investment funds in the Appalachian Region. Two types of awards are available through this Request for Proposal (RFP):

- Technical assistance will be provided to local entities to support new angel-fund formation or to improve the performance of an existing angel-fund/network. Up to four applicants will be selected for this support.
- Direct grant support will to be provided to qualified local organizations to support the formation of a new angel fund. Up to $30,000 of direct grant support will be provided to one qualified applicant in this round.

Selected applicants are anticipated to raise over $1 million each in local investment capital in angel-investment funds for early-stage and/or expanding companies. Proposals are due by 5:00 p.m., Eastern time, on June 15, 2012. Informational webinars will be held on May 14 and 15, 2012, to answer questions about this RFP and about angel-fund formation and operation.

Announcements and Concluding Comments

- Host, speakers, and attendees were thanked for their continued support of INEAP.
- Attendees are encouraged to share any type of collaboration tools, such as inter-agency agreements, alliance agreements, memoranda of understanding, or web casts, which can be posted on INEAP's website to help foster collaboration efforts. The web address for INEAP is www.nist.gov/ineap.

Next Meeting

Date: May 23, 2012
Time: 2:00 - 4:00 p.m.
Host: International Trade Center

Attendees

Clara Asmail, Department of Commerce, National Institute of Standards and Technology, Manufacturing Extension Partnership
William Bailey, American University, Kogod School of Business
Alexander Bant, American University, Kogod School of Business
Raashi Binjrajka, American University, Kogod School of Business
Ann Bradbury, Small Business Administration, Office of Small Business Development Centers
Lee Brindel, American University, Kogod School of Business
Andres Bu Soto, American University, Kogod School of Business
Michael Chodos, Small Business Administration, Office of Entrepreneurial Development
Mark Clark, American University, Kogod School of Business
Ivonne Cunarro, Department of Commerce, Minority Business Development Agency
Matthew Cunningham, American University, Kogod School of Business
Antonio Doss, Small Business Administration, Office of Grants Management
Anthony Frazier, American University, Kogod School of Business
Scott Henry, Small Business Administration, Office of Small Business Development Centers
David Hughes, Appalachian Regional Commission
Pam Hurt, Society of Manufacturing Engineers

Ralph Kirkpatrick, American University, Kogod School of Business
Carolyn Kluck, Appalachian Regional Commission
Lauren Leonard, Department of Labor, Office of Recovery for Auto Communities and Workers
Megan Lizik, Department of Labor, Employment and Training Administration
Glynis Long, Small Business Administration, Office of Women's Business Ownership
Jeff Lucas, Department of Commerce, National Institute of Standards and Technology, Manufacturing Extension Partnership
Isela Martin, Department of Labor, Office of Small and Disadvantaged Business Utilization
Paul Matthai, Environmental Protection Agency, Office of Pollution Prevention and Toxics
Christy McFarland, National League of Cities
Adrian Montgomery, American University, Kogod School of Business
Rachel Newman, Small Business Administration, Office of Small Business Development Centers
Heidi Sheppard, Department of Commerce, National Institute of Standards and Technology, Manufacturing Extension Partnership
Bob Sicina, American University, Kogod School of Business
Kevin Thompson, Department of Labor, Employment and Training Administration
Elizabeth Torres, Department of Veterans Affairs, Office of Small and Disadvantaged Business Utilization, Center for Veterans Enterprise
Gina Wells, Department of Labor, Employment and Training Administration

Attendees on the Phone
Aparna Darisipudi, Department of Labor, Employment and Training Administration
Doug Devereaux, Department of Commerce, National Institute of Standards and Technology, Manufacturing Extension Partnership
Chris Heflin, Department of Commerce, Office of the Deputy Secretary
John Larsen, Department of Commerce, International Trade Administration
Stephen Shapiro, Department of Commerce, Office of the Deputy Director
Stacey Wagner, Department of Commerce, National Institute of Standards and Technology, Manufacturing Extension Partnership

Meeting Location
Small Business Administration
409 3rd Street, S.W.
Washington, D.C. 20416

Time and Date
2:00 - 4:00 p.m., April 25, 2012

Assisted by
SciComm, Inc.

EDCO MOVE START GROW

ECONOMIC DEVELOPMENT FOR CENTRAL OREGON

2023 CENTRAL OREGON ECONOMIC PROFILE

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Welcome to Central Oregon

Where the commute times are short and breathtaking views await you at every turn. The region features dramatic snow-capped mountain ranges and high desert plateaus within Deschutes, Crook and Jefferson Counties. Located halfway between San Francisco and Seattle, one of the hottest small metropolitan markets in the U.S. is Central Oregon. In the last decade the region has seen some of the highest sustained GDP growth, job and population growth. This year, the Milken Institute ranked the Bend-Redmond region in the top 5 of its Best Performing Small Cities study. The report noted growth of the region's concentration of high-tech industry and robust broadband access as key strengths for the ranking.

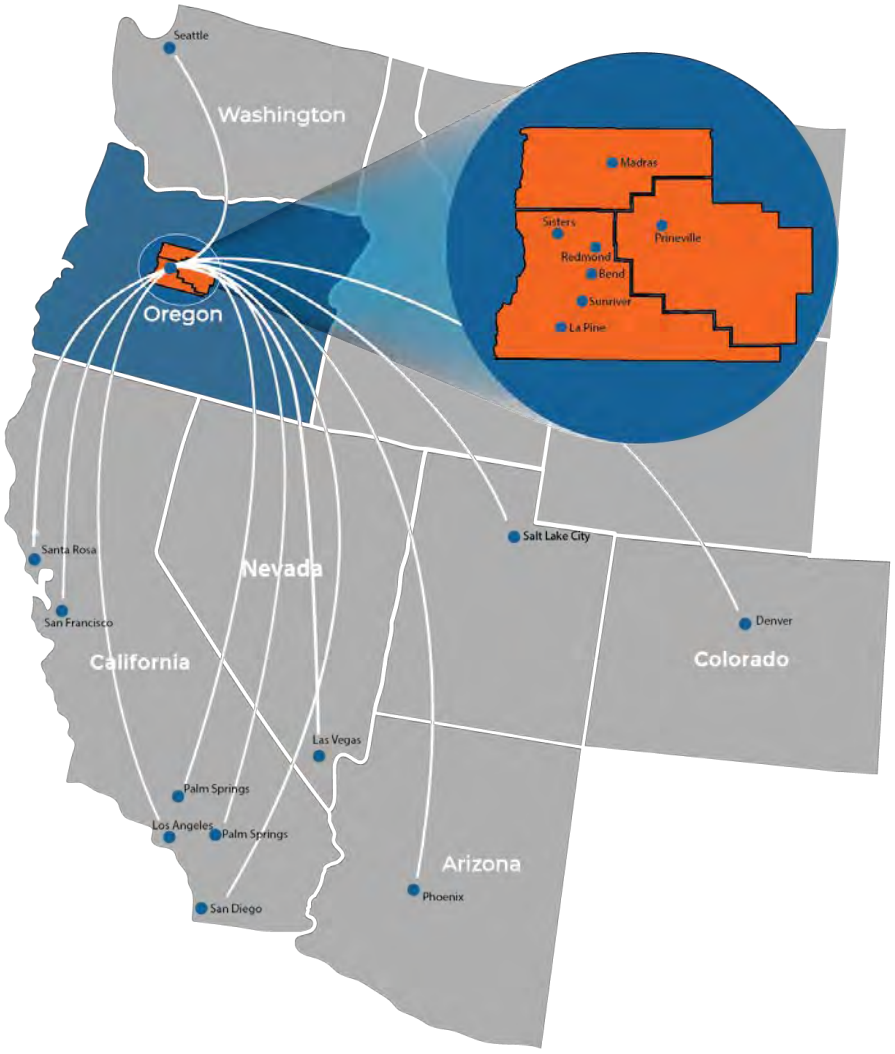
Central Oregon is pulling extraordinary talent and capital, fostering a diverse and highly entrepreneurial business ecosystem. Deschutes County received the most investment in Oregon in 2022, according to SmartAsset. Lured by natural scenic beauty and big city amenities without big city commute times, people are learning that having a true work-life balance is possible. Employees are happier and companies are more innovative and capital-efficient. Although domindated by small to mid-sized firms, Central Oregon brands compete globally - and win.

CENTRAL OREGON OVERVIEW

Regional Population: **259,127**
(2022 estimates from Portland State University)

Regional Labor Force: **123,953**
(Seasonally adjusted total for 2021 from Oregon Employment Department)

Bend-Redmond MSA GDP Per Capita: **$54,390**
(2020 estimate from the Bureau of Economic Analysis)
*Bureau of Economic Analysis data is only available for the Bend-Redmond MSA



Access outside and within the region has never been easier, with five national carriers flying up to 54 segments daily to 12 airports and major freight routes to the I-5 and I-84 corridors, all the while maintaining average commute times of less than 24 minutes between workforce centers around the region.

POPULATION

Central Oregon has been among the fastest growing regions anywhere in the U.S.

In-migration has been the dominating factor in the region's growth. With millions of visitors annually, Central Oregon continues to attract thousands of new residents from all over the country each year for its outdoor amenities, arts and culture opportunities, quality healthcare, and a growing education system.

POPULATION CHANGES FOR CENTRAL OREGON

Area	Population Growth 2010 - 2022	Net Migration %
Oregon	450,777	121%
Counties		
Deschutes County	49,828	109%
Crook County	5,184	98%
Jefferson County	3,684	110%

Source: Population Research Center, 2010-2022

"Central Oregon's economic growth is stronger than the state and nation overall. The primary reason is the high quality of life that attracts new residents. Faster population growth means local businesses can hire and expand at a faster rate due to the influx of working-age migrants and the growing labor force."

Josh Lehner
Economist,
Oregon Office of Economic Analysis

NEW RESIDENTS, NEW IDEAS & NEW ENERGY

#5

BEST MOUNTAIN TOWN IN THE UNITED STATES

***-OUTSIDE*, 2022**

With over 3.9 million visitors flocking to Central Oregon each year, it proves a great introduction to the region's culture, lifestyle and a great first impression for businesses. Central Oregon's population grew by an astounding 29.1% between 2010-2022. In 2022, Bend was one of six small cities with the most startups per capita in the U.S. While the population grows, Central Oregon is strategically investing in infrastructure and public spaces to ensure growth is sustainable. Citizens and organizations across the region are cultivating a community that has consciously decided to live here and attracting new talent pools to serve the increasing demand for labor.

POPULATION TOTALS FOR CENTRAL OREGON

Area	2000	2010	2015	2020	2022	% Growth 2010-2022
Oregon	3,421,399	3,837,300	4,013,845	4,243,959	4,281,851	11.8%
Crook County	19,184	21,020	21,085	24,866	26,162	24.7%
Deschutes County	115,367	157,905	170,740	199,263	207,561	31.6%
Bend	52,029	76,740	81,310	99,453	102, 834	34.2%
La Pine	*Not incorporated*	1,660	1,670	2,547	2,838	71.7%
Redmond	13,481	26,225	27,050	33,784	37,566	43.3%
Sisters	959	2,040	2,280	3,099	3,489	71.2%
Unincorporated	48,898	51,240	53,151	60,380	60,834	18.8%
Jefferson County	19,009	21,750	22,445	24,554	25,404	11.6%
Tri-County Total	153,560	200,675	214,270	248,683	259,127	29.1%

Source: Population Research Center, PSU. 2000 & 2010 census numbers are for April 1 of that year; 2015-2022 data are for July 1 of that year.

MOVE

EDCO guides employers outside the region through the relocation process as a resource for regional data, incentives, talent, site selection, and A-Z problem solving.

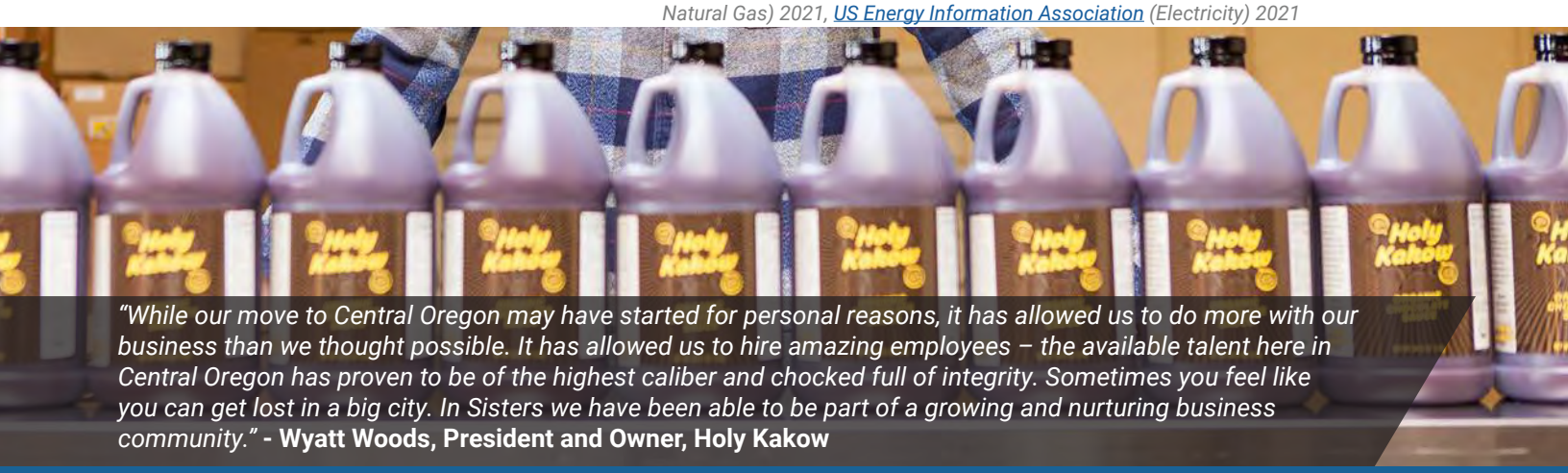
Business Cost Comparison

Oregon offers more incentive programs to traded-sector* businesses than Washington or California. Even without taking those incentives into consideration, Oregon is still a more cost-effective choice for doing business. Connect with EDCO for a detailed look at the business costs in Central Oregon.

**companies that sell their products or services outside the region, bringing new jobs and capital investment to the area*

	OR	CA	WA
Avg. Electricity Rate (¢/kWh)	8.95¢	19.65¢	8.75¢
Avg. Natural Gas Rate ($/kcf)	$5.07	$9.75	$8.21
State & Local Sales Tax Rate	None	8.82%+	8.86%+
State Business Tax Climate Index	#24	#48	#28

Sources: Tax Foundation 2023, US Energy Information Association (Average Industrial Price Natural Gas) 2021, US Energy Information Association (Electricity) 2021



"While our move to Central Oregon may have started for personal reasons, it has allowed us to do more with our business than we thought possible. It has allowed us to hire amazing employees – the available talent here in Central Oregon has proven to be of the highest caliber and chocked full of integrity. Sometimes you feel like you can get lost in a big city. In Sisters we have been able to be part of a growing and nurturing business community." **- Wyatt Woods, President and Owner, Holy Kakow**

Case Study: Holy Kakow

Founded in Portland in 2009, Holy Kakow creates premium organic chocolate sauces and syrups that are used in coffee shops across the nation and globe. After running the business for nearly a decade, President and Owner Wyatt Woods decided a move to the City of Sisters would be beneficial for his family. The next step was to figure out how to move the successful business. After EDCO's help with site selection, incentives, permitting, and more, Holy Kakow was able to move their operations into a new building in the Sisters Business Park. The relocation allowed them to scale for growth, even during the pandemic, expanding their employment from three to eight in the span of a couple months. Holy Kakow have their sights set on new product launches. With the backing of the community and the growing number of craft food businesses in Sisters, the company is surrounded by a strong business ecosystem to help them succeed.

Get connected to the growing industry clusters that include: advanced manufacturing, bioscience, outdoor products, technology, natural foods, and consumer goods.

EDCO links you to tools to help your company including: connections to the local supply chain, talent acquisition, incentives, business finance, market intelligence, and more.

EDCO helps you navigate the regional and local real estate market, infrastructure and permitting processes.

WHY CENTRAL OREGON?

The region offers a pro-business environment with several incentives and business finance options to encourage economic growth. Oregon also allows corporate net operating losses to be carried forward for up to 15 years without a cap, which can meaningfully reduce your business's tax liability.

For businesses looking to relocate, Central Oregon has a reputation for welcoming new companies. The region offers a tightknit community without sacrificing talent, education opportunities or quality healthcare. EDCO's network can help your business streamline decisions when choosing a new location.

START

EDCO mentor and advise scalable young companies from concept to exit on issues such as access to capital, critical expertise and business strategy.

"We moved to Bend to start Altitude Beverages in the fall of 2020. Besides the 300 days of sunshine and incredible outdoor activities, it is a great startup incubator."
- Thomas Angel, Founder & CEO, Altitude Beverages

Case Study: Altitude Beverages

Thomas Angel and Laura Melgarejo moved to Bend to start Altitude Beverages in the Fall of 2020, citing the startup community as a key contributor to their decision to move. Their first product - The Everything Latte - launched that same year and had such success that they expanded the line to include green and black tea lattes and sparkling white tea mocktails. In 2022, Altitude Beverages was a semifinalist at the Bend Venture Conference and has continued to work with EDCO for mentorship and access to funding. With a growing number of consumers looking to incorporate functional ingredients into their routine, Altitude Beverages' shelf-stable, canned products are poised for growth and are now available in about 500 stores across 13 states. Inspired by the community in Central Oregon, Thomas Angel partnered with fellow product makers from the area to form Cultivate Bend, a mutual benefit trade organization aimed at cultivating a vibrant ecosystem for the growing cluster of entrepreneurs, operators and leaders in Central Oregon's food and natural products industry.

ENTREPRENEURIAL SUPPORT

A driving force for Central Oregon's economic performance is a collaborative and inclusive entrepreneurial community. This is supported via the number of new business registrations, which has outpaced far larger cities. According to SmartAsset data, 28.96% of Deschutes County residents have small business incomes, and independent businesses generate about 13.02% of the income for the county.

The region is large enough to provide resources and access to capital that help new entrepreneurs get started, while still being small enough that those resources are interconnected to support businesses as they grow. Assets managed by EDCO include monthly Central Oregon PubTalks, the Stable of Experts mentorship program and the largest Angel Conference in the PNW, the Bend Venture Conference. Since launching in

BEST SMALL CITIES FOR STARTING A BUSINESS

Area	National Rank	Business Environment Rank	Access to Resources Rank
Washington, UT	1	4	3
St. George, UT	2	1	359
Bozeman, MT	3	8	18
Redmond, OR	**16**	**5**	**127**
Bend, OR	**23**	**3**	**54**

Source: WalletHub, April, 2023.

Both Redmond and Bend made WalletHub's Top 30 list for best cities to start a business, at #16 and #23 respectively, based on an index of criteria that included business environment, access to resources and business costs. They were the only two Oregon cities to make it in the top 450 of 1,334 small cities ranked in the index.

GROW

EDCO partners with local traded-sector companies to help them grow and expand, offering them the very same incentives and assistance as relocation projects.

"Our flagship manufacturing facility is located in Bend, nestled at the base of the Cascade Mountain Range, which also inspired the brand name. The views and outdoor amenities are unmatched, but the entrepreneurial and community support we have received from day one has been the driving factor in bringing our homegrown business sustainable success in Oregon and beyond. Our employees, customers and partners are what make Bend home and inspire continued growth." **- Affton Coffelt, Founder and CEO, Broken Top Brands**

Case Study: Broken Top Brands

HANDMADE
BROKEN TOP®
BRANDS

Broken Top Brands creates handmade, sustainable, eco-conscious candles and body products that have been featured in National media outlets such as BuzzFeed, Oprah Daily and HuffPost. Started as Broken Top Candle Co. in 2015 out of Founder Affton Coffelt's kitchen in Bend, the company has now blossomed to 19 employees and has grown its footprint to an 18,000 SF manufacturing facility.

Broken Top Brands is currently selling an array of all natural, biodegradble and paraben-free lifestyle products in the U.S., as well as Canada and parts of Europe. The brand's market is primarily wholesale with an organically growing e-commerce presence. Customers can find their products in over 2,800 retail locations nationally and internationally, with Whole Foods being their largest account.

Broken Top Brands was attracted to starting a business in Central Oregon for its quality of life and supportive community. Due to it's unique company culture and location, the business has had success retaining employees which has enabled its continued expansion. Broken Top Brands has sustained steady growth and continues to partner with EDCO, 1% for the Planet, One Tree Planted, Opportunity Knocks, Bend Chamber, and Business Oregon to serve their loyal customer base.

#5
FOR 5-YEAR JOB GROWTH IN THE U.S.
- MILKEN INSTITUTE, 2022

MANUFACTURING EMPLOYMENT GROWTH by Total Payroll 2012-2022	
U.S.	10.4%
Oregon	17.8%
Deschutes County	79.3%
Jefferson County	85.9%
Crook County	49.1%

Source: State of Oregon Employment Department

"Total nonfarm private sector employment in Central Oregon has grown by 50% over the last 10 years, which continues to be significantly faster than the statewide growth of around 25% in 2022. At the county level, Deschutes County has had the largest private sector growth since 2012, growing by approximately 52%, while Crook County has seen employment grow by 41% and Jefferson County by 35%. Employment in the private sector is projected to grow by 18% across the region between 2021 and 2031." **- Nicole Ramos, Oregon Employment Department**

Workforce Development

Communities in Central Oregon are actively engaged in aligning workforce goals with economic development. Local education institutions and private sector employers continue to find innovative ways to improve skill attainment within the workforce. In addition to a growing post-secondary education framework, East Cascades Works (EC Works) supports the talent needs of employers through intern placement, on-the-job training salary support and recruiting assistance.

Central Oregon Community College (COCC) has campuses in Bend, Prineville, Redmond, and Madras. Students can choose from over 25 Certificate and Associate options.

OSU-Cascades offers over 26 degree programs and recently announced a program that will integrate career preparation into coursework for all students to prepare them for success.

INCOMING INVESTMENT

The combination of a collaborative culture, a supportive attitude among government and economic development partners, plus a location that attracts talent and investment all help Central Oregon compete nationally.

INCOMING INVESTMENT BY COUNTY IN OREGON

Rank	County	Business Growth	GDP Growth (millions)	New Building Permits (per 1,000 homes)	Incoming Investment Index
1	Morrow	2.5%	$152	39.8	46.00
2	**Deschutes**	6.8%	$5,878	16.3	42.03
3	Marion	4.7%	$6,508	14.6	38.73
4	**Crook**	2.7%	$425	20.2	37.38
5	Polk	5.5%	$1,150	7.2	35.21
6	**Jefferson**	4.2%	$319	10.7	34.89
Oregon Totals		**0.3%**	**$2,691**	**8.1**	

Source: SmartAsset, 2023

AIR

Redmond Municipal Airport (RDM; www.flyrdm.com) provides commercial air service with an average of 28 daily outbound flights to Burbank, Denver, Las Vegas, Los Angeles, Palm Springs, Phoenix, Portland (coming November 2023), Salt Lake City, San Diego, San Francisco, Santa Rosa and Seattle via five carriers (Alaska, American, Avelo, Delta, and United).

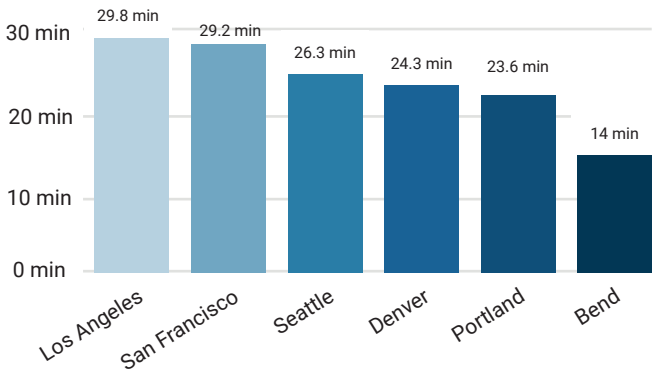
RAIL

Burlington Northern-Santa Fe (BNSF), Union Pacific Rail Road (UPRR) and the City of Prineville Railway (COPR) provide direct connections for shipping to any market in the United States, Canada and Mexico.

FREIGHT

U.S. Highways 97 and 20 are two of the State's major trucking routes, with access to major metro areas with connections to Interstate 5 (N-S) and Interstate 84 (E-W).

Average Commute Times



The average commute time in Bend is **14 minutes** each way, saving the average worker **over one work week per year**!

Source: Census.gov 2021

Travel Time & Distance by Car

- **BEND, OR**
- **PORTLAND, OR** — 164 miles, 3 hours, 13 minutes
- **MEDFORD, OR** — 173 miles, 3 hours, 15 minutes
- **OLYMPIA, WA** — 269 miles, 4 hours, 44 minutes
- **BOISE, ID** — 316 miles, 5 hours, 12 minutes
- **SEATTLE, WA** — 329 miles, 5 hours, 46 minutes
- **SAN FRANCISCO, CA** — 491 miles, 7 hours, 55 minutes
- **LOS ANGELES, CA** — 820 miles, 12 hours, 38 minutes

Travel Time By Air

- **REDMOND, OR**
- **SEATTLE, WA** — 1 hour, 10 minutes
- **SAN FRANCISCO, CA** — 1 hour, 10 minutes
- **SALT LAKE CITY, UT** — 1 hour, 30 minutes
- **BURBANK, CA** — 1 hour, 30 minutes
- **LOS ANGELES, CA** — 2 hours
- **Las Vegas, NV** — 2 hours
- **DENVER, CO** — 2 hours, 24 minutes
- **PHOENIX, AZ** — 2 hours, 30 minutes
- **SAN DIEGO, CA** — 2 hours, 40 minutes
- **PALM SPRINGS, CA** — 3 hours, 55 minutes

SERVICES & INFRASTRUCTURE

UTILITIES

Most of the region has been newly built in the past two decades, making Central Oregon's telecommunications infrastructure one of the Northwest's most technologically advanced. Businesses and telecommuters benefit from reliable fast data speeds and upload times.

EDUCATION

Central Oregon is well-recognized for its high level of education, with some of the best K-12 public schools in the nation. In 2022, the Bend-La Pine school district's average SAT scores surpassed the national average by 57 points. Additionally, the higher education opportunities abound. From Oregon State University-Cascades campus' ongoing expansion, to Central Oregon Community College's four campuses in the region, there are opportunities for all to obtain a quality education.

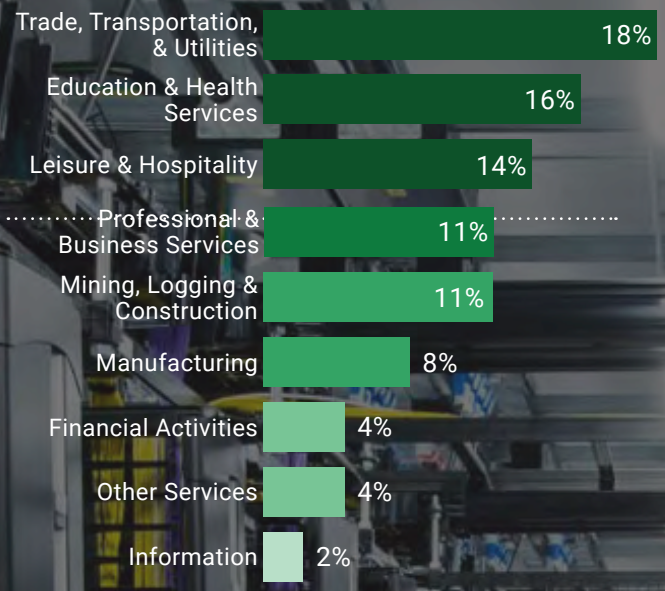
HEALTHCARE

St. Charles Health System is the largest healthcare provider in the region, and is also the largest employer with over 4,500 employees across the tri-county area. The hospital received HealthGrade's 2021 Pulmonary Care Excellence Award™ and offers a network of more than 100 clinics and specialty practices throughout the area.

TOP EMPLOYERS

2022 Central Oregon Industry Composition

Private by Employment



Source: **State of Oregon Employment Department**, *2022*

CENTRAL OREGON RANKED #1 IN THE STATE FOR JOB GROWTH AT 29.7%

- **Oregon Employment Department** , 2011-2021

According to the Oregon Employment Department, 76% of Oregon establishments have between one and nine covered payroll employees and the average private establishment employs around 11 people.

"Traded-sector businesses play a pivotal role in stimulating economic growth by infusing new capital into the local economy, ultimately creating a ripple effect of supporting local governments, retail, service, and utility providers. As the backbone of Central Oregon's economic stability, these employers have been instrumental in driving employment growth across the region." -Jon Stark, CEO, EDCO

Rank 2023	Rank 2022	2023 Central Oregon Largest 50 Private Employers	Employees 2023	Employees 2022
1	1	St. Charles Health Syst., regional	4,400	4,509
2	5	Mt. Bachelor	1,081	894
3	2	Bright Wood Corporation, regional	1,079	1,030
4	4	Les Schwab, regional	953	916
5	3	Sunriver Resort	900	1,000
6	6	Safeway, regional	776	714
7	8	Summit Medical Group, regional	686	628
8	7	Fred Meyer, regional	579	640
9	16	BASX Solutions	528	340
10	9	McDonald's, regional	523	605
11	10	Lonza, formerly Bend Research	463	440
12	28	Epic Aircraft, LLC	410	221
13	13	Black Butte Ranch	400	375
14	12	Mosaic Medical, regional	397	391
15	NL	Costco	370	NC
16	15	Meta - Facebook Data Center	350	350
17	17	PacificSource	348	336
18	NL	BestCare Treatment Services	341	NC
19	11	Rosendin Electric	315	415
20	18	Praxis Health, regional	296	296
21	20	Medline ReNewal	292	267
22	NL	Central Oregon Radiology Assocs.	286	NC
23	19	Brasada Ranch	280	280
24	26	PCC Structurals, Inc.	266	226
T-25	T-46	TDS Telecom	250	150
T-25	43	Riverhouse on the Deschutes	250	157
27	23	Neighbor Impact, regional	249	238
28	T-46	Deschutes Brewery	247	150
29	31	Endura Products	245	206
30	NL	Walmart	234*	234
31	T-33	Sunriver Brewing Company	222	200
T-32	T-29	Tetherow	220	220
T-32	T-29	The Center (Ortho/Neuro Care)	220*	220
34	T-24	10 Barrel Brewing Co.	215	235
35	22	Consumer Cellular	210	245
T-36	T-24	Pronghorn Resort	204	235
T-36	T-33	Touchmark at Mt. Bachelor Village	204	200
38	21	Opportunity Foundation	201	249
39	T-39	Albertson's, regional	200	165
40	35	Keith Manufacturing Co.	196	199
41	32	Bi-Mart, regional	195	204
42	41	Nosler	193	164
43	38	Western Heavy Haul & SMAF	171	171
44	37	First Interstate Bank, regional	168	176
45	NL	Seran Bioscience	165	NC
46	49	Ray's Food Place, regional	163	149
47	44	J Bar J Youth Services	160	154
T-48	36	Indian Head Gaming	155	140
T-48	NL	Quality Truss/Parr Lumber	155	133
50	45	Rebound Physical Therapy	153	153

NL = Not Listed | T = Tied

ADVANCED MANUFACTURING

- More than 100 businesses in advanced manufacturing make their own products here in Central Oregon, as well as provide a critical role in the supply chain for other OEM in aviation/aerospace, brewing & distilling, specialty food processing, and automotive.
- Additive and subtractive machining of metals and plastics, advanced welding and metal fabrication, specialty metals casting, production printing and publishing, as well as specialized machinery and equipment continue to advance locally.
- The largest employers in this industry group include Precision Cast Parts (PCC) Schlosser, Keith Manufacturing and BASX Solutions.

AVIATION & AEROSPACE

- The production of light aircraft in Central Oregon spans back more than 30 years and over that time, 25 aircraft have moved through the process of conceptual design to flight.
- Composite (carbon fiber) fabrication and innovation aircraft are the region's specialty offering a cluster of world-class talent and capabilities here.
- Some of the most successful flight training programs in the country are located in the region with both fixed-wing and helicopter flight schools that serve the global industry, including Leading Edge, Hillsboro Aero Academy and Central Oregon Community College.

BIOSCIENCE

- Producing everything from titanium implants to cutting edge drug research, Central Oregon's bioscience industry has been experiencing year-over-year double digit employment growth for nearly a decade.
- Quietly, Central Oregon's bioscience industry has proven capable of attracting world-class scientific and technical talent that has made companies here competitive on a global scale.
- Swiss-based pharmaceutical research and manufacturer, Lonza, is the largest bioscience company in the region, and among the largest in Oregon, with two campuses and additional operations scattered across the region.

MEDLINE · PHILIPS · GRACE BIO-LABS · seran · Lonza · ThermoFisher SCIENTIFIC

BREWING & DISTILLING

- Central Oregon is home to breweries both large and small, with Deschutes Brewery production placing it as the largest craft brewery by volume in Oregon.
- For Oregon, which has 318 craft breweries, nearly one-third of the largest 30 brewers by volume are located in Central Oregon – testimony to the quality of product produced here.
- The region is also home to a dozen craft cideries and distilleries. Notably, two of these, Bendistillery and AVID Cider, hold the distinction of being the second largest in the state in their respective sectors.

10 BARREL BREWING CO · DESCHUTES BREWERY · WILD ROOTS SPIRITS · SUNRIVER BREWING COMPANY · crux fermentation project · BEND BREWING COMPANY

#3 LEADING HOP PRODUCTION STATE -STATISTA, 2022

#2 BEST CITIES FOR BEER DRINKERS -SMARTASSET, 2022

BUILDING PRODUCTS

- After 100+ years and considerable systemic change across the industry, the building products sector is still Central Oregon's largest traded-sector employer.
- Businesses in this sector compete and win on a global scale, innovating and automating as global leaders in their respective sub-industries, including wood doors and windows, mouldings, cabinetry, furniture, and musical instruments.
- The region's largest manufacturer and third largest private employer, Bright Wood Corporation, is based in Madras, with operations in Redmond, Culver and Prineville. The company has been growing in Central Oregon for over a half century.

Bright Wood Quality Millwork · CertainTeed Saint-Gobain · JELD-WEN Windows & Doors · Breedlove · Chase Doors · Powered by Endura Door Components Made in the USA · Warm Springs Composite Products · Brian's Cabinets

OUTDOOR GEAR & APPAREL

- Central Oregon is home to a diverse group of businesses in a variety of sub-sectors, including rock climbing, water sports, hydration, hiking, backpacking, recreation vehicles, road and mountain biking, outerwear, and software.
- The region is home to the Oregon Outdoor Alliance (OOA) which is dedicated to connecting and cultivating the industry through events, mentorship and advocacy.
- The region's largest manufacturer and third largest private employer, Bright Wood Corporation, is based in Madras, with operations in Redmond, Culver and Prineville. The company has been growing in Central Oregon for over a half century.

Hydro Flask · Entre Prises · Metolius · BOW Bend Outdoor Worx · Ruffwear · Drinktanks · Puffin drinkwear

#5
GREAT CITIES IN THE U.S. FOR OUTDOOR ADVENTURES
- WASHINGTON POST, 2022

PROFESSIONAL SERVICES

- Central Oregon companies are increasingly exporting professional services outside of the tri-county region in specialties including engineering, architecture, accounting, HR, recruitment, creative services, advertising, and publishing to name a few.
- The creative, marketing and advertising sub-sectors of this industry are particularly strong in Central Oregon with firms being attracted to the region from as far away as Barcelona, Spain.

TECHNOLOGY

- Including software companies, electronics manufacturers, alternative energy and data centers, the region has over 130 tech companies employing nearly 3,000 people.
- Five dozen software companies call the region home, often locating their headquarter operations in Central Oregon.
- Prineville is a growing data center hub and is home to Meta's first and largest data center campus, a 4.5 million square foot complex. Central Oregon offers a unique advantage for data centers due to its available infrastructure, affordable industrial land, multiple telecom carriers, desert climate, and globally competitive tax incentives.

#3
FOR 5-YEAR HIGH TECH GDP GROWTH
-MILKEN INSTITUTE, 2022

LIFESTYLE

Located on the eastern slopes of the Cascade Range, where vast forests give way to the arid high desert, Central Oregon boasts year-round adventure, a rare mix of city amenities and world-famous outdoor recreation. The region offers the slower speed of a small town with access to top-rated healthcare and infrastructure to support continued economic growth.

#1
TOP 10 COOLEST PLACES TO LIVE IN AMERICA
-FORBES, 2021

#10
BEST SMALL CITIES FOR BUSINESS
-U.S. CHAMBER OF COMMERCE, 2022

#9
MOST DYNAMIC METROS
-HEARTLAND FORWARD REPORT, 2022

#5
BEST MOUNTAIN TOWN IN THE UNITED STATES
-OUTSIDE, 2023

#8
BEST SKI TOWNS FOR ALPINE ADVENTURES IN THE U.S.
-PACASO, 2023

#2
MOST FITNESS FRIENDLY PLACE IN THE U.S.
-SMARTASSET, 2022

30+ Golf Courses

Miles and Miles of Trails

Flourishing Arts & Culture Scene

31 Breweries & Counting

300 Days of Sunshine

ABOUT EDCO

Founded in 1981, EDCO is a non-profit corporation supported by private and public members and stakeholders. Our mission is to create a balanced and diversified economy with a strong base of middle-class jobs in Central Oregon.

To do this, we focus on helping companies do the following:

MOVE. We guide employers outside the region through the relocation process as a resource for regional data, incentives, talent, site selection, and more.

START. We mentor and advise scalable young companies from concept to exit on issues such as access to capital, critical expertise and business strategy.

GROW. We partner with local traded-sector companies to help them grow and expand.

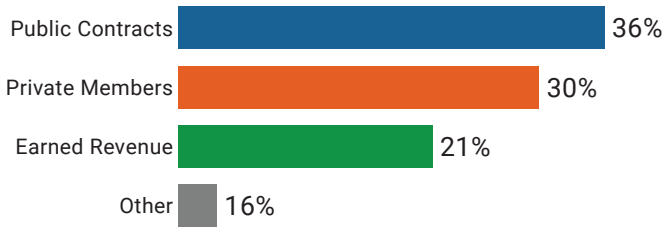
EDCO'S RESULTS

Fiscal Year	Companies	Jobs (New & Retained)	New Capital Investment
2022 - 2023	23	126	$53.7 million
2021 - 2022	13	483	$1.98 billion
2020 - 2021	34	451	$208.7 million
2019 - 2020	36	774	$67.1 million
2018 - 2019	40	587	$70.5 million
2017 - 2018	31	288	$199.7 million
Totals	**177**	**2,709**	**$2.58 billion**

EDCO Platinum Members

- BendTel
- Cascade Natural Gas
- Central Oregon Community College
- City of Bend
- City of La Pine
- City of Madras
- City of Prineville
- City of Redmond
- City of Sisters
- Combined Communications
- Crook County
- Deschutes County
- First Interstate Bank
- Jefferson County
- Mid Oregon Credit Union
- OSU-Cascades
- Pacific Power
- PacificSource Health Plans
- Schwabe, Williamson & Wyatt
- Sensiba San Filippo
- St. Charles Health System
- U.S. Bank
- Velox Systems

EDCO'S Funding Sources



Additional information available at EDCOINFO.COM

- Upcoming networking events, luncheons, conferences, and more
- EDCO Info Hub: current comprehensive data for Central Oregon
- Incentives available to help offset the costs of operating or starting a business in Central Oregon
- Success stories from regional businesses
- Business news on EDCO's blog

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OREGON TECH

Soaring data center electricity demand could trigger Northwest blackouts, industry insiders say

Updated: Dec. 11, 2024, 10:14 p.m. | Published: Dec. 11, 2024, 1:44 p.m.

Power lines feed an Amazon data center near Boardman. Dave Killen / The Oregonian

OREGONLIVE
The Oregonian

By Mike Rogoway | The Oregonian/OregonLive

A panel of authorities on the data center industry told Northwest energy planners Wednesday that the tech sector will take all the electricity it can get its hands on, warning of severe consequences if the region doesn't respond in time.

"We're going to need to build more transmission faster than any time we have in the last 70 years as a region," said Robert Cromwell, who consults with Northwest power utilities. He said the region is already flirting with rolling blackouts because peak energy demand is already near the region's capacity to provide electricity.

OREGONLIVE
The Oregonian

Data center demand is soaring because of artificial intelligence, which uses massive amounts of electricity for advanced computation. These powerful machines already consume more than 10% of all of Oregon's power and forecasters say data center power use will be at least double that by 2030 — and perhaps some multiple higher.

If the Northwest fails to add enough generation and transmission to meet the growing energy needs, Cromwell said periodic blackouts are inevitable at times power demand is at its greatest. He used an industry term, "rotating load shedding," to describe rolling blackouts, which briefly cut off power to homes, businesses and even hospitals that need electricity to provide life-saving care.

"Nothing will change policy faster than elected officials going to constituent funerals, and it won't be for the better because it'll be reactionary and less than fully thought through," Cromwell told Wednesday's meeting of the Northwest Power and Conservation Council.

Oregon has one of the nation's largest and fastest-growing data center industries, owing in large part to some of the most generous tax breaks anywhere in the world. Data centers don't employ many people, but the wealthy tech companies that run them enjoy Oregon tax giveaways worth more than $225 million annually.

Amazon, Apple, Google and Meta operate enormous data centers in central and eastern Oregon. Several other companies, including Oracle, LinkedIn and the social network X, have huge installations in Hillsboro.

Earlier this year, the power council issued a forecast suggesting a range of possibilities for data center power demand through the end of the decade. In the middle case, the council said Northwest data centers would need 4,000 average megawatts of additional electricity in 2030.

That's an enormous jump in demand, equivalent to the power use of 3 million homes.

And yet on Wednesday, Cromwell said the council's median forecast is too low.

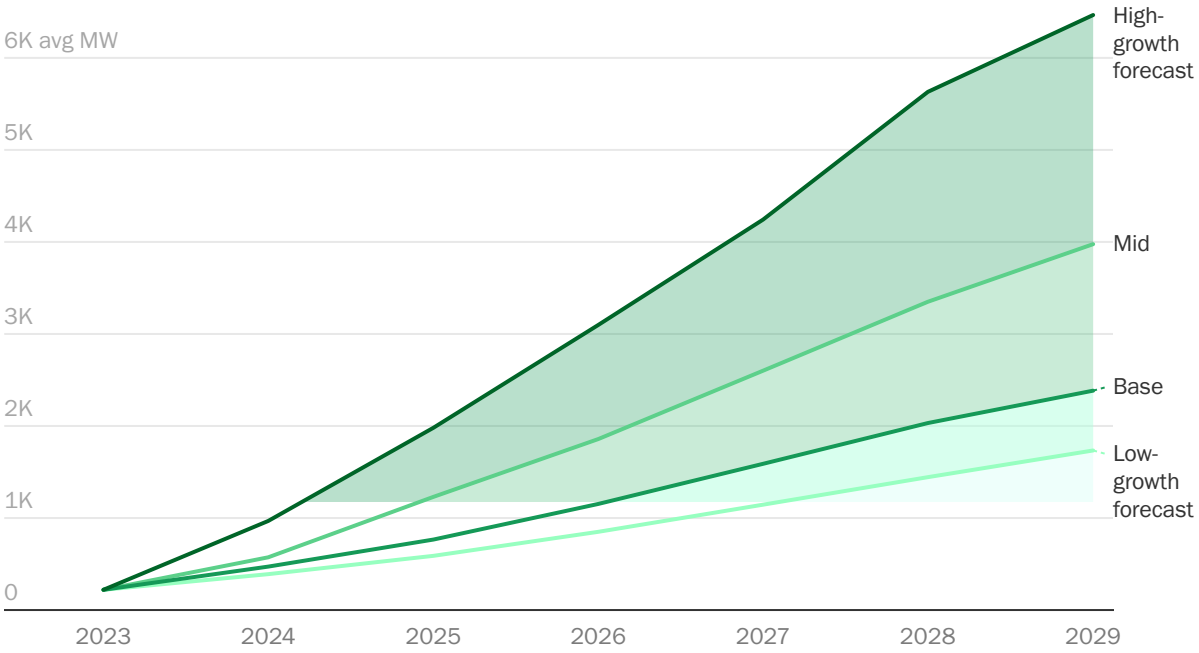
"Your medium case is not high enough and your high case is probably pretty close to spot on," he said.

The high forecast predicts that data centers will actually need an additional 6,500 average megawatts in the next few years — equivalent to the power needs of nearly 5 million homes.

OREGONLIVE
The Oregonian

Expected growth in NW electricity use by tech industry

Energy forecasters say Northwest data centers and chip factories could need thousands of additional megawatts of electricity by the end of the decade. They say 80% of the growth will come from data centers. At the high end of the forecast, new data centers could require nearly as much power as all the homes in Oregon and Washington use today.



The Northwest Power and Conservation Council says all four scenarios are possible. Outside consultants say the high forecast is the most likely.

Source: Northwest Power and Conservation Council • Get the data

"There's no question in my mind that the demand for computation and AI, and the demand to plug in (computer processors), exceeds the available power that we have by 2030," said Brian Janous, a former Microsoft vice president now consulting for industrial electricity users.

There's little prospect of blunting that growth by shifting demand to other data centers during peak times or through the invention of more efficient computers, Janous and others told the council on Wednesday. He said the demand for artificial intelligence is so high that data center operators will use all the electricity they can get and will operate all their facilities around the clock.

When power demand exceeds supply, during winter storms or heatwaves for example, utilities and governments must make wrenching decisions about who loses power and for how long. Turning off power to data centers could preserve power for homes and hospitals but would have its own negative consequences.

Think about the faulty CrowdStrike software update last summer, said panelist Sarah Smith, with the Lawrence Berkeley National Laboratory. That took down banks, hospitals, factories, news sites and many others as online systems went awry.

“Air travel was disrupted for days,” Smith said. “There was a lot of really wide-ranging impacts you could imagine.”

The Northwest Power and Conservation Council is a regional organization that works with utilities and governments in Idaho, Montana, Oregon and Washington to balance future power needs and environmental protections. It convened Wednesday’s panel on data centers to help plan a new forecast the council will issue next year.

Big tech companies generally accept the scientific consensus that carbon emissions are causing climate change. Until recently, most tech companies expressed public commitments to find renewable power for their data centers.

Recently, though, Janous said they’ve become “willing to compromise, in the short run” on their clean power goals because they’re desperate for any source of electricity.

Despite the data centers’ voracious appetite for power, the panelists expressed some hope that the region will be able to meet the challenge and, in time, push data center operators to return to their clean energy aspirations. They suggested a Northwest regional transmission authority, long under discussion, could help streamline the construction of new power lines and collaboration among western states.

Data centers’ power needs are triggering expensive upgrades to the Northwest’s power lines and prompting construction of new power plants. There is growing concern among ratepayer advocates, regulators and politicians that households will end up bearing much of the cost of data center growth through higher residential power bills.

On Wednesday, panelists said data center operators are highly motivated. They said tech companies probably would be willing to bear the cost of additional power themselves, provided they have a pathway to get that energy quickly.

MORE BY MIKE ROGOWAY

"The companies that are asking for this infrastructure are extraordinarily deep-pocketed and there's a huge willingness to pay," Janous said, "because the returns they earn on the back end are massive."

-- Mike Rogoway covers Oregon technology and the state economy. Reach him at mrogoway@oregonian.com.

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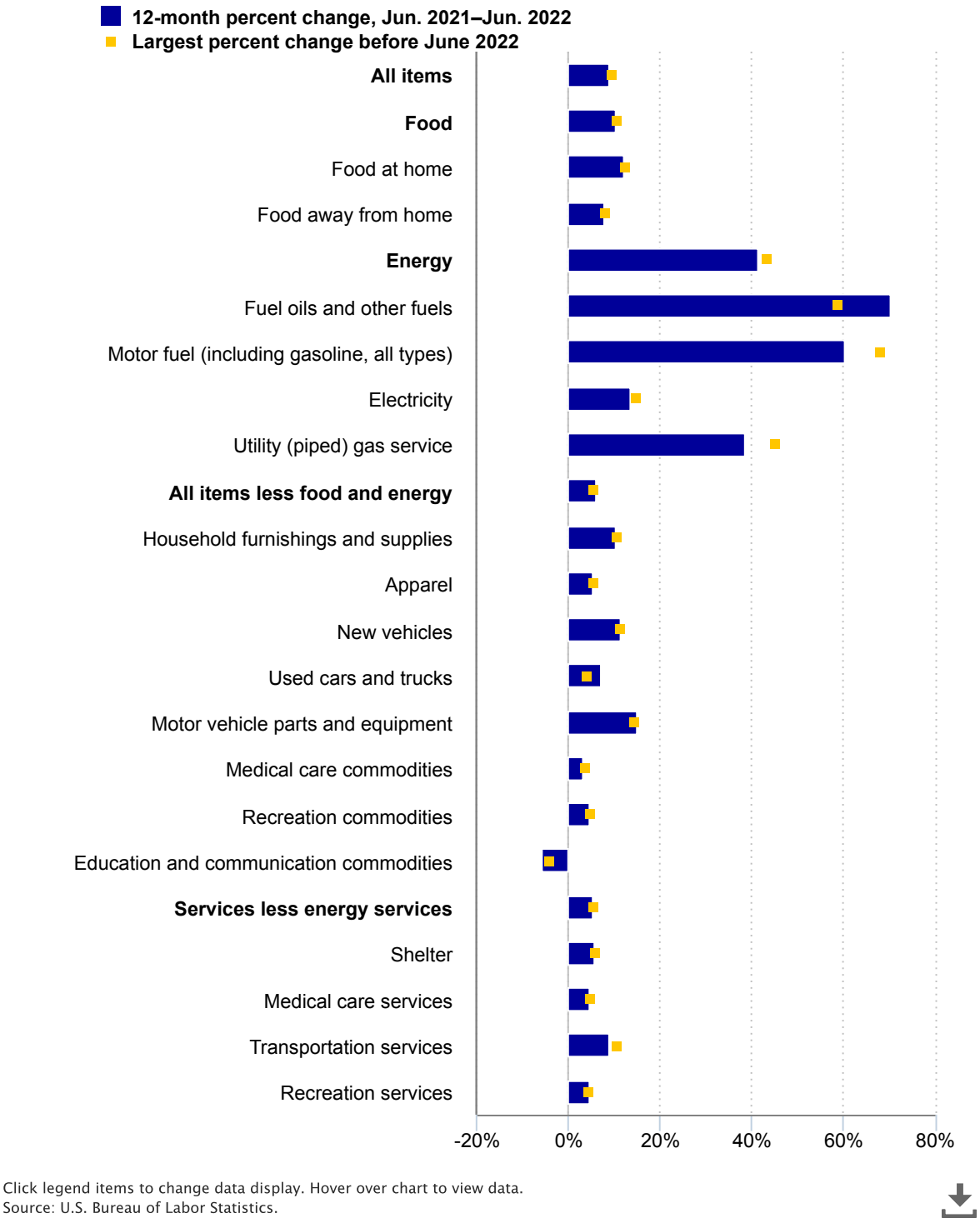
Consumer prices up 9.1 percent over the year ended June 2022, largest increase in 40 years

July 18, 2022

Over the 12 months ended June 2022, the Consumer Price Index for All Urban Consumers increased 9.1 percent. The 9.1-percent increase in the all items index was the largest 12-month increase since the 12-month period ending November 1981.

CHART IMAGE | CHART DATA

Consumer Price Index for All Urban Consumers, 12-month percent change, by expenditure category, June 2022



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

Consumer Price Index for All Urban Consumers, 12-month percent change, by expenditure category, June 2022

Expenditure category	12-month percent change, Jun. 2021–Jun. 2022	Largest percent change before June 2022	Month of previous largest percent change
All items	9.1%	9.6%	Nov. 1981
Food	10.4	10.5	Feb. 1981
Food at home	12.2	12.3	Apr. 1979
Food away from home	7.7	8.0	Nov. 1981
Energy	41.6	43.5	Apr. 1980
Fuel oils and other fuels	70.4	58.8	Apr. 2022

Expenditure category	12-month percent change, Jun. 2021–Jun. 2022	Largest percent change before June 2022	Month of previous largest percent change
Motor fuel (including gasoline, all types)	60.2	68.2	Mar. 1980
Electricity	13.7	14.8	Apr. 2006
Utility (piped) gas service	38.4	45.3	Oct. 2005

Prices for food increased 10.4 percent for the 12 months ending June 2022, the largest increase since February 1981. Prices for food at home rose 12.2 percent over the last 12 months, the largest increase since April 1979. Prices for food away from home rose 7.7 percent, the largest 12-month change since November 1981.

Energy prices rose 41.6 percent over the last year, the largest 12-month increase since April 1980. Within the energy category, motor fuel prices (which includes all types of gasoline) increased 60.2 percent over the year. Gasoline prices increased 59.9 percent, the largest 12-month increase since March 1980. Electricity prices rose 13.7 percent, the largest 12-month increase since April 2006. Natural gas (piped utility gas) prices increased 38.4 percent over the 12 months ended June 2022, the largest increase since October 2005.

Prices for new vehicles increased 11.4 percent over the year, prices for used cars and trucks were up 7.1 percent, while prices for motor vehicle parts and equipment increased 14.9 percent.

These data are from the Consumer Price Index program and are not seasonally adjusted. To learn more, see "Consumer Price Index — June 2022." Also see more charts related to the latest Consumer Price Index news release.

RELATED SUBJECTS
Prices

SUGGESTED CITATION

Bureau of Labor Statistics, U.S. Department of Labor, *The Economics Daily*, Consumer prices up 9.1 percent over the year ended June 2022, largest increase in 40 years at https://www.bls.gov/opub/ted/2022/consumer-prices-up-9-1-percent-over-the-year-ended-june-2022-largest-increase-in-40-years.htm (visited *November 14, 2025*).

OF INTEREST

Spotlight on Statistics

Recent editions of *Spotlight on Statistics*

- Fatal Injuries to Foreign-Born Hispanic or Latino Workers
  Explores the industries, occupations, and events related to these fatalities.
- For-Profit, Nonprofit, and Government Sector Jobs in 2022
  Compares the labor force characteristics and experiences of workers in the for-profit, nonprofit, government, and self-employed sectors.
- Union Membership, Activity, and Compensation in 2022
  Focuses on trends in union membership, work stoppages, and pay and benefits among union members.
- A Look at a Neat Industry: Distilleries
  Examines trends in employment, establishments, wages, and consumer prices for distilleries.
- Healthcare Occupations: Characteristics of the Employed
  Compares the demographic characteristics of workers in healthcare occupations.

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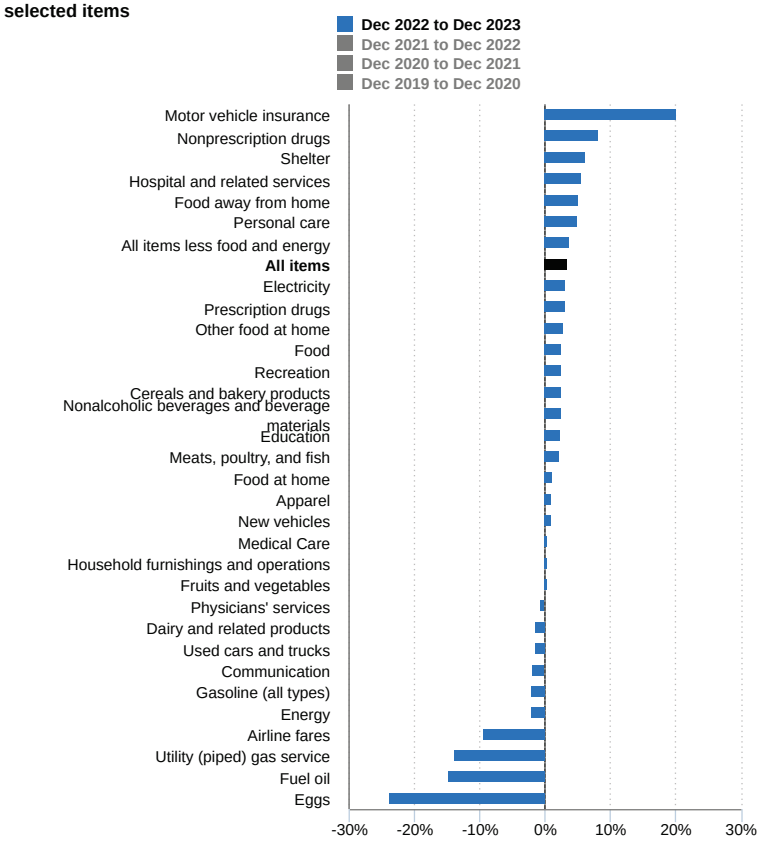
Consumer Price Index: 2023 in review

January 19, 2024

Consumer prices for all items rose 3.4 percent from December 2022 to December 2023. Food prices increased 2.7 percent, reflecting a 1.3-percent increase in prices for food at home and a 5.2-percent increase in prices for food away from home.

CHART IMAGE | CHART DATA

12-month percent change in the Consumer Price Index for All Urban Consumers, selected items



Click legend items to change data display. Hover over chart to view data.
Note: Data are not seasonally adjusted.
Source: U.S. Bureau of Labor Statistics.

12-month percent change in the Consumer Price Index for All Urban Consumers, selected items

Category	Dec 2022 to Dec 2023	Dec 2021 to Dec 2022	Dec 2020 to Dec 2021	Dec 2019 to Dec 2020
Motor vehicle insurance	20.3	14.2	4.1	-4.8
Nonprescription drugs	8.3	5.4	0.8	-1.4
Shelter	6.2	7.5	4.1	1.8
Hospital and related services	5.6	4.6	3.3	3.1
Food away from home	5.2	8.3	6.0	3.9
Personal care	5.0	6.6	3.4	1.8
All items less food and energy	3.9	5.7	5.5	1.6
Note: Data are not seasonally adjusted.				

Category	Dec 2022 to Dec 2023	Dec 2021 to Dec 2022	Dec 2020 to Dec 2021	Dec 2019 to Dec 2020
All items	3.4	6.5	7.0	1.4

Prices for four of the six major food at home groups increased from 2022 to 2023. Prices in the other food at home index increased the most, up 2.8 percent. This index includes food items such as candy, snacks, and sauces which are not classified in the other food categories. Cereals and bakery products prices and nonalcoholic beverages and beverage materials prices each increased 2.6 percent. Prices for fruits and vegetables rose 0.3 percent. Offsetting movements left prices for meats, poultry, fish, and eggs down 0.1 percent. Prices for meats, poultry, and fish were up 2.3 percent. Egg prices fell 23.8 percent, a downward adjustment following their 2022 price increase of 59.9 percent. Dairy and related products had the largest price decline among the major food at home groups, down 1.3 percent in 2023.

Energy prices decreased 2.0 percent in 2023, after increasing 7.3 percent in 2022. Fuel oil prices and utility gas service prices declined 14.7 percent and 13.8 percent, respectively, from December 2022 to December 2023. Gasoline prices declined 1.9 percent in 2023, following a decline of 1.5 percent in 2022. In contrast, electricity prices continued to increase, rising 3.3 percent in 2023 after increasing 14.3 percent in the prior year.

Costs for new vehicles increased 1.0 percent in 2023, compared with a 5.9-percent increase in 2022. Used cars and trucks prices declined 1.3 percent, following a decline of 8.8 percent the previous year. Motor vehicle insurance costs were 20.3 percent higher in December 2023 than in December 2022.

Prices for medical care rose 0.5 percent in 2023, following an increase of 4.0 percent in 2022. Nonprescription drug prices increased 8.3 percent after increasing 5.4 percent the previous year. From December 2022 to December 2023, costs for hospital and related services rose 5.6 percent and prescription drug prices increased 3.3 percent. Prices for physicians' services declined 0.6 percent over the year.

These data are from the Consumer Price Index program and are not seasonally adjusted. For more information, see "Consumer Price Index — December 2023." We also have more charts on consumer prices.

RELATED SUBJECTS
Prices

SUGGESTED CITATION

Bureau of Labor Statistics, U.S. Department of Labor, *The Economics Daily*, Consumer Price Index: 2023 in review at https://www.bls.gov/opub/ted/2024/consumer-price-index-2023-in-review.htm (visited *November 14, 2025*).

OF INTEREST

Spotlight on Statistics

Recent editions of *Spotlight on Statistics*

- Fatal Injuries to Foreign-Born Hispanic or Latino Workers
  Explores the industries, occupations, and events related to these fatalities.
- For-Profit, Nonprofit, and Government Sector Jobs in 2022
  Compares the labor force characteristics and experiences of workers in the for-profit, nonprofit, government, and self-employed sectors.
- Union Membership, Activity, and Compensation in 2022
  Focuses on trends in union membership, work stoppages, and pay and benefits among union members.
- A Look at a Neat Industry: Distilleries
  Examines trends in employment, establishments, wages, and consumer prices for distilleries.
- Healthcare Occupations: Characteristics of the Employed
  Compares the demographic characteristics of workers in healthcare occupations.

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CITY OF
PRINEVILLE
OREGON

Annual Comprehensive Financial Report
Year Ended June 30, 2024

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Attention

If you are reading this annual comprehensive financial report in its PDF format, there are links included within the document to make navigation easier.

- Page numbers and headings within the table of contents are linked to take readers to the appropriate page
- Starting in the Introductory Section, a table of contents button is located on the upper-right corner of each page to take readers back to the table
- Referenced pages within body text are linked to their stated page numbers
- Bookmarks are utilized in the document for all major headings and topics. If a bookmark has a + next to it, it can be clicked to open up a list of subheadings for that section
- External links are included to items referenced within the document, including links to State of Oregon documents

Tip: If readers wish to return to the original page they were on before clicking a link and want to avoid have to scroll back, it is helpful to enable the previous view button within Adobe Acrobat. If it isn't available on the navigation bar within the program, it can be enabled by right clicking the bar and selecting "page navigation" and clicking on "previous view." A new button on the bar will appear that can be clicked to return to the previous view. Alternatively, pressing Alt + Left Arrow (Windows) or Command + Left Arrow (Mac OS) will accomplish the same thing.

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City of Prineville, Oregon
Annual Comprehensive Financial Report
Year Ended June 30, 2024

Prepared by:
City of Prineville Finance Department
Lori Hooper Antram, Finance Director

Available online at
https://www.cityofprineville.com

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Introductory Section

Letter of Transmittal
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CITY FINANCE
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541.447.5627 ext. 1119 phone 541-447-5628 fax

City Manager Steve Forrester

December 27, 2024

To the Honorable Mayor, City Councilors, Finance Committee Members and Citizens of Prineville, Oregon:

We hereby submit the Annual Comprehensive Financial Report (ACFR) of the City of Prineville (the "City") for the fiscal year ended June 30, 2024.

This report presents the financial position of the City as of June 30, 2024 and the results of its operations for the fiscal year then ended. The financial statements and supporting schedules have been prepared in accordance with generally accepted accounting principles (GAAP) in the United States of America and meet the requirements of the standards prescribed by the Oregon Secretary of State Audits Division. We believe the data, as presented, is accurate in all material respects and presented in a manner designed to fairly set forth the financial position and results of operations of the various funds of the City.

The accuracy of the City's financial statements and the completeness and fairness of their presentation is the responsibility of the City's management. The City maintains a system of internal accounting controls designed to provide reasonable assurance that assets are safeguarded against loss or unauthorized use, and that financial records can be relied upon to produce financial statements in accordance with GAAP. The concept of reasonable assurance recognizes that the cost of maintaining the system of internal accounting controls should not exceed benefits likely to be derived.

Pauly, Rogers, and Co. P.C., has issued an unmodified or "clean" opinion on the City's financial statements for the fiscal year ended June 30, 2024. The independent auditor's opinion is located at page 13 in the "Financial Section" of this report.

GAAP requires that management provide a narrative introduction, overview, and analysis to accompany the basic financial statements in the form of a Management's Discussion and Analysis ("MD&A"). This letter of transmittal is designed to complement the MD&A, and should be read in conjunction with it. The City's MD&A is located on page 17, immediately following the independent auditor's report.

Prineville and Its Services

Prineville is a community where citizens, civic organizations, businesses and city government work together to ensure that the community retains its hometown identity, high quality of life, and its natural beauty. The City incorporated in 1880, and today serves a population of 11,466. It is close to the region's business core and more urban amenities, with Bend approximately thirty miles to the southwest and the regional airport in Redmond approximately twenty miles west. The City provides a small-town atmosphere with its historic county courthouse building, other pioneer-era buildings and residential dwellings, and the contemporary architecture of newer homes. Prineville is the gateway to recreation in the Ochoco National Forest and Prineville Reservoir.

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The City is a full-service municipality that operates under a council/manager form of government. The elected Prineville City Council consists of a mayor and six councilors who act as the board of directors. The Council sets policies for city government, enacts ordinances and hires, and directs and evaluates the city manager. In turn, the city manager is the City's chief executive officer, responsible for overall management and administration.

Municipal services provided by the City include police, emergency dispatch, water and wastewater utilities, street operations, planning, engineering, railroad and freight depot facilities, golf course, and airport management services.

The Crook County Fire & Rescue District provides fire and emergency services to the community, the Crook County Parks and Recreation District provides parks and recreation services, and Crook County provides library services. Prineville is the county seat of Crook County.

Local Economy

The City's economy is linked with that of the entire Central Oregon region. Within the last fifteen years Facebook and Apple constructed major data centers in Prineville, which help to diversify the economy. Prineville serves as a hub-community for residents of Crook County, with significant commercial and industrial development. The top 10 largest employers in Prineville include Meta, Crook County School District, Les Schwab Distribution Facility, Endura Products, Crook County, St. Charles Health Systems, Ochoco National Forest, Bureau of Land Management, Western Heavy Haul / SMAF and the City of Prineville. Additionally, agriculture plays a significant cultural and economic role in Prineville.

The City has 15 companies taking advantage of tax abatements as of June 30th, 2024, which has affected the local economy in a positive way. These tax abatements offer a long-term benefit to the community through capital investments, higher wage jobs and community investment. Since the program was initiated, there have been over 2,660 jobs created, $11.8 billion in capital investments and any agreement over three years must pay employees at least 130 percent (130%) of the county's average wage. As of June 30th, 2024, 9 of the 15 active agreements qualified for the wage requirement. Crook County now has the third highest annual average wage of all 36 Oregon counties (all industries), behind only Washington and Multnomah.

Long-term Financial Planning

Long-term financial planning is performed on an ongoing basis. The City prepares 5-, 10- and 20- year financial plans for its General Fund, golf course, utilities and railroad, and is preparing various long-term financial analysis of its transportation system to inform decision makers. The financial plans include reserves by fund that fall within the policy guidelines set by the Prineville City Council and reviewed by the City's Finance Committee during the budget process. Reserve policy guidelines are measured as a percentage of annual operating expenses or current year revenues, and generally range between 15 percent (15%) and 25 percent (25%) depending on the fund.

The BN 25 budget was adopted in June of 2023. Water rates are anticipated to increase 2 percent (2%) year over year for the foreseeable future. Sewer rates are anticipated to fall in line with water rates with 2 percent (2%) year over year increases anticipated. Also included in the BN 25 budget was dollars for a facilitator to help with strategic planning and council goals. In line with strategic planning, fiscal policies will be updated in BN 25.

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In regards to the City's long-term debt obligations, the City had a total of $18.8 million in long-term debt obligations including $15.1 million in full faith and credit obligations (FFCO) and a United States Department of Agriculture (USDA) bond for $3.6 million in federal funds as of June 30, 2024.

City's Credit Ratings

In August of fiscal year 2015, Standard and Poor's rating services affirmed the City's "A+" long-term rating. Their rationale was cited as the City has "strong financial management, very strong budgetary flexibility, very strong liquidity, strong budgetary performance, adequate debt and contingent liabilities, and a strong institutional framework." Our private lender for the FFCO in FY 19 for acquisition of the new public safety building stated in the approval letter, "We are once again impressed with the City's management and high credit quality." The City continues to maintain strong financial management, and has improved in all of the areas stated above in the Standard and Poor's comments for our rating in FY 15.

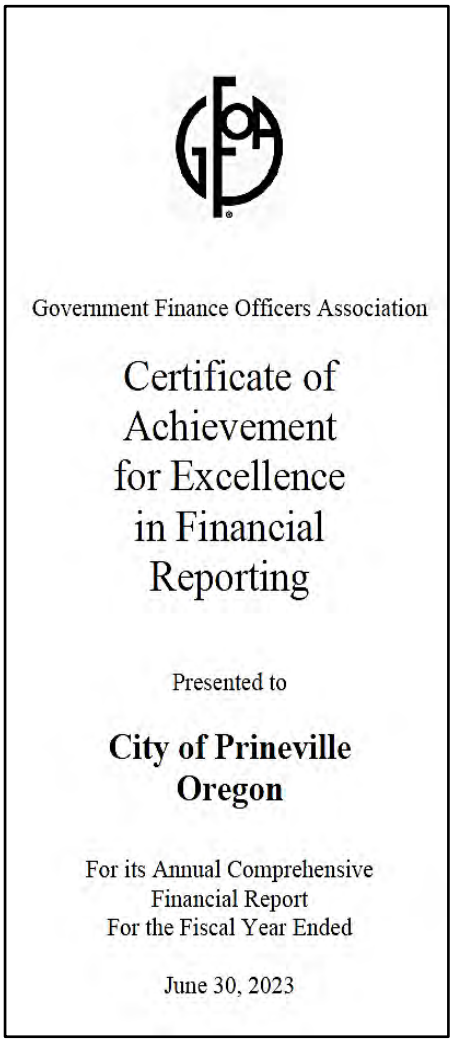
Major Initiatives

The City continues its incremental strategic planning process for the community and organization. The foundation has been established with the creation of a financial planning and decision-making framework for its major operations: water, wastewater, and transportation systems, police and emergency dispatch, railroad and freight facilities, and golf facilities. The Council and management are working toward clearly defined goals and objectives. During the budget review process, goals and objectives are developed and prioritized by the City Council and staff. The process is a continuing cycle of setting goals and objectives, reviewing short- and long-term goals, evaluating results, and reassessing the goals and their priority.

In preparing the budget for biennium 2025, the City Council updated and adopted various goals that were incorporated into budgeted operations. The City Council also established guidelines to achieve goals in the following major areas: urban and growth management, utility infrastructure, finances, downtown enhancement, recreation and culture, and partnerships with other agencies. Additionally, the City's Finance Committee, consisting of Mayor Jason Beebe and Councilors, Gail Merritt and Janet Hutchison, continue their focus on long-range financial stability, sustainability and audit oversight, and improving all finance processes.

Awards

Annual Comprehensive Financial Reporting Award. The City received the *Certificate of Achievement for Excellence in Financial Reporting* (CAEFR) award from the Government Finance Officers Association (GFOA) for its fiscal year 2023 report, making it the eighth time the City has applied and received the award. The CAEFR is a prestigious national award that recognizes conformance with the highest standards


Government Finance Officers Association

Certificate of Achievement for Excellence in Financial Reporting

Presented to

City of Prineville Oregon

For its Annual Comprehensive Financial Report For the Fiscal Year Ended

June 30, 2023

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of preparation of state and local government financial reports. In order to receive this award, government unit must publish an easily readable and efficiently organized ACFR whose contents conform to program standards and satisfy both accounting principles generally accepted in the United States of America and applicable legal requirements.

Distinguished Budget Presentation Award. The City submitted and received the *Distinguished Budget Presentation Award* for its BN 23-25 budget document from the GFOA. This is the 18th consecutive City budget document to receive this award. The award is the highest form of recognition in governmental budgeting. Its attainment represents a significant accomplishment by a governmental entity, its financial staff, and its management. This international award program was first established in 1984 to encourage exemplary budgetary practices and to provide peer recognition for government finance officers who prepare budget documents. Budget proficiency is rated in four major categories: as a policy document, an operations guide, a financial plan and a communications device.

Acknowledgements

The preparation of this Annual Comprehensive Financial Report was a combined effort of the dedicated finance staff under the direction of Lori Hooper Antram. We wish to express our appreciation to everyone who contributed to the preparation of this report. Lastly, we wish to recognize the Mayor, Councilors, and the Finance Committee for their full support for maintaining the highest standards of professionalism in the management of the City's finances.

Respectfully submitted,

FY 24 City of Prineville Finance Team

Steve Forrester
City Manager

Lori Hooper Antram
Finance Director

Mayor Jason Beebe

City of Prineville Elected Officials

Mission Statement

Adopted February 9, 2016

The City of Prineville provides quality municipal services and programs which contribute to our reputation as a desirable place to live, work and play.

We strive to improve our quality of life through transparency; open communication; investment in essential infrastructure; public safety; community programs; and business, while staying within the constraints of fiscally responsible government.

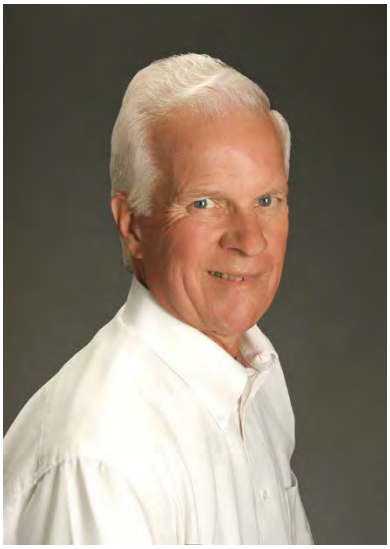
Councilor Shane Howard

Councilor Janet Hutchison

Councilor Gail Merritt

Councilor Scott Smith

Councilor Marv Sumner



Councilor Steve Uffelman

Elected Officials	Term Expires
Jason Beebe, Mayor	December 31, 2024
Shane Howard, Councilor	December 31, 2026
Janet Hutchison, Councilor	December 31, 2026
Gail Merritt, Councilor	December 31, 2024
Scott Smith, Councilor	December 31, 2026
Marv Sumner, Councilor	December 31, 2024
Steve Uffelman, Councilor	December 31, 2024

Appointed Officials	Position
Steve Forrester	City Manager
Jered Reid	City Attorney

Management Team	Position
Kelly Coffelt	Airport Manager
Lori Hooper Antram	Finance Director
Casey Kaiser	Public Works Director
Zach Lampert	Head Golf Professional / Facility Manager
Karee Miller	Human Resource Director
Josh Smith	Planning Director
Matt Wiederholt	Railroad and Freight Depot Manager
James Wilson	IT Director
Shane Wilson	Interim Police Chief

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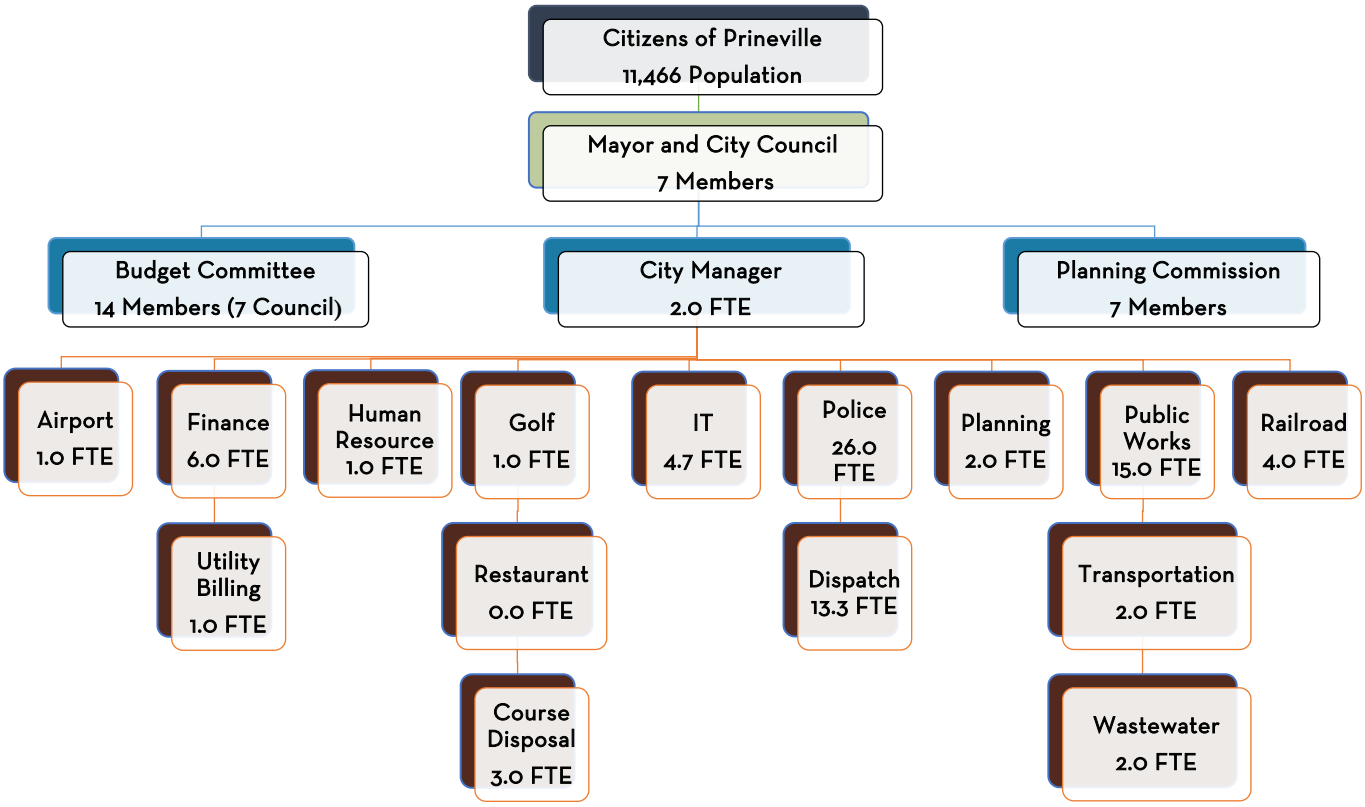
City of Prineville, Oregon
Organization Chart

Year Ended June 30, 2024



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Financial Section

Independent Auditors' Report
Management's Discussion and Analysis

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www.paulyrogersandcocpas.com

December 9, 2024

To the Honorable Mayor and Members of the City Council
City of Prineville

INDEPENDENT AUDITORS' REPORT

Report on the Audit of the Financial Statements

Opinions

We have audited the accompanying financial statements of the governmental activities, the business-type activities, each major fund, and the aggregate remaining fund information of City of Prineville, as of and for the year ended June 30, 2024, and the related notes to the financial statements, which collectively comprise the basic financial statements as listed in the table of contents.

In our opinion, the financial statements referred to above present fairly, in all material respects, the respective financial position of the governmental activities, the business-type activities, each major fund, and the aggregate remaining fund information of City of Prineville, as of June 30, 2024, and the respective changes in financial position and, where applicable, cash flows thereof for the year then ended in accordance with accounting principles generally accepted in the United States of America.

Basis for Opinions

We conducted our audit in accordance with the auditing standards generally accepted in the United States of America and the standards applicable to financial audits contained in *Government Auditing Standards*, issued by the Comptroller General of the United States. Our responsibilities under those standards are further described in the Auditors' Responsibilities for the Audit of the Financial Statements section of our report. We are required to be independent of City of Prineville to meet our other ethical responsibilities, in accordance with the relevant ethical requirements relating to our audit. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinions.

Responsibilities of Management for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with accounting principles generally accepted in the United States of America, and for the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is required to evaluate whether there are conditions or events, considered in the aggregate, that raise substantial doubt about City of Prineville's ability to continue as a going concern for twelve months beyond the financial statement date, including any currently known information that may raise substantial doubt shortly thereafter.

Auditors' Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditors' report that includes our opinions. Reasonable assurance is a high level of assurance but is not absolute assurance and therefore is not a guarantee that an audit conducted in accordance with generally accepted auditing standards and *Government Auditing Standards* will always detect a material misstatement when it exists.

The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control. Misstatements are considered material if there is a substantial likelihood that, individually or in the aggregate, they would influence the judgment made by a reasonable user based on the financial statements.

In performing an audit in accordance with generally accepted auditing standards and *Government Auditing Standards*, we:

- Exercise professional judgment and maintain professional skepticism throughout the audit.
- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, and design and perform audit procedures responsive to those risks. Such procedures include examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the City of Prineville's internal control. Accordingly, no such opinion is expressed.
- Evaluate the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluate the overall presentation of the financial statements.
- Conclude whether, in our judgment, there are conditions or events, considered in the aggregate, that raise substantial doubt about the City of Prineville's ability to continue as a going concern for a reasonable period of time.

We are required to communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit, significant audit findings, and certain internal control-related matters that we identified during the audit.

Required Supplementary Information

Accounting principles generally accepted in the United States of America require that the management's discussion and analysis, and required supplementary information, as listed in the table of contents, be presented to supplement the basic financial statements. Such information is the responsibility of management and, although not a part of the basic financial statements, is required by the Governmental Accounting Standards Board, who considers it to be an essential part of financial reporting for placing the basic financial statements in an appropriate operational, economic, or historical context. We have applied certain limited procedures to the required supplementary information in accordance with auditing standards generally accepted in the United States of America, which consisted of inquiries of management about the methods of preparing the information and comparing the information for consistency with management's responses to our inquiries, the basic financial statements, and other knowledge we obtained during our audit of the basic financial statements. We do not express an opinion or provide any assurance on the information because the limited procedures do not provide us with sufficient evidence to express an opinion or provide any assurance.

The budgetary comparison information presented as required supplementary information, is the responsibility of management and was derived from and relates directly to the underlying accounting and other records used to prepare the basic financial statements. Such information has been subjected to the auditing procedures applied in the audit of the basic financial statements and certain additional procedures, including comparing and reconciling such information directly to the underlying accounting and other records used to prepare the basic financial statements or to the basic financial statements themselves, and other additional procedures in accordance with auditing standards generally accepted in the United States of America. In our opinion, the information is fairly stated, in all material respects, in relation to the basic financial statements as a whole.

Supplementary Information

Our audit was conducted for the purpose of forming opinions on the financial statements that collectively comprise the basic financial statements. The supplementary information, as listed in the table of contents, and the schedule of expenditures of federal awards, as required by Title 2 U.S. Code of Federal Regulations (CRF) Part 200, Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, are presented for purposes of additional analysis and are not a required part of the basic financial statements. The supplementary information, as listed in the table of contents, is the responsibility of management and was derived from and relates directly to the underlying accounting and other records used to prepare the basic financial statements. Such information has been subjected to the auditing procedures applied in the audit of the basic financial statements and certain additional procedures, including comparing and reconciling such information directly to the underlying accounting and other records used to prepare the basic financial statements or to the basic financial statements themselves, and other additional procedures in accordance with auditing standards generally accepted in the United States of America. In our opinion, the supplementary information, as listed in the table of contents, and the schedule of expenditures of federal awards are fairly stated, in all material respects, in relation to the basic financial statements as a whole.

Other Information

Management is responsible for the other information included in the annual report. The other information comprises the other information, as listed in the table of contents, the introductory, statistical, and the compliance and other reports sections as listed in the table of contents, and the listing of board members containing their term expiration dates, located before the table of contents, but does not include the basic financial statements and our auditors' report thereon. Our opinions on the basic financial statements do not cover the other information, and we do not express an opinion or any form of assurance thereon.

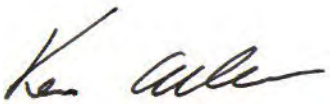
In connection with our audit of the basic financial statements, our responsibility is to read the other information and consider whether a material inconsistency exists between the other information and the basic financial statements, or the other information otherwise appears to be materially misstated. If, based on the work performed, we conclude that an uncorrected material misstatement of the other information exists, we are required to describe it in our report.

Report on Other Legal and Regulatory Requirements

In accordance with *Government Auditing Standards*, we have also issued our report dated December 9, 2024 on our consideration of the internal control over financial reporting and on our tests of compliance with certain provisions of laws, regulations, contracts, and grant agreements and other matters. The purpose of that report is to describe the scope of our testing of internal control over financial reporting and compliance and the results of that testing, and not to provide an opinion on the effectiveness of the internal control over financial reporting or on compliance. That report is an integral part of an audit performed in accordance with *Government Auditing Standards* in considering internal control over financial reporting and compliance.

In accordance with Minimum Standards for Audits of Oregon Municipal Corporations, we have issued our report dated December 9, 2024, on our consideration of compliance with certain provisions of laws and regulations, including the provisions of Oregon Revised Statutes as specified in Oregon Administrative Rules. The purpose

of that report is to describe the scope of our testing of compliance and the results of that testing and not to provide an opinion on compliance.



Kenneth Allen, CPA
Municipal Auditor
PAULY, ROGERS AND CO., P.C.

Management's Discussion and Analysis (MD&A) is presented to facilitate financial analysis and provide an overview of the financial activities of the City of Prineville (the "City") for the fiscal year ended June 30, 2024. Information in the MD&A is based on currently known facts, decisions and conditions. Please read the MD&A in conjunction with the basic financial statements and the accompanying notes.

Financial Highlights

The City's assets and deferred outflows of resources totaled $163.3 million at June 30, 2024, consisting of $121.8 million in capital assets, $28.1 million in cash and investments, $303,000 in restricted cash and investments, $9.2 million in other assets, and $3.9 million deferred outflows of resources. Total assets and deferred outflows of resources increased by $12.5 million from the previous fiscal year.

The City's liabilities and deferred inflows of resources totaled $44.2 million at June 30, 2024 consisting of $25.8 million in long-term liabilities, $14.5 million in accounts payable and other liabilities, and $3.9 million in deferred inflows related to pensions and leases.

The assets and deferred outflows of resources of the City exceeded its liabilities and deferred inflows of resources by $119.2 million at the close of fiscal year 2024, an increase of $13.6 million over the prior year. Unrestricted net position totaled $10.9 million with the remainder of the City's net position invested in capital assets totaling $103.9 million, capital projects $224,000, streets and highways $3.3 million, and debt service reserve $945,000.

For governmental activities, the City generated $1.1 million in fees and charges for services and received $3.3 million in operating grants and contributions. Direct expenses, including interest on long-term debt for governmental activities were $16.0 million for the year, resulting in a net direct expense of $11.6 million. Receipt of $15.1 million in general revenues and $3.8 million in transfers resulted in a change in net position of $7.2 million.

For business-type activities, the City generated $17.0 million in fees and charges for services. Capital grants and contributions to fund direct expenses totaled $1.7 million. Expenses for business-type activities totaled $8.8 million resulting in a change to net position of $6.3 million.

Fund balance in the City's governmental funds was $14.4 million at June 30, 2024, an increase of $5.7 million from June 30, 2023.

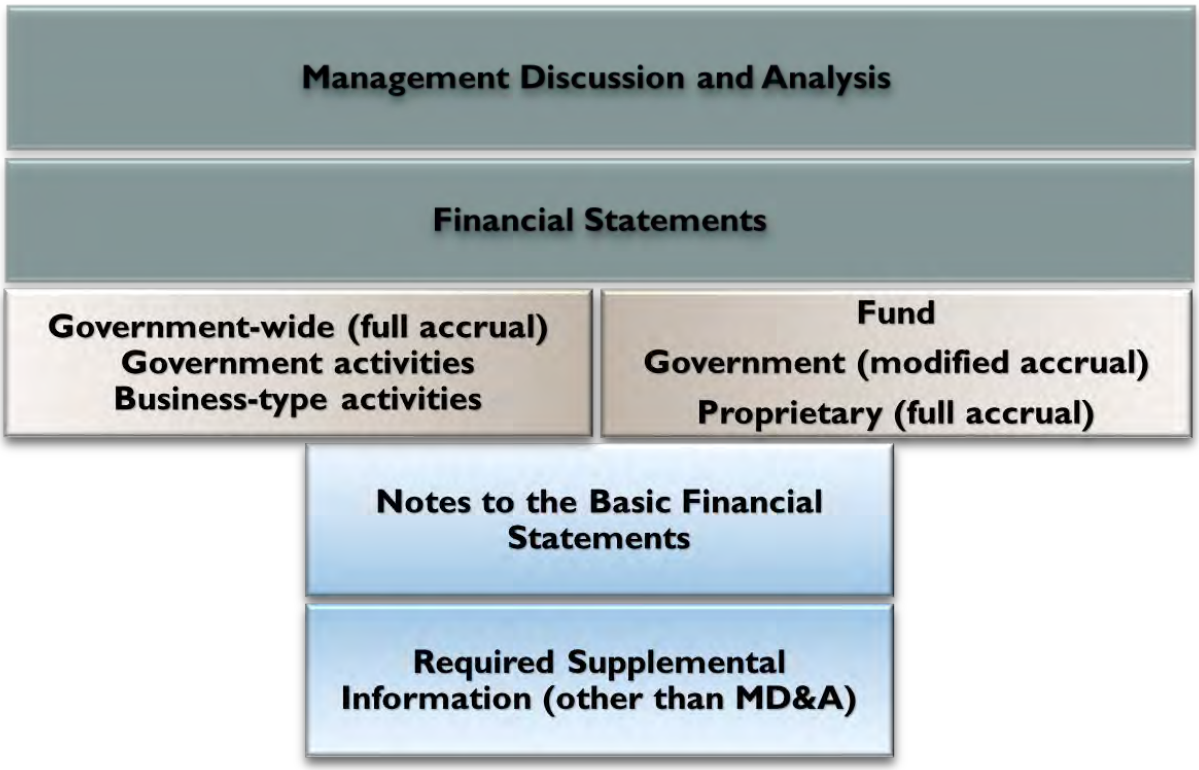
The City's total long-term debt decreased $1.8 million during the fiscal year ended June 30, 2024. Debt per capita decreased from $1,819 to $1,638 (-9.9%), using the City population of 11,466. The population increased by 115 from 11,351 according to the Portland State University preliminary population report as of on July 1, 2024.

Overview of the Financial Statements

In addition to this discussion and analysis, the financial section of this annual report contains the *basic financial statements, required supplementary information,* and *other supplementary information*, including the *combining statements and schedules* of the non-major funds.

The basic financial statements also include *notes* that explain the information in the financial statements and provide additional details. The following chart illustrates how the various sections of this report are arranged to one another.

Required Elements of the Annual Comprehensive Financial Report



Government-wide Financial Statements

The G*overnment-wide Financial Statements* are designed to provide readers with a broad overview of the City's finances, in a manner similar to a private-sector business.

The *Statement of Net Position* presents information on all City assets, deferred outflows of resources, liabilities and deferred inflows of resources, with the difference reported as *net position*. Over time increases or decreases in the net position may serve as a useful indicator of whether the financial position of the City is improving or deteriorating.

The *Statement of Activities* presents information showing how the City's net position changed during the fiscal year ended June 30, 2024. Changes in net position are reported when the underlying event giving rise to the change occurs, regardless of the timing of the related cash, or other financial assets, flows. Thus, revenues and expenses are reported in this statement for some items – such as property taxes and accrued vacation – that will result in cash flows in future fiscal periods.

Each of these government-wide financial statements, *Statement of Net Position* and *Statement of Activities,* distinguish functions of the City that are supported primarily by taxes and inter-governmental revenues (*government activities)* from other functions that are intended to recover all – or a significant portion of – their cost through user fees and charges (*business-type activities).* The governmental activities of the City include general government, public safety, highways and streets, and interest on long-term debt. The business-type activities include railroad, golf, airport, and public works, including water and wastewater.

The City's government-wide financial statements begin on page 31 and the government-wide financial policies are included in the notes to financial statements.

Fund financial statements. A *fund* is a grouping of related accounts that is used to maintain control over resources that have been segregated for specific activities or objectives. The City of Prineville, like other state and local government entities, uses fund accounting to ensure and demonstrate compliance with finance-related legal requirements. Each of the funds of the City is classified in one of three categories: government funds, proprietary funds and fiduciary funds.

Governmental funds. *Governmental funds* are used to account for essentially the same functions as *governmental activities* in the government-wide financial statements. However, unlike the government-wide financial statements, government fund financial statements focus on *near term inflows and outflows of spendable resources,* as well as on *balances of spendable resources* available at the end of the fiscal year. Such information may be useful in evaluating a government's near-term financing requirements.

Because the focus of governmental funds is narrower than that of the government-wide financial statements, it is useful to compare the information presented for *governmental funds* with similar information presented for *governmental activities* in the government-wide financial statements. By doing so, readers may better understand the long-term impact of the government's near-term financing decisions. Reconciliations from the *Government Funds Balance Sheet to the Government-wide Statement of Net Position* and from the *Government Funds Statement of Revenues, Expenditures and Changes in Fund Balances to the Government-wide Statement of Activities* are included in this report.

The City reported activity in five individual governmental funds and three internal service funds performing governmental activities during the fiscal year ended June 30, 2024. Information is presented separately in the *Governmental Funds Balance Sheet* and in the *Governmental Funds Statement of Revenues, Expenditures and Changes in Fund Balances* for the general fund and the City's other major funds (emergency dispatch, transportation, transportation system development charges, and pension obligation debt service). Data from all other governmental funds are combined into a single, aggregated presentation. Individual data for each of these non-major governmental funds, if applicable, is provided in the form of combining statements in the "Other Supplementary Data" section of this report and in the budget to actual comparison schedules.

The City adopts a biennial budget for each of its funds. A budget to actual schedule has been provided for each fund to communicate budgetary compliance.

The "Basic Governmental Fund Financial Statements" can be found on pages 31-38 of this report.

Proprietary funds. The City maintains two types of proprietary funds. Enterprise funds are used to report the same functions as business-type activities in the government-wide financial statements. The City uses enterprise funds to account for its railroad and freight depot, water, wastewater, airport, and golf fund. Internal service funds are used to report the administrative and facility operations of the City where charges for services are primarily recovered from other operations and functions of the City.

Proprietary funds financial statements provide similar, but more detailed, information as the government-wide financial statements. The proprietary fund financial statements provide information separately for the Railroad and Freight Depot, Water, Wastewater, Airport, and Golf Funds.

The "Basic Proprietary Funds Financial Statements" can be found beginning on page 39.

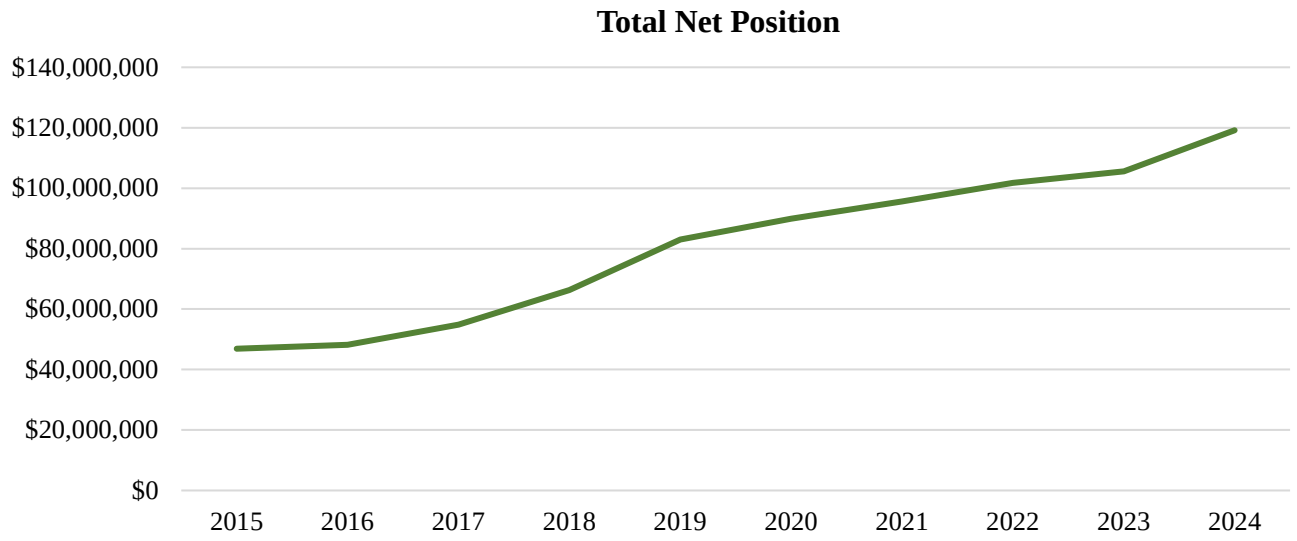
Notes to the financial statements. The notes provide additional information that is essential to a full understanding of the data provided in the government-wide and fund financial statements. The notes to the financial statements begin on page 45. The combining statements referred to above in connection with non-major governmental funds and business-type funds are presented in the "Additional Supplementary Information" section of this report.

Statement of Net Position

Net position, at a specific point in time, serves as a useful indicator of an entity's financial position. In the case of the City, assets and deferred outflows of resources exceed liabilities and deferred inflows of resources by $119.2 million at June 30, 2024.

The City's net position is heavily allocated to its investment in capital assets (land, infrastructure, buildings and equipment) less the related outstanding debt issued to acquire those capital assets and accumulated depreciation, $103.9 million, 87 percent (87.1%) of total position. The City's net investments in capital assets for water and wastewater utilities represent approximately 64 percent (64.0%) of total net investment in capital assets.

- The net position of the governmental funds equaled $37.4 million, an increase of $7.2 million or 24 percent (24.0%) over the prior year-end net position.
- The net position in the water utility totaled $39.4 million, an increase of $5.2 million or approximately 15 percent (15.2%) over the prior year-end net position.
- The net position in the wastewater utility totaled $31.3 million, an increase of $1.2 million or roughly 4 percent (4.2%) from the prior year-end net position.
- The net position in the railroad totaled $7.5 million, a decrease of $12,000 over prior year, or -0 percent (-0.2%) from the prior year-end net position.
- The net position in the Golf Course Fund totaled $3.5 million, an increase of $55,000 or roughly 2 percent (1.6%) over the prior year-end net position.



The City's net position includes approximately $4.4 million (3.7%) that is restricted. This restricted portion is for debt service of $945,000, transportation operations of $3.3 million and capital projects of $224,000. The unrestricted portion of the City's net position is $10.9 million and may be used to meet the City's ongoing obligations to citizens and creditors.

Net Position at June 30, 2024 and 2023

	Governmental activities		Business-type activities		Total	
	2024	2023	2024	2023	2024	2023
Current assets	$ 28,016,426	$ 23,172,592	$ 9,301,070	$ 8,938,462	$ 37,317,496	$ 32,111,054
Non-current assets		-	302,560	302,560	302,560	302,560
Capital assets	33,798,342	31,971,260	87,991,275	82,668,713	121,789,617	114,639,973
Total assets	61,814,768	55,143,852	97,594,905	91,909,735	159,409,673	147,053,587
Deferred outflows	3,939,196	3,746,895	-	-	3,939,196	3,746,895
Total assets and deferred outflows	65,753,964	58,890,747	97,594,905	91,909,735	163,348,869	150,800,482
Current liabilities	11,298,048	11,870,888	1,261,732	847,130	12,559,780	12,718,018
Long-term debt - net of current portion	15,769,041	14,313,235	11,956,158	13,066,176	27,725,199	27,379,411
Total liabilities	27,067,089	26,184,123	13,217,890	13,913,306	40,284,979	40,097,429
Deferred inflows	1,266,156	2,530,608	2,625,283	2,580,515	3,891,439	5,111,123
Total liabilities and deferred inflows	28,333,245	28,714,731	15,843,173	16,493,821	44,176,418	45,208,552
Net investment in capital assets	27,822,248	25,829,405	76,035,117	69,602,537	103,857,365	95,431,942
Restricted	3,269,733	2,025,707	1,169,272	909,699	4,439,005	2,935,406
Unrestricted	6,328,738	2,320,904	4,547,343	4,903,678	10,876,081	7,224,582
Total net position	37,420,719	30,176,016	81,751,732	75,415,914	119,172,451	105,591,930
Total net position, liabilities and deferred inflows	$ 65,753,964	$ 58,890,747	$ 97,594,905	$ 91,909,735	$ 163,348,869	$ 150,800,482

Overall, the City increased its net position by $13.6 million during fiscal year 2024 while also continuing to make investments in capital infrastructure, reduce its other outstanding debt obligations, and control operational spending. The $6.3 million increase in business-type activities can be largely attributed to capital investments made in water and wastewater infrastructure.

As of June 30, 2024, the City reports positive balances in all three categories of net position for the government.

Statement of Activities

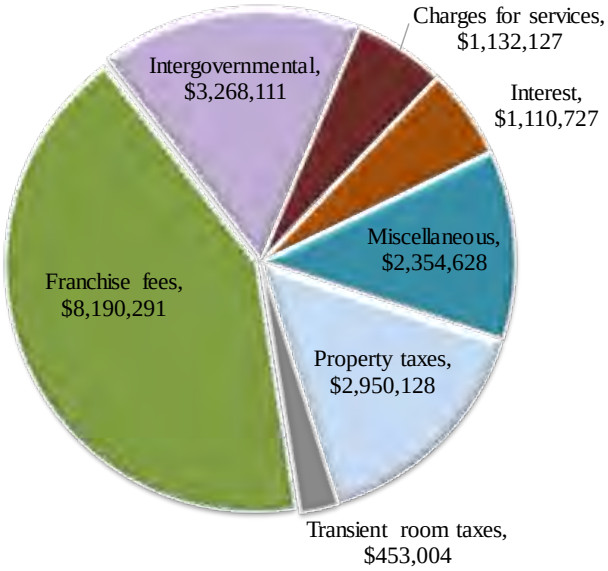
As with the *Statement of Net Position*, the City reports governmental activities on a consolidated basis.

Governmental activities increased Prineville's net position by $7.2 million during fiscal year ended June 30, 2024 as compared to an increase of approximately a $3.1 million in the prior year. Revenue increased by $4.5 million and expenses, excluding transfers, increased by $716,000. Key elements of these changes as illustrated in the summary of activities table on the next page are primarily the results of an increase of electrical franchise fees from data center activities, property tax, and interest and increases in public safety.

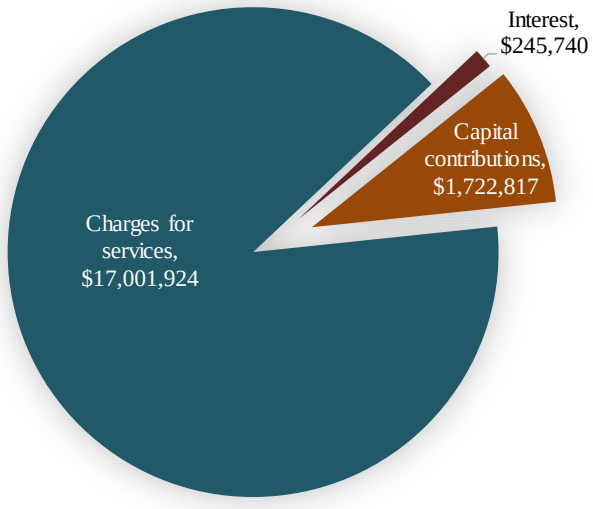
The revenues charted in the pie chart below in the sources for governmental activities include all program and general revenues for governmental activities such as property and transient room taxes, franchise fees, charges for services, intergovernmental revenue and miscellaneous revenues.

Business-type activities increased the City of Prineville's net position by $6.1 million. Water Fund revenues represent approximately 52 percent (52.2%) of total business-type revenue, with 95 percent (94.8%) of its revenue coming from charges for service. Charges for services in the Water Fund totaling $9.4 million are largely associated with metered water sales and reimbursements for water system expansion projects. The Wastewater Fund revenue represents approximately 32 percent (31.6%) of business activities with $4.5 million of the $4.8 million in charges for services coming from sewer utility charges. Capital contributions totaled approximately $1.7 million with $517,000 in the Water Fund and $1.2 million in the Wastewater Fund for developer installed water and sewer lines. Other business-type activities include the airport, railroad, and golf course. These activities represent approximately 15 percent (15.0%) of revenues during the year, and generally these revenues fall into the charges for service, and intergovernmental revenue areas.

Revenue by Source - Governmental Activities



Revenue by Source - Business-type Activities



A summary of the *Statement of Activities* follows:

	Governmental Activities		Business-type Activities		Total		
	2024	2023	2024	2023	2024	2023	Change
Revenue							
Property taxes	$ 2,950,128	$ 2,771,257			$ 2,950,128	$ 2,771,257	$ 178,871
Transient room taxes	453,004	499,799			453,004	499,799	(46,795)
Franchise fees	8,190,291	5,157,475			8,190,291	5,157,475	3,032,816
Intergovernmental	3,268,111	4,119,992			3,268,111	4,119,992	(851,881)
Charges for services	1,132,127	974,582	17,001,924	12,170,864	18,134,051	13,145,446	4,988,605
Interest	1,110,727	556,065	245,740	158,218	1,356,467	714,283	642,184
Capital contributions	-	99,668	1,722,817	580,766	1,722,817	680,434	1,042,383
Miscellaneous	2,354,628	802,414	-	9,300	2,354,628	811,714	1,542,914
Total revenue	19,459,016	14,981,252	18,970,480	12,919,148	38,429,496	27,900,400	10,529,096
Expenses							
General government	2,592,017	4,580,968		-	$ 2,592,017	$ 4,580,968	$ (1,988,951)
Public safety	12,064,233	9,504,018		-	12,064,233	9,504,018	2,560,215
Streets and highways	1,241,716	1,070,694		-	1,241,716	1,070,694	171,022
Interest	145,001	170,876		-	145,001	170,876	(25,875)
Depreciation		-		-	-	-	-
Railroad		-	957,872	1,127,496	957,872	1,127,496	(169,624)
Water		-	2,554,068	2,508,764	2,554,068	2,508,764	45,304
Wastewater		-	3,096,369	2,731,182	3,096,369	2,731,182	365,187
Golf and restaurant		-	1,714,697	1,440,016	1,714,697	1,440,016	274,681
Other non-major		-	483,002	913,647	483,002	913,647	(430,645)
	16,042,967	15,326,556	8,806,008	8,721,105	24,848,975	24,047,661	801,314
Increase (decrease) in net position before transfers	3,416,049	(345,304)	10,164,472	4,198,043	13,580,521	3,852,739	9,727,782
Transfers in (out)	3,828,654	3,450,911	(3,828,654)	(3,450,911)	-	-	-
Increase (decrease) in net position	7,244,703	3,105,607	6,335,818	747,132	13,580,521	3,852,739	9,727,782
Net position, July 1, 2023	30,176,016	27,070,409	75,415,914	74,668,782	105,591,930	101,739,191	3,852,739
Restatements and adjustments	-	-	-	-	-	-	-
Net position, July 1 restated	30,176,016	27,070,409	75,415,914	74,668,782	105,591,930	101,739,191	3,852,739
Net position, June 30, 2024	$ 37,420,719	$ 30,176,016	$ 81,751,732	$ 75,415,914	$ 119,172,451	$ 105,591,930	$ 13,580,521

Financial Analysis of Prineville's Funds

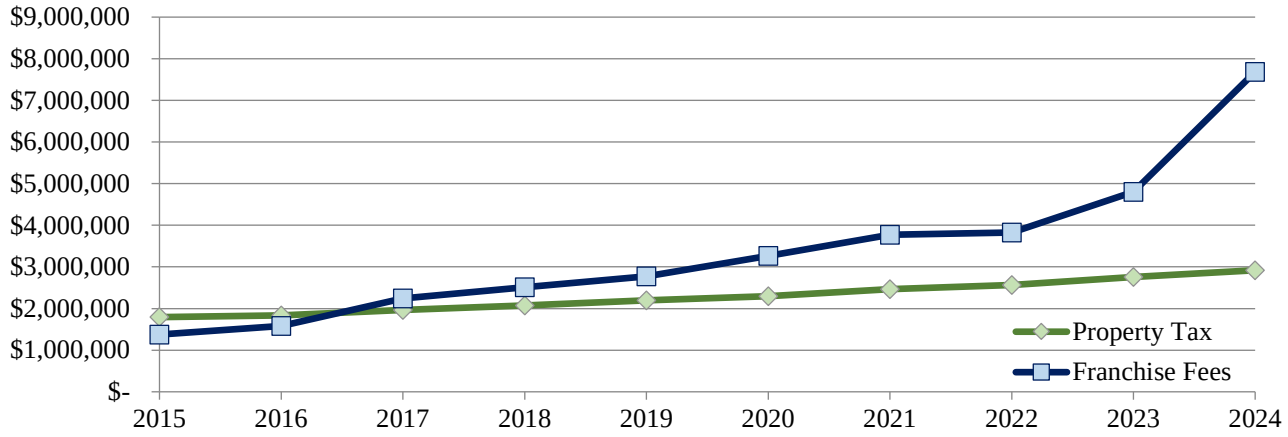
The City of Prineville uses fund accounting to ensure and demonstrate compliance with finance-related legal requirements.

Governmental funds. The focus of the City of Prineville's governmental funds is to provide information on near-term inflows, outflows and balances of available resources. Such information is useful in assessing Prineville's financing requirements. In particular, unassigned fund balance may serve as a useful measure of a government's net resources available for spending as of the end of the fiscal year.

As of June 30, 2024, $14.4 million is the reported combined ending fund balance for the City of Prineville's governmental funds, an increase of approximately $5.7 million from June 30, 2023. The increase is primarily the result of increases in electrical franchise fees in the General Fund. In emergency dispatch, the fund balance continued to increase with open position unable to be filled. In the Transportation SDC Fund, Oregon House Bill 5006 grants for the Peters Road to Combs Flat Road extension contributed to the increase in fund balance. In the Pension Obligation Debt Service Fund, increases can be attributed to the City maintaining transfers in at a level to build fund balance for creating another Oregon Public Employees Retirement System (PERS) side account in the future. Net increases or decreases in fund balance are as follows:

General Fund/Community Development	$ 3,602,013	103%
Emergency Dispatch	$ 501,832	36%
Transportation Fund	$ 137,572	20%
Transportation SDC Fund	$ 1,106,454	84%
Pension Debt Service Fund	$ 363,099	20%

General Fund Budgetary Highlights. The General Fund is the chief operating fund of the City. As of June 30, 2024, total fund balance was $7.1 million, an increase of $3.6 million (103.3%) from prior year. Within the General Fund ending balance, $6.8 million is considered unassigned. General Fund actual current year resources were $13.3 million for the first half of the 2023-2025 biennium. There were no expense categories that exceeded the biennial budget in the General Fund. Interest and miscellaneous revenues have outpaced the two-year budget in year one. The largest contributing factors to this are the Local Government Investment Pool interest coming in higher than anticipated and having more cash on hand due to increased collection in electrical franchise fees. In miscellaneous revenue the Chamber of Commerce gave the City a grant for street lighting for around the new justice center that was not anticipated at the time of budgeting. Police department expenses totaled $5.0 million with $4.1 million coming from personnel services and approximately $310,000 spent on outfitting six new police cars and motor vehicle maintenance. In non-departmental, spending was at $1.0 million with $167,000 in transient lodging taxes going to the chamber of commerce and $689,000 going to support the biomass project. Total General Fund expenditures were $6.0 million. The General Fund ended year one of the biennium budget with revenues exceeding expenditures by $7.3 million. Fund balance increased through the year largely due to the unanticipated revenue collection associated with increased electrical franchise fees with data center buildings coming back online after renovations. The graph below shows General Fund property tax collection and electrical franchise fee trends from 2015 through 2024.



Emergency Dispatch. The Emergency Dispatch Fund balance increased roughly $502,000. In FY 24, dispatcher vacancies continued to be difficult to fill and the under staffing contributed to the increases in fund balance. Call taker positions were added in FY 24 to try and relieve some of the dispatchers work load and to add a step before

becoming a dispatcher, but those positions have also been difficult to fill. At the end of FY 24 the E911 Director was working with the community college to help improve recruiting efforts.

Transportation and Transportation SDC Funds. Fund balance increased $138,000 in the Transportation Fund. The fund balance increase is largely attributed to Oregon State Gas Taxes coming in higher than expected with travel increasing with the end of the pandemic. In the Transportation SDC Fund, the fund balance increased $1.1 million with cash on hand increasing interest revenue dramatically due to $9.9 million in grants that were distributed up front before the projects they were funding started. The grant funded projects for the completion of the N Main Street and NE Peters Road safety improvements and the preliminary work for Combs Flat Extension project (pictured below) made up the capital spending in the Transportation SDC Fund.

Pension Debt Service Fund. Fund balance increased $363,000 in the Pension Debt Service Fund to $2.2 million. This was anticipated as reserves are being built up to be used for accrued liabilities associated with payroll and to stabilize PERS rates in the future.

Proprietary funds. The focus of the City's proprietary funds is to provide information on the financial performance, i.e., ability for each fund to recover full costs of the services provided. Such information is useful in assessing Prineville's ability to continue to provide those services on a sustainable basis.

As of June 30, 2024, the City realized an increase in net position of $6.3 million for the combined performance of all proprietary funds. Operating revenues over operating expenses from combined proprietary funds are $8.4 million, contributing to an overall increase in net position. The biggest factor to the increase in net position was the impact of capital contributions in the Water and Wastewater Funds and operational profits in the Water Fund.

Railroad and Freight Depot Fund. The railroad's net position decreased slightly by $12,000 through the fiscal year. Operational revenues over expenses resulted in a profit of roughly $43,000 with depreciation contributing to 29 percent (29.4%) of the operational expenses. The railroad ended the year with a net position as of June 30, 2024 of $7.5 million. Operational revenue is up for the railroad in comparison to the prior year 13 percent (13.3%), with significant increases in switching and storage charges. Switching fees are charged to move cars into and from storage, so the charges are directly related. Freight depot charges for services are up over prior year by roughly 7 percent (7.2%), largely due to increased lease revenue from Heniff Transportation and Ed Staub and Son's and an increase in lumber customers utilizing the freight depot for storage. In FY 24, a used locomotive was purchased to help improve efficiencies and is expected to be put into operation in FY 25 (pictured below). Overall revenues over expenditures, including transfers out, have decreased the fund balance by $227,000 to $1.0 million.

Photo taken by Dade Shank

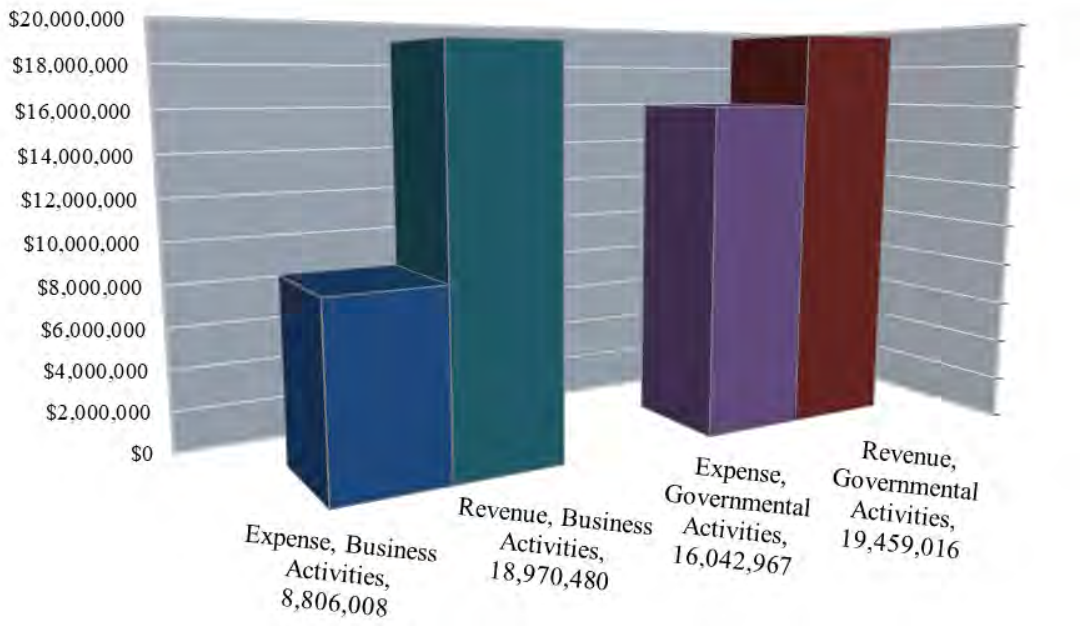
Golf and Restaurant Fund. The net position in golf increased $55,000 largely due to a budgeted transfer of $370,000 from the Wastewater Fund for operational support. Golf operational revenues in comparison to the prior year are up 14 percent (13.6%) with operational expenses up 19 percent (19.2%). Operational expenses are up primarily due to increased personnel and maintenance costs due to the increased activity. Operationally, the golf course finished the year strong with rounds of golf up by approximately 4,130 over the prior year. Fund balance decreased throughout the year $51,000, ending the year at $1.1 million.

Airport Fund. The airport's net position decreased $156,000 to $8,000. The airport is a collaboration effort between Crook County and the City. A new intergovernmental agreement (IGA) was put in place during FY 24 and the operations of the airport were leased out to a third party fixed based operator (FBO) starting in October 2023. The City's sole responsibility is now managing the manager of the airport and Crook County has taken the rest of the responsibilities. The IGA is set up in a way where the fund balance is to be at breakeven resulting in the fund balance at June 30, 2024 of roughly zero.

Water Fund. The net position of the Water Fund increased $5.2 million through the fiscal year, ending at $39.4 million on June 30th, 2024. The primary contributing factors for the increase of net position are due to capital contributions - system development charge collections, other operational revenues associated with reimbursements for water system expansions from data centers and operational profits. Water rates increased 3 percent (3%) in July of 2023. Overall metered water sales revenue was up in comparison to the prior year by 4 percent (4.0%) which can largely be attributed to the rate increases that were implemented during the year.

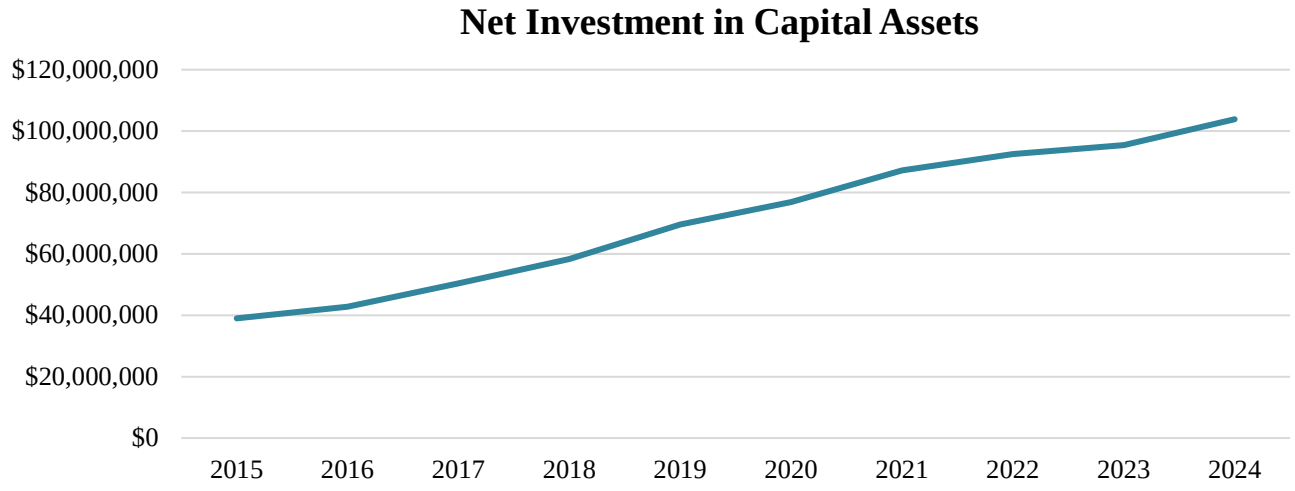
Wastewater Fund. In the Wastewater Fund, net position increased $1.2 million with operational profits of roughly $1.8 million. Wastewater charges for services are largely associated with customer utility charges totaling $4.5 million. This is an increase of 7 percent (7.0%) in comparison to the prior year largely due to an increases in connection charges as residential construction increased in FY 24 and rate increases. Sewer rates increased as of July 2023 by 3 percent (3%) and a master plan update for wastewater was started in FY 23 and was completed in FY 24.

The City continues to actively pursue additional business for the airport, railroad and freight depot operations. It has also adjusted its utility rates incrementally to recover total costs of operations and provide adequate funding for debt service and capital replacement and expansion.



Capital Asset and Debt Administration

Capital Assets. The City's net investment in capital assets for its governmental and business-type activities as of June 30, 2024 is $103.9 million. The investment in capital assets includes land, buildings, equipment and infrastructure such as roads, water and wastewater systems. The net increase in net capital assets for the year ended June 30, 2024 was $8.4 million.



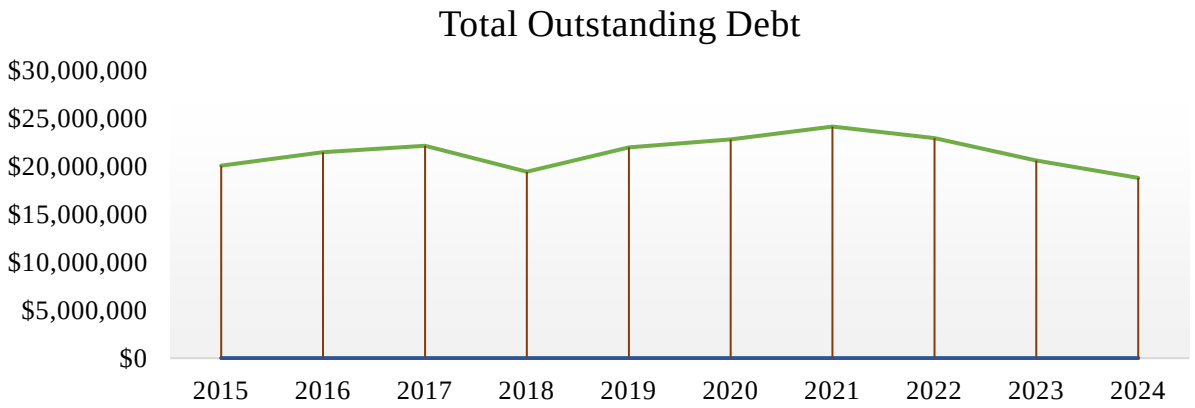
Additional information on capital assets is included in "Note 4" to the financial statements of this report on pages 60-62.

Long-term debt. As of June 30, 2024, the City's outstanding bonded debt was $18.8 million, $1.9 million less than at June 30, 2023. Of this, $15.1 million is backed by the full faith and credit of the City, which includes $4.7 million for obligations repaid with water, wastewater and golf revenues, $1.2 million refinanced note payable for pension obligation repaid from all funds with employees subject to Oregon Public Employees Retirement System retirement payments, $699,000 of refunded federal debt for the city hall building, $3 million in interim financing

through Business Oregon for the Aquifer Storage and Recovery project, an IFA loan for $594,000, a note payable for a street sweeper in the amount of $114,000 and $4.81 million for the remodel and adaptation of the new police facility. The City also had $3.6 million bond outstanding in wastewater with USDA for the wetlands. The City is liable for notes payable with government commitment if other revenues are insufficient to repay the debt. There are no debt requirements, commitments or other limitations required by debt holders that significantly affect the availability of resources for current or future use.

Schedule of Outstanding Long-term Debt
June 30, 2024 and June 30, 2023

	Governmental Activities		Business-type Activities		Total	
	2024	2023	2024	2023	2024	2023
Full faith and credit obligations			$ 4,723,388	$ 5,741,249	$ 4,723,388	$ 5,741,249
Water, golf and wastewater					-	-
Pension note payable	1,172,919	1,450,562			1,172,919	1,450,562
Federal debt			3,639,007	3,703,325	3,639,007	3,703,325
Oregon IFA / CWSRL			593,763	621,602	593,763	621,602
Other leases, SBITA's and notes payable	5,655,882	6,131,073	3,000,000	3,000,000	8,655,882	9,131,073
Totals	$ 6,828,801	$ 7,581,635	$ 11,956,158	$ 13,066,176	$ 18,784,959	$ 20,647,810



Additional information on the City's long-term debt is included in "Note 5" to the financial statements on pages 62-68.

Key Economic Factors and Budget Information for the Future, FY24 update

- ***Unemployment and real estate*** – Oregon's unemployment rate for FY24 began at 3.6%, had a high of 4.2% and ended 4.1%. Crook County began at 5.6%, had a high of 6.4% and ended at 6.1%; according to the Oregon Employment Department. As of October, FY24, Oregon unemployment has decreased to 4.0%, with Crook County decreasing to 5.6%, as the Federal Reserve signaled a couple of interest rates cuts through the end of the year countering years of rate increases to tackle high inflation caused by the pandemic. Unemployment has remained remarkably low and steady the last 3-years during this period of higher than normal inflation. Demand for goods and services remained steady due to high employment and a very significant increase in federal spending on infrastructure through the "Inflation Reduction Act". Supply chain issues have normalized and inflation has slowed nearing the Federal Reserve's 2% target. The Central Oregon region in general is attracting a significant amount of growth that will likely insulate the region from any significant economic downturn caused by a reversal in interest rate trends. At this time, it appears as though the economy will have a soft landing with slow intentional rate cuts through 2025; however, common economic assumptions that have guided investors, business and consumers prior

to the pandemic no longer seem to apply and the incoming Federal administration has prior history of being unpredictable.

- According to reports from the City's Realtor of Record, the median home sale price for Crook County through October 2024 is approximately $484,000. This is slightly higher than October 2023, but lower than the summer highs of $510,000. These prices are significantly higher than pre-pandemic prices that hovered around the $280,000 mark. Price increases were initially due to high demand that was compounded by material supply issues and inflationary costs of the last 3-years. Raising interest rates helped to curtail prices over the last few years with new and existing home sales declining, due to unwillingness to finance at higher rates and the Federal reserve signaling cuts at the end of 2024 and into 2025. As of November 2024, the Federal Reserve has cut rates by 75 basis points. With the demand for housing in the region we are unlikely to see a collapse of the market, though; the lack of new housing projects is a concern. For now, housing prices in Central Oregon have found a new floor that is significantly higher than pre-pandemic prices.

- Dwelling approvals for FY24 include 44 single family, 2 ADUs and a 17-unit manufactured home park that will not likely be built. No multi-family applications were received. This was a ~22% decrease in single-family approvals while multi-family was non-existent. The previous year's numbers are attributed to two large projects just now beginning to develop. Total dwelling approvals for FY16 – FY24 were 38, 76, 114, 229, 111, 88, 455, 378, 63 respectively. Through November of FY25 the City has seen 23 dwelling approvals. This is significantly higher than the 8 dwellings in the same time frame last year. Last year's prediction of approximately 40 single-family dwellings in FY24 proved accurate. Expectations for single family development in FY25 remain the same around 40 single family units, as existing developments build out. While FY25 may be on par with FY24 the lack of new applications for housing developments is concerning. Some of the housing pressure may subside, with the two large multi-family housing projects getting underway.

- ***Meta & Apple*** – In January 2010, Meta initiated their first 334,000 square foot data center. Since then Meta has completed 11 data centers buildings totaling approximately 5 million square feet with plans for expansion. In October 2012, Apple initiated construction of a 338,000 square foot data center. At this time the 3rd building has been completed and the first of 3 more are beginning development.

Residential, Commercial and Public development – Continued data center development, as well as a noticeable increase in commercial and industrial development has maintained a healthy economy even as residential development has declined due to high interest rates needed to combat inflation. At this time, it appears a national economic downturn may have been avoided. It is possible that in the event of a national downturn, Prineville will be somewhat insulated due to local and regional demand.

New commercial construction has continued on the Ochoco Mill site including a new carwash. The construction of the Justice Center and the museum expansion are complete. The Service commercial zone created in the airport industrial area in FY23 is under construction. Other commercial development has slowed with few new applications and serval small developments finishing through the winter.

Industrial development is still the bright spot in the community with continued development in the Tom McCall Business Park and continued interest in the Baldwin and Murphy Court Industrial Parks.

The Public sector has been extremely busy planning and implementing large infrastructure projects, such as the expansion of the City's Aquifer Storage and Recovery system (ASR), design of Peters Road intersection, Combs Flat extension and irrigation piping, 3rd St. rebuild, 30" water lines for industrial development, airport expansion and rail tie replacement.

PERS – As of December 31, 2023, the City has a funded ratio of 70 percent (70%) and has an unfunded actuarial liability (UAL) of $8.87 million, which reflects an increase of $1.34 million from December 31, 2022.

Effective July 1, 2023 through June 30, 2025, the City's PERS contribution rates for Oregon Public Service Retirement Plan (OPSRP) general service, OPSRP police and fire, and tier I / II are 14.62, 19.41 and 19.92 percent respectively. Rates for the 2025 – 2027 biennium were posted in September 2024 and were significantly higher than originally projected due to weak returns in investment in 2023. Final rates for OPSRP general service, OPSRP police, and fire and tier I / II are 21.19, 26.46 and 25.16 percent respectively.

Historically, PERS contribution rates have fluctuated based upon earnings, the amount of the City's UAL, and the percentage of the UAL to covered payroll. Generally, PERS rates have decreased as the City approached or exceeded full funding. In 2015, the Moro decision ruled unconstitutional affected the 2016 rate in a negative way increasing the City's UAL. However, the City received a 6 percent rate credit for the side account contribution in 2014 really stabilizing the contribution rate for the City.

To address the UAL on a long-term basis and provide stability to the City's retirement contributions, the City chose to take advantage of low interest rates (4.94%) and enter into a loan obligation of $2.95 million to be repaid over 15 years. The loan proceeds were invested with PERS in a side account, which resulted in reduced PERS contribution rates beginning in fiscal year 2016. The actuarial report show rates were reduced by -6 percent and a rate credit of 6 percent was received in FY 17. In 2018, the City refunded its pension obligation at a rate lower (3.70%) than the 2014 rate, keeping the same maturity and freeing the City from very constricting covenants. The current outstanding debt totals $1.17 million as of June 30, 2024. On March 25, 2019, the City made an $800,000 deposit to a new PERS side account receiving an additional 1.35 percent (1.35%) offset to our rate, additionally we able to receive the 25 percent (25%) matching funds from the State of Oregon totaling $200,000, this additional deposit was factored into the December 31, 2019 valuation and provided an additional rate decrease for the July 1, 2021 to June 30, 2023 rates. The City has been building up reserves to open up another side account to help provide additional rate relief. That reserve is at roughly $1.79 million as of June 30, 2024 and the new side account is anticipated to be opened in the summer of 2025.

See "Note 7" on pages 69-75 in the financial statements for additional discussion related to PERS.

Requests for Information

This financial report is designed to provide a general overview to those parties interested in Prineville's finances. Questions concerning the information provided in the report of requests for additional information should be addressed to the City's Finance department at 387 NE Third Street, Prineville, Oregon 97754.

Financial Section

Basic Financial Statements

Government-wide Financial Statements

Fund Financial Statements

Governmental Funds

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City of Prineville

Statement of Net Position

June 30, 2024

	Governmental Activities	Business-type Activities	Total
Assets			
Cash and investments	$ 24,758,353	$ 3,370,105	$ 28,128,458
Receivables (net of allowances for uncollectibles)			
Property taxes	142,868	-	142,868
Accounts	2,052,224	3,524,772	5,576,996
Inventory	26,591	465,507	492,098
Prepaid expenses	-	600	600
Lease receivable	264,539	2,711,937	2,976,476
Internal balances	771,851	(771,851)	-
Restricted cash and investments	-	302,560	302,560
Capital assets:			
Subscription assets (net of amortization)	10,846	-	10,846
Lease assets (net of amortization)	13,687	-	13,687
Non-depreciable	2,833,242	7,937,996	10,771,238
Other (net of accumulated depreciation)	30,940,567	80,053,279	110,993,846
Total assets	61,814,768	97,594,905	159,409,673
Deferred outflows of resources			
Pension related deferrals - Net pension liability	3,694,289	-	3,694,289
Pension related deferrals - OPEB liability GASB 75	244,907	-	244,907
Total deferred outlfows of resources	3,939,196	-	3,939,196
Liabilities, deferred inflows and net position			
Liabilities			
Accounts payable	1,251,422	747,442	1,998,864
Accrued interest	15,793	79,877	95,670
Deposits payable	-	82,025	82,025
Other liabilities	-	63,196	63,196
Unearned Revenue	9,176,790	-	9,176,790
Subscription liability	-	-	-
Accrued compensated absences	854,043	289,192	1,143,235
Non-current liabilities:			
Due within one year:			
Lease liability	12,287	-	12,287
Bonds payable	-	66,087	66,087
Notes payable	775,266	1,059,197	1,834,463
Due in more than one year:			
Lease liability	2,916	-	2,916
Proportionate share of net pension liability	8,416,700	-	8,416,700
OPEB Liability GASB 75	523,509	-	523,509
Bonds payable	-	3,572,920	3,572,920
Notes payable	6,038,363	7,257,954	13,296,317
Total liabilities	27,067,089	13,217,890	40,284,979
Deferred inflows			
Leases	246,671	2,625,283	2,871,954
Pension related deferrals - net pension liability	956,145	-	956,145
Pension related deferrals - OPEB Liability GASB 75	63,340	-	63,340
Total deferred inlfows of resources	1,266,156	2,625,283	3,891,439
Net position			
Net investment in capital assets	27,822,248	76,035,117	103,857,365
Restricted for:			
Streets and highways	3,269,733	-	3,269,733
Debt service	-	944,915	944,915
Capital projects	-	224,357	224,357
Unrestricted	6,328,738	4,547,343	10,876,081
Total net position	$ 37,420,719	$ 81,751,732	$ 119,172,451
Total liabilities, deferred inflows of resources and net position	$ 65,753,964	$ 97,594,905	$ 163,348,869

The accompanying notes are an integral part of these financial statements.

City of Prineville

Statement of Activities

Year Ended June 30, 2024

Function / program	Expenses	Program revenues: Fees and charges for services	Program revenues: Operating grants and contributions	Program revenues: Capital grants and contributions	Net (expense) revenue and changes in net position: Governmental activities	Net (expense) revenue and changes in net position: Business-type activities	Net (expense) revenue and changes in net position: Total
Governmental activities							
General government	$ 2,592,017	135,425	$ 886,901	$ -	$ (1,569,691)		$ (1,569,691)
Public safety	12,064,233	322,337	1,716,038	-	(10,025,858)		(10,025,858)
Highways and streets	1,241,716	674,365	665,172		97,821		97,821
Interest on long-term debt	145,001	-	-	-	(145,001)		(145,001)
Total governmental activiti	16,042,967	1,132,127	3,268,111	-	(11,642,729)		(11,642,729)
Business-type activities							
Railroad	957,872	1,000,455	-	-	-	$ 42,583	42,583
Water	2,554,068	9,378,091	-	516,527	-	7,340,550	7,340,550
Wastewater	3,096,369	4,784,874	-	1,206,290	-	2,894,795	2,894,795
Golf and restaurant	1,714,697	1,512,188	-	-	-	(202,509)	(202,509)
Airport	483,002	326,316	-	-	-	(156,686)	(156,686)
Total business-type activiti	8,806,008	17,001,924	-	1,722,817	-	9,918,733	9,918,733
Total activities	$24,848,975	$ 18,134,051	$3,268,111	$ 1,722,817	(11,642,729)	9,918,733	(1,723,996)
	General revenues						
	Taxes:						
	Property taxes, levied for general purposes				2,950,128	-	2,950,128
	Transient room taxes				453,004	-	453,004
	Franchise fees				8,190,291	-	8,190,291
	Earnings on investments				1,110,727	245,740	1,356,467
	Miscellaneous				2,354,628	-	2,354,628
	Total general revenues				15,058,778	245,740	15,304,518
	Transfers				3,828,654	(3,828,654)	-
	Changes in net position				7,244,703	6,335,819	13,580,522
	Net position, July 1, 2023				30,176,016	75,415,913	105,591,929
	Net position, June 30, 2024				$37,420,719	$ 81,751,732	$119,172,451

The accompanying notes are an integral part of these financial statements.

City of Prineville

Balance Sheet

Governmental Funds

June 30, 2024

	General Fund	Emergency Dispatch Fund	Transportation Fund	Transportation SDC Fund	Pension Debt Service Fund	Total Governmental Funds
Assets						
Cash and investments	$5,695,525	$1,791,445	$ 1,151,426	$ 11,776,309	$2,184,240	$ 22,598,945
Receivables:						
Property taxes	142,868	-	-	-	-	142,868
Accounts	1,758,327	131,251	120,822	41,630	-	2,052,030
Due from other funds	771,851	-	-	-	-	771,851
Total assets	$8,368,571	$1,922,696	$ 1,272,248	$ 11,817,939	$2,184,240	$ 25,565,694
Liabilities and fund balances						
Liabilities:						
Accounts payable	$ 380,376	$ 20,349	$ 432,611	$ 211,053	$ -	$ 1,044,389
Unearned revenue	-	-	-	9,176,790	-	9,176,790
Total liabilities	380,376	20,349	432,611	9,387,843	-	10,221,179
Deferred inflows of resources						
Unavailable revenue - property taxes	125,637	-	-	-	-	125,637
Unavailable revenue - other	771,851	-	-	-	-	771,851
Total deferred inflows of resources	897,488	-	-	-	-	897,488
Fund balance						
Restricted	-	-	839,637	2,430,096	-	3,269,733
Committed	-	1,902,347	-	-	2,184,240	4,086,587
Assigned to:						
Other purposes	248,505	-	-	-	-	248,505
Unassigned	6,842,202	-	-	-	-	6,842,202
Total fund balances	7,090,707	1,902,347	839,637	2,430,096	2,184,240	14,447,027
Total liabilities, deferred inflows of resources and fund balances	$8,368,571	$1,922,696	$ 1,272,248	$ 11,817,939	$2,184,240	$ 25,565,694

The accompanying notes are an integral part of these financial statements.

City of Prineville

Reconciliation of the Balance Sheet of Governmental Funds to the Statement of Net Position

June 30, 2024

Amounts reported for governmental activities in the Statement of Net Position are different because:	
Fund balance - total governmental funds	$ 14,447,027
Capital assets used in governmental activities are not financial resources, and therefore, are not reported in funds.	31,587,343
Unavailable revenues are deferred on the budgetary financial statements, but in the government wide state they are considered revenues	897,488
The assets and liabilities of the internal service funds are included in governmental activities in the Statement of Net Position.	(3,978,264)
The Net Pension Asset (Liability), and deferred inflows and outflows related to the Net Pension Asset is the difference between the total pension liability and assets set aside to pay benefits earned to past and current employees and beneficiaries	(3,586,456)
Long-term liabilities, including bonds payable, financed purchases and accrued vacation, are not due and payable in the current period, and therefore, are not reported in the funds.	(1,588,684)
The OPEB GASB 75 Liability, and deferred inflows and outflows related to the OPEB GASB 75 Liability is the difference between the total pension liability and assets set aside to pay benefits earned to past and current employees and beneficiaries	(341,942)
Bond interest is not accrued as a liability in the government funds.	(15,793)
Net position of governmental activities	$ 37,420,719

The accompanying notes are an integral part of these financial statements.

City of Prineville

Statement of Revenues, Expenditures and Changes in Fund Balance

Governmental Funds

Year Ended June 30, 2024

	General Fund	Emergency Dispatch Fund	Transportation Fund	Transportation SDC Fund	Pension Debt Service Fund	Total Governmental Funds
Revenues						
Taxes	$ 3,372,541	$ -	$ -	$ -	$ -	$ 3,372,541
Intergovernmental	1,124,599	1,674,105	1,144,488	665,172	-	4,608,364
Franchise fees	7,685,591	-	504,700	-	-	8,190,291
Licenses and permits	45,411	-	13,817	-	-	59,228
Charges for services	425,242	-	-	-	548,000	973,242
Systems development charges	-	-	-	674,365	-	674,365
Interest	274,159	74,725	39,311	529,806	96,413	1,014,414
Miscellaneous	394,255	-	45,411	-	-	439,666
Total revenues	13,321,798	1,748,830	1,747,727	1,869,343	644,413	19,332,111
Expenditures						
Current:						
General government	1,344,358	-	-	-	-	1,344,358
Public safety	4,986,334	1,270,820	-	-	-	6,257,154
Highways and streets	-	-	644,020	-	-	644,020
Capital outlay	-	564,678	846,235	729,171	-	2,140,084
Debt service:						
Principal	-	-	-	-	277,643	277,643
Interest	-	-	-	-	53,671	53,671
Total expenditures	6,330,692	1,835,498	1,490,255	729,171	331,314	10,716,930
Excess (deficiency) of Revenues over expenditur	6,991,106	(86,668)	257,472	1,140,172	313,099	8,615,181
Other financing sources (uses)						
Transfers in	441,767	824,300	400,000	-	50,000	1,716,067
Transfers out	(3,830,860)	(235,800)	(519,900)	(33,718)	-	(4,620,278)
Total other financing sources (uses)	(3,389,093)	588,500	(119,900)	(33,718)	50,000	(2,904,211)
Net change in fund balances	3,602,013	501,832	137,572	1,106,454	363,099	5,710,970
Fund balance, July 1, 2023	3,488,694	1,400,515	702,065	1,323,642	1,821,141	8,736,057
Fund balance, June 30, 2024	$ 7,090,707	$1,902,347	$ 839,637	$2,430,096	$2,184,240	$ 14,447,027

The accompanying notes are an integral part of these financial statements.

City of Prineville

Reconciliation of Statement of Revenues, Expenditures and Changes in Fund Balance to the Statement of Activities
Governmental Funds
Year Ended June 30, 2024

Amounts reported for governmental activities in the statement of activities are different because:			
Net change in fund balances - total governmental funds		$	5,710,970
Governmental funds report capital outlay as expenditures. However, in the Statement of Activities the cost of those assets is allocated over their estimated useful lives and reported as depreciation expense. This is the amount by which capital outlay was less actual additions and depreciation expense			
Capital Outlay	3,086,556		
Depreciation expense	(1,439,114)		1,647,442
Revenues in the Statement of Activities that do not provide current financial resources and are not reported as revenue in the fund statements:			30,591
Internal service funds are used to account for all costs arising from the operations of the City's central services activities and insurance programs. The primary funding sources are charges to the other funds. This is the net gain of the funds for the year.			9,805
Long-term debt proceeds provide current financial resources to governmental funds, but issuing debt increases long-term liabilities in the Statement of Net Position. Repayment of long-term debt principal is an expenditure in the governmental funds, but the repayment reduces long-term liabilities in the Statement of Net Position. This is the amount by which debt proceeds exceeds principal payments:			286,963
The Pension Expense and the changes in deferred inflows and outflows related to the Net Pension Asset represents the changes in Net Pension Asset (Liability) from year to year due to changes in total pension liability and the fair value of pension plan net position available to pay pension benefits.			(475,243)
Some expenses reported in the Statement of Activities do not require the use of current financial resources, and therefore, are not reported as expenditures in governmental funds.			
Accrued interest	62		
Accrued compensated absences	43,013		
OPEB Liability GASB 75	(8,900)		34,175
Change in net position of governmental activites		$	7,244,703

The accompanying notes are an integral part of these financial statements.

Financial Section

Basic Financial Statements

Fund Financial Statements

Proprietary Funds

Enterprise Funds

Railroad

Water

Wastewater

Golf and Restaurant

Internal Service Funds

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City of Prineville

Statement of Net Position

Proprietary Funds

June 30, 2024

	Business-type Activities - Enterprise Funds						Governmental Activities Internal Service Funds
	Water	Wastewater	Golf Course	Railroad	Non-major Fund, Airport	Total	
Assets							
Current assets							
Cash and investments	$ (292,656)	$ 1,589,219	$ 1,145,574	$ 920,015	$ 7,953	$ 3,370,105	$ 2,159,408
Accounts receivable, net	2,725,440	640,197	53,475	74,637	31,023	3,524,772	194
Inventory	134,554	85,127	78,279	167,547	-	465,507	26,591
Prepaid expenses	-	-	600	-	-	600	-
Lease receivable	-	185,509	56,656	2,469,772	-	2,711,937	264,539
Capital asset - subscription assets (net of amortization)	-	-	-	-	-	-	10,846
Capital asset - lease assets (net of amortization)	-	-	-	-	-	-	13,687
Total current assets	2,567,338	2,500,052	1,334,584	3,631,971	38,976	10,072,921	2,475,265
Non-current assets							
Restricted cash and investments	-	302,560	-	-	-	302,560	-
Capital assets:							
Non-depreciable	6,361,481	1,259,017	171,365	146,133	-	7,937,996	-
Capital assets (net of accumulated depreciation)	35,540,185	34,981,944	2,545,723	6,977,265	8,162	80,053,279	2,186,466
Total non-current assets	41,901,666	36,543,521	2,717,088	7,123,398	8,162	88,293,835	2,186,466
Total assets	$ 44,469,004	$ 39,043,573	$ 4,051,672	$ 10,755,369	$ 47,138	$ 98,366,756	$ 4,661,731
Deferred outflows of resources							
Pension Related Deferrals	-	-	-	-	-	-	1,361,054
Total assets & deferred outflows	$ 44,469,004	$ 39,043,573	$ 4,051,672	$ 10,755,369	$ 47,138	$ 98,366,756	$ 6,022,785
Liabilities and net position							
Current liabilities:							
Accounts payable	$ 585,348	$ 97,285	$ 38,988	$ 20,536	$ 5,285	$ 747,442	$ 207,033
Due to other funds	-	-	-	-	-	-	-
Accrued interest payable	25,413	53,960	504	-	-	79,877	11,457
Deposits payable	30,705	51,320	-	-		82,025	-
Other liabilities	-	-	63,196	-		63,196	-
Accrued compensated absences	-	30,291	116,475	108,766	33,660	289,192	467,284
Bonds payable, current portion	-	66,087	-	-	-	66,087	-
Notes payable, current portion	163,383	772,296	123,518	-	-	1,059,197	465,813
Lease liability, current portion	-	-	-	-	-	-	12,287
Proportionate share of net pension liability	-	-	-	-	-	-	3,100,890
Total current liabilities	804,849	1,071,239	342,681	129,302	38,945	2,387,016	4,264,764
Non-current liabilities							
Due to general fund	-	-	-	771,851	-	771,851	-
Lease liability	-	-	-	-	-	-	2,916
Bonds payable, net of current portion	-	3,572,920	-	-	-	3,572,920	-
Notes payable, net of current portion	4,266,533	2,868,877	122,544	-	-	7,257,954	5,134,434
Total non-current liabilities	4,266,533	6,441,797	122,544	771,851	-	11,602,725	5,137,350
Total liabilities	5,071,382	7,513,036	465,225	901,153	38,945	13,989,741	9,402,114
Deferred inflows of resources							
Leases	-	198,041	55,262	2,371,980	-	2,625,283	246,671
Pension related deferrals	-	-	-	-	-	-	352,264
Total deferred inflows of resources	-	198,041	55,262	2,371,980	-	2,625,283	598,935
Total liabilities & deferred inflows	5,071,382	7,711,077	520,487	3,273,133	38,945	16,615,024	10,001,049
Net position							
Net Investment in Capital Assets	37,471,750	28,960,781	2,471,026	7,123,398	8,162	76,035,117	2,072,410
Restricted							
SLARRA	-	37,585	-	-	-	37,585	-
Debt service	-	944,915	-	-	-	944,915	-
Capital projects	-	186,772	-	-	-	186,772	-
Unrestricted	1,925,872	1,202,443	1,060,159	358,838	31	4,547,343	(6,050,674)
Total net position	39,397,622	31,332,496	3,531,185	7,482,236	8,193	81,751,732	(3,978,264)
Total liabilities, deferred inflows and net postion	$ 44,469,004	$ 39,043,573	$ 4,051,672	$ 10,755,369	$ 47,138	$ 98,366,756	$ 6,022,785

The accompanying notes are an integral part of these financial statements.

City of Prineville

Statement of Revenues, Expenses and Changes in Net Position

Proprietary Funds

Year Ended June 30, 2024

	Business-type Activities - Enterprise Funds						Governmental Activities Internal Service Funds
	Water	Wastewater	Golf Course	Railroad	Non-major Fund, Airport	Total	
Operating revenues							
Intergovernmental	$ -	$ -	$ -	$ -	$ 31,023	$ 31,023	$ 207,484
Charges for services	3,952,033	4,472,106	1,502,651	847,757	295,293	11,069,840	352,653
Other operating revenues	5,426,058	312,768	9,537	152,698	-	5,901,061	15,101
Total operating revenues	9,378,091	4,784,874	1,512,188	1,000,455	326,316	17,001,924	575,238
Operating expenses							
Salaries and wages	-	261,648	826,537	493,149	196,974	1,778,308	4,373,437
Materials and supplies	1,323,873	1,440,245	609,791	182,722	276,097	3,832,728	2,481,921
Depreciation	1,187,723	1,243,069	274,135	282,001	9,931	2,996,859	395,710
Subscription amortization	-	-	-	-	-	-	16,740
Lease amortization	-	-	-	-	-	-	26,091
Total operating expenses	2,511,596	2,944,962	1,710,463	957,872	483,002	8,607,895	7,293,899
Operating income (loss)	6,866,495	1,839,912	(198,275)	42,583	(156,686)	8,394,029	(6,718,661)
Non-operating revenues (expenses)							
Interest income	46,202	98,279	53,532	44,970	2,757	245,740	96,313
Interest expense	(42,472)	(151,407)	(4,234)	-	-	(198,113)	(100,712)
Gain/(loss) on disposal of assets	-	-		-	-	-	-
Sale of assets	-	-	-	-	-	-	-
Total non-operating revenues (expenses)	3,730	(53,128)	49,298	44,970	2,757	47,627	(4,399)
Capital contributions - system development charges	516,527	257,050	-	-	-	773,577	-
Capital contributions	-	949,240	-	-	-	949,240	-
Transfers in	172,100	165,239	370,000	-	30,360	737,699	7,033,453
Transfers out	(2,359,858)	(1,909,595)	(165,800)	(99,100)	(32,000)	(4,566,353)	(300,588)
Change in net position	5,198,994	1,248,718	55,223	(11,547)	(155,569)	6,335,819	9,805
Net position, July 1, 2023	34,198,628	30,083,778	3,475,962	7,493,783	163,762	75,415,913	(3,988,069)
Net position, June 30, 2024	$ 39,397,622	$ 31,332,496	$ 3,531,185	$ 7,482,236	$ 8,193	$ 81,751,732	$ (3,978,264)

The accompanying notes are an integral part of these financial statements.

City of Prineville

Statement of Cash Flows

Proprietary Funds

Year Ended June 30, 2024

	Business-type Activities - Enterprise Funds						Governmental Activities Internal Service Funds
	Water	Wastewater	Golf Course	Railroad	Non-major Fund, Airport	Total	
Cash flow from operating activities							
Cash received for services	$ 8,372,282	$ 4,776,500	$ 1,512,648	$ 988,242	$ 300,653	$ 15,950,325	$ 837,005
Cash paid to suppliers for goods and services	(923,328)	(1,447,779)	(633,799)	(219,964)	(243,507)	(3,468,377)	(2,654,099)
Cash paid to employees for services	-	(255,541)	(813,795)	(497,005)	(190,828)	(1,757,169)	(4,029,696)
Net cash from operating activities	7,448,954	3,073,180	65,054	271,273	(133,682)	10,724,779	(5,846,790)
Cash flow from non-capital financing activities							
System development charges	516,527	257,050	-	-	-	773,577	-
Transfers in	172,100	165,239	370,000	-	30,360	737,699	7,033,453
Transfers out	(2,359,858)	(1,909,595)	(165,800)	(99,100)	(32,000)	(4,566,353)	(300,588)
Net cash from non-capital activities	(1,671,231)	(1,487,306)	204,200	(99,100)	(1,640)	(3,055,077)	6,732,865
Cash flow from capital and related financing activities							
Bond/Debt principal paid	(159,039)	(827,484)	(123,493)	-	-	(1,110,016)	(447,071)
Interest paid	(58,027)	(151,408)	(4,234)	-	-	(213,669)	(102,314)
Acquisition of capital assets	(6,054,218)	(573,942)	(256,754)	(485,269)	-	(7,370,183)	(568,400)
Sale of assets	-	-	-	-	-	-	-
Net cash from capital and related financing activities	(6,271,284)	(1,552,834)	(384,481)	(485,269)	-	(8,693,868)	(1,117,785)
Cash flow from investing activities							
Interest earnings	46,202	98,279	53,296	44,970	2,757	245,504	96,244
Net cash from investing activities	46,202	98,279	53,296	44,970	2,757	245,504	96,244
Net change in cash and investments	(447,359)	131,319	(61,931)	(268,126)	(132,565)	(778,662)	(135,466)
Cash and investments, July 1, 2023	154,703	1,760,460	1,207,505	1,188,141	140,518	4,451,327	2,294,874
Cash and investments, June 30, 2024	$ (292,656)	$ 1,891,779	$ 1,145,574	$ 920,015	$ 7,953	$ 3,672,665	$ 2,159,408
Reconciliation of operating income (loss) to net cash from operating activities							
Operating income/(loss)	$ 6,866,495	$ 1,839,912	$ (198,275)	$ 42,583	$ (156,686)	$ 8,394,029	$ (6,718,661)
Adjustments to reconcile operating income/ (loss) to net cash from operating activities:							
Depreciation	1,187,723	1,243,069	274,135	282,001	9,931	2,996,859	395,710
Amortization - subscriptions			-				16,740
Amortization - leases	-	-	-	-	-	-	26,091
Change in assets and liabilities:							
Accounts receivable	(1,009,069)	(17,129)	229	(197)	(25,663)	(1,051,829)	266,134
Inventory	(31,879)	(25,038)	(4,113)	(39,706)	54,253	(46,483)	(21)
Prepaid expenses	-	-	-	-	-	-	-
Deposits payable	3,260	(4,640)	-	-	(3,600)	(4,980)	-
Net Pension Asset, Deferred Inflows	-	-	-	-	-	-	(80,224)
Net Pension Asset, Deferred Outflows	-	-	-	-	-	-	357,452
Lease, deferred inflows		(170,822)	(19,481)	(119,968)	-	(310,271)	(26,318)
Lease receivable		184,217	19,712	107,952	-	311,881	21,951
Accounts payable	432,424	17,504	(32,648)	2,464	(3,118)	416,626	(103,576)
Subscriptions payable	-	-	-	-	-	-	(16,803)
Leases payable	-	-	-	-	-	-	(51,778)
Other accrued expenses	-	8,528	12,753	(3,856)	6,146	23,571	66,513
Other liabilities	-	(2,421)	12,742	-	(14,945)	(4,624)	-
Total adjustments	582,459	1,233,268	263,329	228,690	23,004	2,330,750	871,871
Net cash from operating activities	$ 7,448,954	$ 3,073,180	$ 65,054	$ 271,273	$ (133,682)	$ 10,724,779	$ (5,846,790)
Noncash investing, capital, and financing activities							
Contributions of capital assets	-	949,240	-	-	-	949,240	-

The accompanying notes are an integral part of these financial statements.

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Financial Section

Notes to Financial Statements

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1. Summary of Significant Accounting Policies

Reporting Entity

The City of Prineville is a municipal corporation, incorporated in 1880. It operates under its own charter with a council/manager form of government. The Prineville City Council, composed of the mayor and six council members, comprises the legislative branch of the government. The City Council appoints a city manager who serves as the administrative head of the entity. As required by GAAP in the United States of America, all significant activities of the City have been included in the basic financial statements. The City qualifies as a primary government since the City has a separately elected governing body, is a legally separate entity, and is fiscally independent. There are various governmental agencies and special service districts, which provide public services within the City's boundaries. The City is not financially accountable for any of these entities; therefore, none of them are considered component units, nor are they included in these financial statements.

Government-wide and Fund Financial Statements

The government-wide financial statements, the *Statement of Net Position* and the *Statement of Activities*, report information on all of the City's activities. For the most part, the effect of interfund activity has been removed from the government-wide statements. An exception to this is services or goods provided by an activity and used by another activity. Governmental activities, which are primarily supported by taxes and intergovernmental revenues, are segregated from business-type activities, which are primarily supported by charges for services and fees.

The *Statement of Activities* demonstrates the degree to which the direct expenses of a given activity are offset by program revenues. Direct expenses are those that are clearly identifiable with a specific activity. Program revenues include charges to customers or applicants who purchase, use or directly benefit from goods, services, or privileges provided and capital grants and contributions that are restricted to meeting the operational or capital requirements of a particular activity. Indirect expenses are recovered through internal service fund charges. These indirect expenses are allocated based on a full-cost approach, thereby allocating indirect expenses among functions with the objective of allocating all expenses. Taxes and other revenues that are not properly included among program revenues are reported as general revenues.

Separate financial statements are provided for governmental and proprietary funds. Major individual governmental funds and major individual enterprise funds are reported as separate columns in the fund financial statements.

The City reports the following major governmental funds:

General fund – This fund accounts for the activity of the police department and non-departmental activities. Additionally, activity accounted for in a sub-fund for community development is combined with the general fund for financial statement presentation.

Emergency dispatch fund – Accounts for the emergency dispatch services provided to all public safety agencies within Crook County. Resources include a transfer from the Prineville Police Department, 911 telephone taxes administered by Crook County, and the other public safety agencies utilizing the services.

Transportation fund – Accounts for the City's transportation systems, including street, sidewalk and bike paths, operations and maintenance. The primary revenue source is the state gas tax allocated to cities.

1. Summary of Significant Accounting Policies (continued)

Transportation SDC fund – Accounts for the receipt and expenditures of system development charges (SDC) that are dedicated for transportation system expansion improvements.

Pension obligation debt service fund – Accounts for the payment of debt issued to fund a pension retirement unfunded actuarial liability, and other governmental accrued liabilities. The primary revenue source is a charge to all City funds that have employees with earnings subject to OPERS retirement contributions.

Major Proprietary funds are:

Railroad fund – Accounts for the operation and maintenance of the City's railroad and freight depot operations. The primary source of revenue is charges for services to utilize the rail system and storage facilities.

Water fund – This fund accounts for the operation and maintenance of water service and distribution facilities. The principal source of revenue is charges for water consumption. Additionally, a water SDC sub-fund, which accounts for the receipt and expenditures of system development charges that are dedicated for water system expansion improvements, is consolidated for reporting purposes.

Wastewater fund – This fund accounts for the operation and maintenance of the wastewater collection and treatment system. The principal source of revenue is charges for service. Additionally, a wastewater SDC sub-fund, which accounts for the receipt and expenditures of system development charges that are dedicated for wastewater system expansion improvements, is consolidated to the wastewater fund for financial reporting purposes.

Golf course fund – Accounts for the operation and maintenance of the golf course, restaurant and wastewater treatment. The principal sources of revenue are green fees, cart rentals, food and beverage sales, and charge to the wastewater fund.

Additionally, the City reports the following:

Internal Service Funds

Internal service funds account for services provided for departmental units within the City.

Services provided by the internal service funds include facility maintenance, fleet maintenance, technology and communications, administrative services, and risk management. The cost of the services provided is recovered by charges to the department receiving the service. The reporting for the internal service funds are consolidated in the reporting of the proprietary statements.

Administrative services fund – Accounts for the City Council, city manager's office, finance department and information technology operations. The principal source of revenue is charges to City departments and operations.

Building facilities fund – Accounts for the operations, maintenance, debt service and replacement costs of the city hall building, public works building, police department facilities, Barnes Butte property, and the senior center project. The principal source of revenue is rent, and grants.

1. Summary of Significant Accounting Policies (continued)

The Plaza Maintenance sub-fund is combined with the building facilities for financial statement presentation.

Public works support services fund - Accounts for the public works department staff and vehicle/equipment maintenance operations. The principal source of revenue is charges to City operations utilizing public works staff, such as water, wastewater, and streets.

Non-major Funds

The City also reports the following non-major funds:

Non-major Governmental Funds

Special Revenue Funds

Community development fund – Accounts for the City's community development and planning activities. The principal sources of revenue are planning fees and charges and transfer from the general fund. This fund is combined with the general fund.

Non-major Proprietary Funds

Airport fund – Accounts for the operation of the Prineville-Crook County Airport. The City operates the County-owned airport as provided in an intergovernmental agreement. Principal sources of revenue include fuel sales, and hangar, building and ground leases.

Internal Service Fund

Plaza maintenance fund - Accounts for the operation of the plaza located between city hall and a county office building. Principal sources of revenue include intergovernmental revenue from Crook County and City payments. This sub-fund is combined with the building facilities fund.

The City's government-wide and proprietary statements are based on all applicable Governmental Accounting Standards Board (GASB) pronouncements.

Interfund transfers, interfund services provided and used, interfund reimbursements and interfund payables and receivables are all interfund activities. The effect of interfund activities and administrative charges are eliminated from the government-wide financial statements. Interfund services that are provided and used are not eliminated from the government-wide statements since elimination would distort the program revenues and direct costs of the City's functions.

Amounts reported as program revenues in the government-wide statement of activities include: fees, charges to users for services provided, goods produced or privileges provided; operating grants and contributions; and capital grants and contributions. Taxes, grants and contributions that are not restricted are reported as general revenues. Transient room taxes and franchise fees are based on gross receipts and are reported as general revenues.

1. Summary of Significant Accounting Policies (continued)

Proprietary funds distinguish operating revenues and expenses from non-operating items. Operating revenues and expenses generally result from providing services and producing and delivering goods in connection with a proprietary fund's primary ongoing operations. The primary operating revenues of the water fund, wastewater fund, railroad fund, golf and restaurant fund, and airport fund are charges to customers for sales and services. The primary revenue of the City's internal service funds are charges for services to other City funds, received in the form of transfers.

The water fund and wastewater fund also receive fees, which are intended to recover the cost of providing new customers to the utility systems. Operating expenses for the proprietary funds include the cost of sales and services, administrative expenses, and depreciation. All revenues and expenses not meeting this definition are reported as non-operating revenues and expenses.

Measurement Focus and Basis of Accounting

Measurement focus is a term used to describe which transactions are recorded within the various financial statements. Basis of accounting refers to when transactions are recorded. The government-wide financial statements are presented on a full-accrual basis of accounting with an economic resource measurement focus, as are the proprietary fund financial statements. An economic resource focus concentrates on an entity or fund's net position. All transactions and events that affect the total economic resources (net position) during the period are reported. An economic resources measurements focus is inextricably connected with full accrual accounting. Under the full accrual basis of accounting, revenues are recorded when earned and expenses are recorded at the time liabilities are incurred, regardless of the timing of related cash inflows and outflows.

Governmental fund financial statements are presented on a modified accrual basis of accounting with a current financial resource measurement focus. The measurement focus concentrates on the fund's resources available for spending currently or in the near future. Only transactions and events affecting the fund's current financial resources during the period are reported. Similar to the connection between an economic resource measurement focus and full accrual basis of accounting, a current financial resource measurement focus is inseparable from a modified accrual basis of accounting. Under the modified accrual basis of accounting, revenues are recognized when susceptible to accrual (i.e., when they become measurable and available). Measurable means the amount of the transaction can be determined and revenues are considered available when they are collected within the current period or expected to be collected soon enough thereafter to be used to pay liabilities of the current period. For this purpose, the City considers revenues to be available if they are collected within 60 days of the end of the current fiscal period. Revenues considered susceptible to accrual are property taxes, state, county and local shared revenues, franchise taxes, intergovernmental revenues, and investment income.

An unearned revenue liability arises on the balance sheets of the governmental funds when potential revenue does not meet both the measurable and available criteria for recognition in the current period. This unavailable revenue consists primarily of uncollected property taxes not deemed available to finance operations of the current period. In the government-wide statement of activities, with a full accrual basis of accounting, revenue must be recognized as soon as it is earned regardless of its availability. Thus, the liability created on the balance sheets of the governmental funds for unavailable revenue, is eliminated. Similar to the way its revenues are recorded, governmental funds only record those expenditures that affect current financial resources. However, debt service expenditures, as well as expenditures related to compensated absences and claims and judgments, are recorded only when payment is due. In the government-wide financial statements, however, with a full accrual basis of accounting, all expenses affecting the economic resource status of the government are recognized.

1. Summary of Significant Accounting Policies (continued)

Since the governmental fund statements are presented on a different measurement focus and basis of accounting than the government-wide statements' governmental column, a reconciliation is necessary to explain the adjustments needed to transform the fund based financial statements into the governmental column of the government-wide presentation. This reconciliation is part of the basic financial statements.

Proprietary funds distinguish operating revenues and expenses from non-operating items. Operating revenues and expenses generally result from providing services, and producing and delivering goods in connection with a proprietary fund's principal ongoing operations. Operating expenses for the proprietary funds include the cost of sales and services, administrative overhead, and depreciation on capital assets. All revenues and expenses not meeting this definition are reported as non-operating revenues and expenses.

Use of Estimates

The preparation of financial statements, in conformity with accounting principles generally accepted in the United States of America, requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, disclosure of contingent assets and liabilities at the date of the financial statements, and reported amounts of revenues and expenditures/expenses during the reporting period. Actual results may differ from those estimates.

Assets, Liabilities, Deferred Outflows/Inflows of Resources and Equity

Assets Liabilities and Net Position

Cash and Investments

State statutes authorize the City to invest in obligations of the U.S. Treasury, certificates of deposit, U.S. government agency securities, instrumentalities of U.S. government-sponsored corporations, commercial paper, bankers' acceptances, repurchase agreements and the State of Oregon Treasurer's Local Government Investment Pool (LGIP). Additionally, Oregon Revised Statutes require that deposits be made with approved depository banks. Local Government Investment Pool balances are backed by the full faith and credit of the State of Oregon.

The City maintains a cash and investment pool for all of the City's funds. Monies within the cash and investment pool are identified by fund and by type. Interest earned on the cash and investment pool is allocated to the individual funds based on the individual fund's average cash balance for the period in which the interest was earned. For the *Statement of Cash Flow* purposes, the City considers "cash" to include the pooled cash and investments. The cash and investment pool possess the general characteristics of a demand deposit account since the cash and investment pool has sufficient liquidity in that any fund may deposit or withdraw cash at any time without notice or penalty.

Inventory

The City accounts for inventories using the purchases method, the basis used to value inventories is the cost basis, and the method used to apply that basis is first-in first-out at lower of cost or market.

1. Summary of Significant Accounting Policies (continued)

Receivables

Real and personal property taxes receivable that are collected within 60 days after year-end are considered measurable and available, and therefore, are recognized as revenue. The remaining balance is recorded as unavailable or unearned revenue because it is not deemed available to finance the operations of the current period. Property taxes are levied and become a lien on the property as of July 1. Taxes are payable in three installments on November 15, February 15 and May 15. Taxes unpaid as of May 16 are considered delinquent. All property taxes are billed and collected by Crook County, Oregon and then turned over to the City.

Grant proceeds are recorded as revenue in the period in which qualified program expenditures are incurred. Franchise fees and transient room taxes are recorded as revenue in the period in which they are earned, provided they are remitted to the City within 60 days after year-end.

All governmental type accounts receivable, property taxes, grants, notes, assessments and other receivables are shown net of an allowance for uncollectible accounts, and as of June 30, 2024, no uncollectible amounts are anticipated or have been recognized by management.

Prepaid Expenses

In both government-wide and fund financial statements, certain payments to vendors reflect costs applicable to future City accounting periods and are recorded as prepaid expenses. The cost of prepaid items is recorded as expenditures/expenses when consumed rather than when purchased.

Capital Assets

Purchased or constructed capital assets for governmental activities are recorded at estimated historical cost prior to fiscal year 2007 with subsequent additions at cost. Business-type capital assets are recorded at cost. Donated capital assets, donated works of art and similar items, and capital assets received in a service concession arrangement are recorded at their acquisition value. Infrastructure (bridges, roads, water and sewer improvements, and drainage systems) acquired during the year have been recorded at cost or fair value if contributed by developers. The City defines capital assets as assets with an initial cost of more than $10,000 and an estimated life of more than one year. The cost of normal maintenance and repairs that do not add to the value of the asset or materially extend assets' lives are not capitalized.

Capital assets of the City are depreciated using the straight-line method over the following estimated useful lives:

	Years
Buildings and structures	25-50
Improvements other than buildings	10-20
Machinery and equipment	5-30
Vehicles	5-10
Infrastructure	30-40

1. Summary of Significant Accounting Policies (continued)

Subscription Assets

Subscription assets are assets in which the government obtains control of the right to use the underlying IT asset. The value of the subscription asset is initially measured as the sum of the initial subscription liability amount, any payments made to the IT software vendor before commencement of the subscription term, and any capitalizable implementation costs, less any incentives received from the SBITA vendor at or before the commencement of the subscription term. The subscription asset is amortized in a straight-line manner over the course of the subscription term.

Subscription Liabilities

In the government-wide financial statements, subscription liabilities are reported as liabilities in the Statement of Net Position. In the governmental fund financial statements, the present value of subscription payments expected to be made during the subscription term is reported as other financing sources. The subscription liability is initially measured at the present value of subscription payments expected to be made during the subscription term. Future subscription payments are discounted using the interest rate the SBITA vendor charges the government, which may be implicit, or the government's incremental borrowing rate if the interest rate is not readily determinable. Amortization of the discount on the subscription liability is recognized as an outflow of resources (for example, interest expense) in subsequent financial reporting periods.

Accrued Compensated Absences

It is the City's policy to permit employees to accumulate earned but unused vacation and sick leave within limits set by collective bargaining agreements, personnel policies and employment agreements. All employees with accrued paid leave are paid the outstanding accrued vacation balance at separation of employment. Employees with sick leave accruals that meet longevity requirements are paid, within limits, for their sick leave accruals. All vacation and sick pay is accrued when incurred in the government-wide and proprietary statements. Compensated absences are paid by the individual funds when they become due. The general fund, emergency dispatch fund, transportation fund and the community development fund are governmental funds that have primarily incurred and paid compensated absences in prior years.

Lease Assets and Lease Liabilities

Lease assets are assets which the District leases for a term of more than one year. The value of the leases is determined by the net present value of the leases at the government's incremental borrowing rate at the time of the lease agreement, amortized over the term of the agreement

In the government-wide financial statements, leases payable are reported as liabilities in the Statement of Net Position. In the governmental fund financial statements, the present value of lease payments is reported as other financing sources.

1. Summary of Significant Accounting Policies (continued)

Long-term Debt

In the government-wide financial statements, long-term debt is reported as a liability in the applicable governmental activities, business-type activities, or proprietary fund-type *Statement of Net Position*. Prepaid assets, and deferred amounts on refunding, if significant, are deferred and amortized over the life of the bond using straight-line amortization. Bond premiums and discounts are amortized using the straight-line method. In the fund financial statements, governmental fund-types recognize bond premiums, as well as bond issuance costs during the current period. The face amount of debt issued is reported as other financing sources. Premiums received on debt issuances are reported as other financing sources while discounts on debt issuances are reported as other financing uses. Issuance costs, whether or not withheld from the actual debt proceeds received, are reported as debt service expenditures.

Deferred Outflows/Inflows of Resources

In addition to assets, the *Statement of Net Position* will sometimes report a separate section for deferred outflows of resources. This separate financial statement element, deferred outflows of resources, represents a consumption of net assets that applies to a future period(s), and so will not be recognized as an outflow of resources (expense/expenditure) until then.

In addition to liabilities, the Statement of Financial Position will sometimes report a separate section for deferred inflows of resources. This separate financial statement element represents an acquisition of net assets that applies to a future period(s) and so will not be recognized as an inflow of resources (revenue) until that time.

Fund Equity
The City implemented GASB Statement No. 54 for the year ended June 30, 2011. GASB Statement No. 54 requires analysis and presentation of fund balance in five categories. The new fund balance categories are:

- *Non-spendable* – Includes items that are not in a spendable form because they are either legally or contractually required to be maintained intact.
- *Restricted* – Includes items that are restricted by external creditors, grantors or contributors, or restricted by legal constitutional provisions.
- *Committed* – Includes items that have committed funding for specific purposes or uses by the governing board.
- *Assigned* – Includes items assigned by specific uses, authorized by the city manager and or finance director.
- *Unassigned* – This is the residual classification used for those balances not assigned to another category in the general fund. Deficit fund balances in other governmental funds are also presented as unassigned.

GASB Statement No. 54 implementation requires the highest legal authority to approve authorized commitments of fund balance and to approve who can authorize making assignments of fund balance. The City Council makes commitments through Resolutions. The city manager is authorized to make assignments of fund balance per City Resolution Number 1247.

GASB Statement No. 54 also requires a spending policy, as it relates to ending fund balance. The spending policy states in what order fund balance categories are spent. The spending policy provides that restricted balances are spent first, followed by committed, then unassigned.

1. Summary of Significant Accounting Policies (continued)

Pension Plan

Substantially all of the City's employees, except for Railroad Fund employees, are participants in the State of Oregon Public Employees Retirement System (PERS). For the purpose of measuring the net pension liability, deferred outflows of resources and deferred inflows of resources related to pensions, and pension expense, information about fiduciary net position of PERS and additions to/deductions from PERS's fiduciary net position have been determined on the same basis as they are reported by PERS. For this purpose, benefit payments (including refunds of employee contributions) are recognized when due and payable in accordance with the benefit terms. Investments are reported at fair value. GASB Statements 68 and 71 have been implemented as of July 1, 2014.

Interfund Transfers

Transfers between funds provide support for various City programs in accordance with budgetary authorizations. They are utilized to cover administrative services, provide for additional funding for reserve purposes, contribute towards the cost of capital projects, and to provide for other operational resources.

Budget

The City adopts a biennial budget in accordance with Oregon Revised Statutes (ORS) 294.305 through 294.565. The adopted budget is on a modified accrual basis for all funds. Minor reclassifications are made between the budgetary and the GAAP statements. The Oregon Constitution and ORS require that the budget must be balanced and that the fiscal year for local governments is from July 1 through June 30. The Prineville Budget Committee, consisting of seven citizen representatives, the six city councilors and mayor, is required by ORS as part of the budget process. Through a process of public hearings and deliberations, the Budget Committee reviews, and then recommends a budget to City Council for approval. The budget sets forth City Council's goals and objectives, and identifies the resources necessary to accomplish the goals and objectives. The City's budget is legally adopted by City Council resolution before July 1.

The City maintains budgetary controls to ensure compliance with legal provisions of the City's annual appropriations resolution adopted by the City Council as part of the budget process. The legal level of budgetary control, by City Council resolution, is by department within the general fund and administrative services internal service fund, by program within the golf and restaurant fund and the public works support services internal service fund and by major function, i.e., personal services, material and services, capital outlay, transfers, debt service and other requirements in the remaining funds. The City cannot legally exceed appropriations at these respective levels. Departments may transfer appropriations within a department. All such transfers are reviewed by finance department staff for appropriateness with approval by the city manager as appropriate.

Appropriations lapse at fiscal year-end; projects not completed in the current fiscal year must be re-appropriated in the next fiscal year as part of the adoption of the annual budget.

City Council may change the budget throughout the fiscal year by transferring appropriations between levels of legal compliance. Unexpected additional resources may be budgeted by adopting supplemental budgets as authorized by ORS. A supplemental budget requires newspaper publications, and City Council approval at a minimum, and may require public comments or hearings over a certain dollar threshold. The City Council also approved one resolution adjusting appropriations during the year.

All expenditures were within authorized appropriations.

1. Summary of Significant Accounting Policies (continued)

Net Position Flow Assumptions

The City may fund outlays for a particular purpose from both restricted and unrestricted resources. In order to calculate the amounts to report as restricted net position and unrestricted net position in the government-wide and proprietary fund financial statements, a flow assumption must be made about the order in which resources are considered to have been applied. It is the City's policy to deplete restricted net position first, then committed, then assigned, and lastly unrestricted.

Fund Balance Flow Assumptions

The City may fund outlays for a particular purpose from both restricted and unrestricted resources. In order to calculate the amounts to report as restricted, committed, assigned and unassigned fund balance in the governmental fund financial statements a flow assumption must be made about the order in which resources are considered to have been applied. When both restricted and unrestricted resources are available for use, it is the City's policy to use restricted resources first, then unrestricted resources as needed. When components of restricted fund balance can be used for the same purpose, committed fund balance is depleted second, followed by assigned fund balance. Unassigned fund balance is applied last.

Reserve Policies

The City shall maintain adequate working capital reserves in all funds.

The General Fund shall maintain sufficient working capital to allow the City to adequately fund operations until property taxes are received in November of each year without borrowing. The General Fund shall maintain six (6) months working capital to allow the City to adequately fund operations until property taxes are received in November of each year without borrowing, and shall maintain a goal of twenty (20) percent reserve of its revenue budget. It is the intent of the City to limit the use of the General Fund reserves to non-recurring needs, to ensure the City has the flexibility to respond and mitigate short-term economic downturns, short-term volatility in revenues, and unforeseen emergency situations or circumstances, fund other capital needs or other such non-recurring needs. Additionally, the City will maintain a debt service reserve equal to the annual debt service payment for all debt paid by the general fund.

The City's business-like funds, excluding the rail road, shall maintain a minimum working capital balance sufficient for sixty (60) days of operating expenses, together with a five (5) percent of budgeted revenue for an emergency repair reserve. Additionally, the City will seek to stabilize utility rates by setting aside funds (capital projects reserve), as funding is available from existing resources, for scheduled capital maintenance programs to reduce future borrowing. Where resources from rates and other sources are insufficient to fund scheduled capital projects, long-term debt may be utilized. Evaluation of future debt service requirements will be incorporated into the financial analysis noted above, including funding and maintaining debt service reserves equal to the annual debt service payment for all debt within the funds.

The City's Transportation fund shall maintain at a minimum working capital balance sufficient for sixty (60) days of operating expenses, together with an emergency reserve of five percent (5.0%) of current year revenue. Additionally, the City will set aside funds (capital projects reserve), as funding is available from existing resources, for scheduled capital maintenance programs, and one time capital improvements that are identified in the master plan. The City commits to evaluate annually and utilize electrical franchise fees collected to fund additional capital contributions as needed for projects, and to retain and maintain the pavement condition index (PCI) at the level approved by the City Council.

1. Summary of Significant Accounting Policies (continued)

The City's internal service funds shall maintain, at minimum, a working capital balance of fifteen (15) percent of operating expenses and the city will commit funds and maintain a debt service reserve equal to the annual debt service payment for all debt within the funds.

The City's debt service funds shall maintain adequate working capital to pay required debt service without borrowing and fund debt service reserves in an amount equal to the annual debt service payment.

Due to the variability in revenues resulting from business cycles for the City's rail road operation, the City's rail road fund shall maintain one year's operating expense and twenty (20) percent of total budget for capital reserve. The City will strive to maintain combined total reserves of not less than $1 million with a target of $2 million, increased annually by the percent change in the CPI.

The City's other operating funds shall maintain a minimum working capital balance sufficient for 45 days of operating expenses, for non-recurring capital projects the City will review annually the five year CIP, estimate the impact to the budgets and target an appropriate reserve amount to fund the projects or maintain a debt service payment should the project be too large to fund with current resources, and the City will commit funds and maintain a debt service reserve equal to the annual debt service payment for all debt within the funds.

The policies establish the amounts the City will strive to maintain. They set forth the guidelines for both current activities and long-range planning. The policies are reviewed annually to assure the highest standards of fiscal management. The City may use the unassigned fund balances on a one-time or temporary basis for purposes described above, committed funds may be spent with approval of the city council on a one time basis. The City will develop a plan to restore unassigned and committed reserves to the desired levels.

Fair Value Inputs and Methodologies and Hierarchy

Fair value is defined as the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. Observable inputs are developed based on market data obtained from sources independent of the reporting entity. Unobservable inputs are developed based on the best information available about the assumptions market participants would use in pricing the asset. The classification of securities within the fair value hierarchy is based up on the activity level in the market for the security type and the inputs used to determine their fair value, as follows:

Level 1 – unadjusted price quotations in active markets/exchanges for identical assets or liabilities that each Fund has the ability to access

Level 2 – other observable inputs (including, but not limited to, quoted prices for similar assets or liabilities in markets that are active, quoted prices for identical or similar assets or liabilities in markets that are not active, inputs other than quoted prices that are observable for the assets or liabilities (such as interest rates, yield curves, volatilities, loss severities, credit risks and default rates) or other market–corroborated inputs)

Level 3 – unobservable inputs based on the best information available in the circumstances, to the extent observable inputs are not available (including each Fund's own assumptions used in determining the fair value of investments)

The hierarchy gives the highest priority to unadjusted quoted prices in active markets for identical assets or liabilities (Level 1 measurements) and the lowest priority to unobservable inputs (Level 3 measurements).

1. Summary of Significant Accounting Policies (continued)

Accordingly, the degree of judgment exercised in determining fair value is greatest for instruments categorized in Level 3. The inputs used to measure fair value may fall into different levels of the fair value hierarchy. In such cases, for disclosure purposes, the fair value hierarchy classification is determined based on the lowest level input that is significant to the fair value measurement in its entirety.

2. Cash and Investments

The City maintains a pooled cash and investment account for all City funds. The types of investments in which the City may invest are restricted by State of Oregon statutes and a council-adopted investment policy. Authorized investments include U.S. Treasury obligations including treasury notes, bond and strips; federal instrumentality securities from specific federal agencies; commercial paper rated at least A-1 or an equivalent rating; corporate bonds rated at least Aa or an equivalent rating; bankers acceptances rated at least Aa or an equivalent rating; the Oregon State Treasurer's LGIP limited by state statute; certificates of deposits; repurchase agreements and obligations of the states of Oregon, California, Idaho and Washington rated AA or better.

At June 30, 2024, the City's cash and investments were comprised of the following:

Cash on hand	$	3,000
Demand checking accounts		9,374,964
Local government investment pool		19,053,054
	$	28,431,018

	Governmental Activities	Business-type Activities	Total
Cash and investments	$ 24,758,353	3,370,105	28,128,458
Restricted cash and investments	-	302,560	302,560
Total cash and investments	24,758,353	3,672,665	28,431,018

Deposits with Financial Institutions

Deposits with financial institutions are comprised of demand checking accounts. Effective July 1, 2008, the State of Oregon formed the Oregon Public Funds Collateralization Program under ORS 295. The collateralization program creates a state-wide pool of qualified bank depositories for local governments, providing collateralization for bank balances that exceed the limits of Federal Depository Insurance Corporation (FDIC), and eliminating the need for certificates of participation. As of June 30, 2024, the City had a total bank balance of $9,755,238 of which $250,000 was covered by FDIC and the NCUA, with the remaining amount collateralized by the Oregon Public Collateralization Program.

Custodial Credit Risk

Custodial credit risk is the risk that deposits with a financial institution may not be returned to the City. The City's policy, in compliance with state statutes, requires that bank deposits be covered by FDIC and deposited in a financial institution that is qualified in the Oregon Public Funds Collateralization Program. Additionally, deposits in the LGIP are administered by the Oregon State Treasury with the advice of other state agencies and is not rated or registered with the U.S. Securities and Exchange Commission.

2. Cash and Investments (continued)

The LGIP is an open-ended, no-load diversified portfolio offered to any agency, political subdivision, or public corporation of the state that by law is made the custodian of, or has control of any public funds. The LGIP is commingled with the State of Oregon's short-term funds. In seeking to best serve local governments of Oregon, the Oregon Legislature established the Oregon Short-term Fund Board. The purpose of the Board is to advise the Oregon State Treasury in the management and investment of the LGIP.

The board established portfolio diversification percentages based on the types and maturities of investments. LGIP must manage and invest its funds as a prudent investor would, exercising reasonable care, skill and caution. Professional standards indicate that the investments in external investment pools are not subject to custodial risk because they are not evidenced by securities that exist in physical or book entry form. Nevertheless, management does not believe that there is any substantial custodial risk related to investments in the LGIP. A copy of the State's Annual Comprehensive Financial Report may be obtained at http://www.ost.state.or.us/.

Investments

Investments in the Local Government Investment Pool (LGIP) are included in the Oregon Short-Term Fund, which is an external investment pool that is not a 2a-7-like external investment pool, and is not registered with the U.S. Securities and Exchange Commission as an investment company. Fair value of the LGIP is calculated at the same value as the number of pool shares owned. The unit of account is each share held, and the value of the position would be the fair value of the pool's share price multiplied by the number of shares held. Investments in the Short-Term Fund are governed by ORS 294.135, Oregon Investment Council, and portfolio guidelines issued by the Oregon Short-Term Fund Board, which establish diversification percentages and specify the types and maturities of investments. The portfolio guidelines permit securities lending transactions as well as investments in repurchase agreements and reverse repurchase agreements. The fund appears to be in compliance with all portfolio guidelines at June 30, 2024. The LGIP seeks to exchange shares at $1.00 per share; an investment in the LGIP is neither insured nor guaranteed by the FDIC or any other government agency. Although the LGIP seeks to maintain the value of share investments at $1.00 per share, it is possible to lose money by investing in the pool. We intend to measure these investments at book value since it materially approximates fair value. The pool is comprised of a variety of investments. These investments are characterized as a level 2 fair value measurement in the Oregon Short Term Fund's audited financial report. As of June 30, 2024, the fair value of the position in the LGIP is 100 percent of the value of the pool shares as reported in the Oregon Short Term Fund audited financial statements. Amounts in the State Treasurer's Local Government Investment Pool are not required to be collateralized.

Interest Rate Risk

The City's investment policy limits its investment maturities as a means of managing its exposure to fair value losses arising from increasing interest rates. At June 30, 2024, the City did not hold any individual investments. As such, its interest rate risk is limited to adjustments in its money market accounts, including the LGIP.

Credit Risk

As mentioned above, Oregon Revised Statutes limits the investments that the City may have to high quality bonds with limited exposure to credit risk. The City is in compliance with these statutes at June 30, 2024.

3. Receivables

Accounts Receivable

The City maintains security deposits for utility accounts and writes off uncollectible accounts as they occur. Past write-off experience is insignificant to the balance of accounts receivable therefore no allowance for doubtful accounts has been recorded.

As of June 30, 2024, accounts receivable consisted of the following:

Accounts receivable-governmental activities	$	2,052,224
Accounts receivable- business type		3,524,772
Total	$	5,576,996

Amounts Due from Other Funds

An amount due to the general fund from the railroad fund in the amount of $771,851 is recorded. The amount due is the result of transfers from the general fund to the freight depot fund through June 30, 2024 to pay debt service related to industrial park development, with the intent for the transfers to be repaid at a future date. However, repayment terms have not been established pending the railroad demonstrating the ability to generate sufficient positive cash flow to discontinue the transfers and repay the debt on a recurring basis. Accordingly, unearned revenue of $771,851 has been recorded in the general fund.

4. Capital Assets

Purchased or constructed capital assets acquired prior to June 30, 2007 are recorded at estimated historical cost with subsequent additions at cost. Donated capital assets, donated works of art and similar items, and capital assets received in a service concession arrangement are recorded at their acquisition value at the time of donation or contribution. Infrastructure (roads, water, wastewater, sidewalks and other similar improvements) acquired during the year are recorded at cost or fair value if contributed by developers. The City defines capital assets as assets with an initial cost of more than $10,000 and an estimated useful life of more than one year. The cost of normal maintenance and repairs that do not add value of the asset or materially extend the assets' useful lives are not capitalized.

Capital assets of the City are depreciated using the straight-line method over the following estimated useful lives:

	Years
Buildings and structures	25-50
Improvements other than buildings	10-20
Machinery and equipment	5-30
Vehicles	5-10
Infrastructure	30-40

4. Capital Assets (continued)

Governmental activities: Capital asset activity for governmental activities for the year ended June 30, 2024, was as follows:

	Balance June 30, 2023	Additions	Deletions	Balance June 30, 2024
Governmental activities:				
Capital assets not being depreciated:				
Land and Easements	$ 2,739,442	$ -	$ -	$ 2,739,442
Work in progress	93,500	300	-	93,800
Total capital assets not being depreciated	2,832,942	300	-	2,833,242
Capital assets being depreciated:				
Buildings and improvements	$ 8,608,337	$ 132,130		$ 8,740,467
Vehicles and equipment	7,565,570	1,311,541	(71,241)	8,805,870
Infrastructure	39,769,013	2,260,766		42,029,779
Subscription Assets	34,779	-	(9,092)	25,687
Leased Assets	168,771	-	-	168,771
Total capital assets being depreciated	56,146,470	3,704,437	(80,333)	59,770,574
Less accumulated depreciation for:				
Buildings and improvements	1,830,478	292,156	-	2,122,634
Vehicles and equipment	5,677,263	597,972	(71,241)	6,203,994
Infrastructure	19,364,225	944,696	-	20,308,921
Subscription assets (amortization)	7,193	16,740	(9,092)	14,841
Leased assets (amortization)	128,993	26,091	-	155,084
				-
Total accumulated depreciation	27,008,152	1,877,655	(80,333)	28,805,474
Total Capital Assets Net of Depreciation	$ 31,971,260			$ 33,798,342

Depreciation and amortization expense was charged to the functions of governmental activities as follows:

Public Safety	$ 306,134
Highways and Streets	146,655
General Government	1,424,866
Total	$ 1,877,655

4. Capital Assets (continued)

Business-type activities: Capital asset activity for business-type activities, by fund, for the year ended June 30, 2024, is as follows.

	Balance June 30, 2023	Additions	Deletions	Balance June 30, 2024
Business-type activities:				
Capital assets not being depreciated:				
Land and Easements	$ 1,672,447	$ 446,144	$ -	$ 2,118,591
Work in progress	2,015,847	4,854,075	(1,050,516)	5,819,406
Total capital assets not being depreciated	3,688,294	5,300,219	(1,050,516)	7,937,997
Capital assets being depreciated:				
Buildings and improvements	$ 48,844,264	$ 456,020	$ -	$ 49,300,284
Vehicles and equipment	5,627,159	487,247	(12,653)	6,101,753
Infrastructure	59,529,755	3,126,451	-	62,656,206
Total capital assets being depreciated	114,001,178	4,069,718	(12,653)	118,058,243
Less accumulated depreciation for:				
Buildings and improvements	19,741,281	1,049,110	-	20,790,391
Vehicles and equipment	4,700,424	189,888	(12,653)	4,877,659
Infrastructure	10,579,054	1,757,861	-	12,336,915
				-
Total accumulated depreciation	35,020,759	2,996,859	(12,653)	38,004,965
Total Capital Assets Net of Depreciation	$ 82,668,713			$ 87,991,275

5. Debt

In the following schedules, long-term obligations information is presented separately with respect to governmental and business-type activities, including individual fund information for business-type activity. The schedules present current year changes in these obligations and the current portions, amount due within one year, for each issue. For the governmental activities, compensated absences are liquidated by the fund that pays for the employee costs associated with the services received. Compensated absences are due and payable on demand upon an employee's retirement or other separation from employment. There are two known employee retirements or separations as of June 30, 2024. The amount due to these employees including benefits, as of June 30, 2024, is presented as a current liability, with the balance of the compensated obligation shown as a non-current liability.

5. Debt (continued)

	Amount of Original Issue	Interest Rates	Balance July 1, 2023	Additions	Reductions	Balance June 30, 2024	Amount Due Within One Year
Governmental Activities:							
All faith and credit obligations							
Direct borrowings:							
Note payable - Pension Obligation Refi 2017	$ 2,549,000	3.70%	$ 1,450,562	$ -	$ 277,643	$ 1,172,919	$ 299,825
Note payable - Police Building 2020	5,958,000	1.73%	5,103,000	-	316,000	4,787,000	333,000
USDA 2022 Refunding - City Hall	986,811	1.21%	794,295	-	95,133	699,162	95,854
Note Payable - Street Sweeper 2022	184,940	2.84%	149,994	-	35,938	114,056	36,959
Financed purchase - Police tasers	49,782	3.30%	-	49,782	9,320	40,462	9,628
Long-term debt obligations	9,728,533		7,497,851	49,782	734,034	6,813,599	775,266
Compensated absences	-		830,543	445,702	422,202	854,043	854,043
Total governmental activities	$ 9,543,593		$ 8,328,394	$ 495,484	$ 1,156,236	$ 7,667,642	$ 1,629,309

5. Debt (continued)

	Amount of Original Issue	Interest Rates	Balance July 1, 2023	Additions	Reductions	Balance June 30, 2024	Amount Due Within One Year
Business-Type Activities							
Bond:							
USDA 2018 - wastewater	$ 4,000,000	2.75%	$ 3,703,325	$ -	$ 64,318	$ 3,639,007	$ 66,087
Total bonds:	4,000,000		3,703,325	-	64,318	3,639,007	66,087
Direct borrowings							
FFCO - Series 2022 refunding - water, golf, wastewater	7,472,555	1.21%	5,741,249	-	1,017,861	4,723,388	1,031,080
IFA - 2016 wastewater	750,000	1.00%	621,602	-	27,839	593,763	28,117
OBDD - water	3,024,900	1.30%	3,000,000	-	-	3,000,000	-
Total direct borrowings:	11,247,455		9,362,851	-	1,045,700	8,317,151	1,059,197
Long-term debt obligations	15,247,455		13,066,176	-	1,110,018	11,956,158	1,125,284
Compensated absences	-		265,621	86,239	62,668	289,192	289,192
Total business type activities	$30,494,910		$13,331,797	$ 86,239	$ 1,172,686	$ 12,245,350	$ 1,414,476

Governmental Activities

A United States Department of Agriculture (USDA) debt obligation was utilized to finance the construction of city hall in 2006. This debt was refinanced in 2018 and then again in 2022. The annual debt service requirement is $105,844 including interest of 1.22 percent annually. The City reserved an amount of $105,000 for future requirements on this debt. The note contains a provision stating that in the event of default the Lender may exercise any amount available at law or in equity. However, amounts due from the City are not subject to acceleration.

A $2.55 million note payable entered into in 2018 was utilized to fund the City's actuarial unfunded pension liability. This was a refunding of a 2014 note payable. Annual debt service in fiscal year 2019 was $275,961 increasing by an average of 3.7 percent annually, consistent with the projected annual increase in payroll obligations. The obligation matures in 10 years, fiscal year 2028, and includes taxable interest of 3.70 percent annually. The note does not have significant default provisions.

A $184,940 note payable entered into in 2022 was utilized to purchase a street sweeper. The annual debt service requirement is $40,198, including interest of 2.84 percent annually. The note contains a provision stating that in the event of default the Lender may exercise any amount available at law or in equity, it may declare all or part of the indebtedness immediately due and payable, and may require all equipment to be returned.

The city financed the purchase of Tasers for the Police Department. The annual debt service requirement is $10,963, including 3.3% interest annually. In the event of default, the City will be invoiced for the remaining balance of the MSRP of the devices.

5. Debt (continued)

A $5.96 million note payable entered into in 2020 was utilized to complete the police building project and refinance an existing loan balance of $3.74 million, which was utilized for the first part of the construction of a new police building. The annual debt service requirement varies from $369,343 to $558,498, including interest of 1.73 percent annually. The note contains a provision stating that in the event of default the Lender may increase the interest rate by 3.00 percent and exercise any amount available at law or in equity. However, amounts due from the City are not subject to acceleration.

Future maturities of governmental long-term debt at June 30, 2024, are as follows:

Direct Borrowings:

	Pension Bonds		Street Sweeper	
Year	Principal	Interest	Principal	Interest
2025	$ 299,825	$ 43,421	$ 36,959	$ 3,239
2026	326,592	32,322	38,009	2,190
2027	352,868	20,232	39,088	1,110
2028	193,634	7,170	-	-
Total	$ 1,172,919	$ 103,145	$ 114,056	$ 6,539

	Police Building		FFCO 2022 - City Hall		Police Tasers	
Year	Principal	Interest	Principal	Interest	Principal	Interest
2025	$ 333,000	$ 82,815	$ 95,854	$ 8,460	$ 9,628	$ 1,335
2026	351,000	77,054	97,531	7,300	9,946	1,018
2027	370,000	70,982	99,148	6,120	10,274	689
2028	390,000	64,581	99,705	4,920	10,614	349
2029	410,000	57,834	101,214	3,714	-	-
2030-2034	2,384,000	175,250	205,709	3,736	-	-
2035	549,000	9,498	-	-	-	-
Total	$ 4,787,000	$ 538,014	$ 699,161	$ 34,250	$ 40,462	$ 3,391

Business-type Activities

In addition to the schedule on the previous page, debt for each of the business-type activities for the year ended June 30, 2024, by the business activity responsible for the repayment of the debt obligation, are presented below. The City issued $7.473 million in full faith and credit obligations to refinance four outstanding obligations totaling $7.326 million ($5.17 million wastewater related, $2.06 million of water related debt, and $264 thousand golf related debt). The full faith and credit obligations mature in fiscal year 2031 for water and wastewater, and 2026 for golf, and have effective interest rates of 1.22 percent. Sources of repayment include water utility, wastewater utility, and golf revenues. The obligations have a provision stating that at event of default, the Lender may increase the interest rate applicable to the outstanding balance by 3 percent and exercise any remedy available at law or equity. Amounts due are not subject to acceleration.

Wastewater. The wastewater utility has financed the City's sewer treatment plant, golf course treatment facility, and collection system improvements through several debt obligations. These obligations are described as follows:

5. Debt (continued)

A previously refunded issue was refunded again in 2018 with proceeds of the full faith and credit obligation noted above. Full faith and credit obligation series 2011 was refunded. A CWSRL obligation requires annual debt service payments of $587,230, including interest of 3 percent (2.94 percent). The obligation contains a provision stating that in the event of default, Oregon DEQ (lender) may declare the outstanding loan amount plus any accrued interest fees and other amounts immediately due and payable, cease making disbursement of loan proceeds, operate the facility that produces pledged revenues and collect the gross revenues, set and collect utility rates and charges, pay or settle any liens, or direct the State treasurer to withhold any amounts otherwise due to the Borrower from the State of Oregon.

In 2019, the City finalized a finance agreement with USDA. The total amount received was $4,000,000 at an interest rate of 2.75 percent. The loan becomes due in 2058 and the annual debt service is $166,660. The debt service reserve requirement is fully funded in the amount of $166,660. The City also keeps a short-lived asset replacement reserve account as restricted funds in the amount of $191,595. USDA, at its option, may declare all or part of the indebtedness immediately due and payable.

In 2016, the City finalized a finance agreement with Oregon Infrastructure Authority. The City finished drawing down on the loan in 2019 for a total amount of $750,000 at an interest rate of 1 percent. The loan becomes due in 2042 and the annual debt service is $34,056. The note contains a provision stating that in the event of default, Oregon Infrastructure Authority, at its option, may declare all or part of the indebtedness immediately due and payable.

The summary of wastewater outstanding obligations and their future maturities including principal and interest at June 30, 2024, are as follows:

Wastewater	Balance June 30, 2023	New Issues	Principal Paid	Balance June 30, 2024
Revenue Bond:				
USDA 2018	$ 3,703,326	$ -	$ 64,319	$ 3,639,007
Direct Borrowings:				
Full Faith and Credit Obligations Refunding 2022	3,782,737	-	735,327	3,047,410
IFA Loan 2016	621,602	-	27,839	593,763
Total Wastewater	$ 8,107,665	$ -	$ 827,485	$ 7,280,180

	USDA 2018	
Year	Principal	Interest
2025	$ 66,087	$ 100,073
2026	67,905	98,255
2027	69,772	96,388
2028	71,691	94,469
2029	73,662	92,498
2030-2034	399,835	430,965
2035-2039	457,920	372,880
2040-2044	524,444	306,356
2045-2049	600,631	230,169
2050-2054	687,887	142,913
2055-2058	619,173	43,048
Total	$ 3,639,007	$ 2,008,014

5. Debt (continued)

Direct Borrowing

Year	IFA Loan 2016 Principal	IFA Loan 2016 Interest	Full Faith 2022 Principal	Full Faith 2022 Interest
2025	$ 28,117	$ 5,938	$ 744,178	$ 36,874
2026	28,399	5,656	748,208	27,869
2027	28,683	5,372	501,613	18,816
2028	28,969	5,086	244,994	12,746
2029	29,259	4,796	259,668	9,782
2029-33	150,744	19,531	548,749	10,048
2034-38	158,432	11,843	-	-
2039-43	141,160	3,675	-	-
Total	$ 593,763	$ 61,897	$ 3,047,410	$ 116,135

Water. The City entered into a loan agreement with Oregon Infrastructure Finance Authority of the Business Development Department (OBDD) to fund Aquifer Storage and Recovery. The total amount to be received is $3,024,900 at an interest rate of 1.30 percent. At June 30, 2024 the City has drawn down $3,000,000. No amortization schedule has been set yet and all of the balance is classified as due in more than one year. The OBDD loan contains a provision that all amounts outstanding become immediately due in the event of default.

A summary of outstanding debt payable from water system revenues including future maturities of water-related debt principal and interest, at June 30, 2024, are as follows:

Water	Balance June 30, 2023	New Issues	Principal Paid	Balance June 30, 2024
Full Faith and Credit Obligations 2022	$ 1,588,956	$ -	$ 159,040	$ 1,429,916
Total Debt	$ 1,588,956	$ -	$ 159,040	$ 1,429,916

Direct Borrowing:

Year	Full Faith 2022 Principal	Full Faith 2022 Interest
2025	$ 163,383	$ 17,302
2026	163,453	15,325
2027	200,381	13,347
2028	209,942	10,923
2029	222,517	8,382
2028-2032	470,240	8,612
Total	$ 1,429,916	$ 73,891

Golf. As described above, the City refinanced the outstanding note payable in 2017 and again in 2023. The term on the new note payable is five years maturing in 2026 with interest of 1.22 percent. The Golf Course's debt obligations, including future maturities of principal and interest at June 30, 2024, are as follows:

5. Debt (continued)

Golf	Balance June 30, 2023	New Issues	Principal Paid	Balance June 30, 2024
Direct Borrowings:				
Full Faith and Credit Obligations Refunding 2022	$ 369,555	$ -	$ 123,493	$ 246,062
Total Golf	$ 369,555	$ -	$ 123,493	$ 246,062

Direct Borrowing

	FFC Refunding 2022	
Year	Principal	Interest
2025	$ 123,518	$ 2,977
2026	122,544	1,483
Total	$ 246,062	$ 4,460

6. Interfund Transfers

Interfund transfers between governmental and business-type activities are reported as net transfers in the *Statement of Activities*. Details of the transfers between governmental and business-type activities are as follows:

Fund	Transfers In	Transfers Out
General Fund	$ 441,767	$ 3,830,860
Transportation Fund	824,300	235,800
Emergency Dispatch Fund	400,000	519,900
Transportation SDC Fund	-	33,718
Pension Debt Service Fund	50,000	-
Water	172,100	2,359,858
Wastewater	165,239	1,909,595
Railroad	370,000	165,800
Golf	-	99,100
Airport Fund	30,360	32,000
Internal Service Funds	7,033,453	300,588
Total	$ 9,487,219	$ 9,487,219

Transfers from the general fund to the emergency dispatch fund reflect the City's share of the contracted service, to transportation fund for capital improvements, to the airport fund for the operational funding agreement between the City and Crook County, and to the other governmental funds transfers reflect contributions to fund community development operations and pay for internal services such as administration, finance, information technology, and building facilities. Transfers from other funds to internal service funds reflect the internal cost allocation of internal services such as administration, finance, information technology, facilities, pension liabilities, and public works personnel and support services. The transfer from the wastewater fund to golf and restaurant fund is for payment for treatment services, and the transfers to water and wastewater are transfers from SDC funds for qualified infrastructure improvements paid for by utility funds.

7. Defined Benefit Pension Plan

Plan Description – The Oregon Public Employees Retirement System (PERS) consists of a single cost-sharing multiple-employer defined benefit plan. All benefits of the system are established by the legislature pursuant to Oregon Revised Statute (ORS) Chapters 248 and 248A. Oregon PERS produces an independently audited Annual Comprehensive Financial Report which can be found at:
https://www.oregon.gov/pers/Documents/Financials/CAFR/2023-Annual-Comprehensive-Financial-Report.pdf
If the link is expired please contact Oregon PERS for this information.

a. **PERS Pension (Chapter 248)**. The ORS Chapter 248 Defined Benefit Plan is closed to new members hired on or after August 29, 2003.
   i. **Pension Benefits**. The PERS retirement allowance is payable monthly for life. It may be selected from 13 retirement benefit options. These options include survivorship benefits and lump-sum refunds. The basic benefit is based on years of service and final average salary. A percentage (2.0 percent for police and fire employees, and 1.67 percent for general service employees) is multiplied by the number of years of service and the final average salary. Benefits may also be calculated under either a formula plus annuity (for members who were contributing before August 22, 1981) or a money match computation if a greater benefits results.
   A member is considered vested and will be eligible at minimum retirement age for a service retirement allowance if he or she has had a contribution in each of five calendar years or has reached at least 50 years of age before ceasing employment with a participating employer (age 45 for police and fire members). General service employees may retire after reaching age 55. Police and fire members are eligible after reaching age 50. Tier 1 general service employee benefits are reduced if retirement occurs prior to age 58 with fewer than 30 years of service. Police and fire member benefits are reduced if retirement occurs prior to age 55 with fewer than 25 years of service. Tier 2 members are eligible for full benefits at age 60. The ORS Chapter 248 Defined Benefit Pension Plan is closed to new members hired on or after August 29, 2003.
   ii. **Death Benefits**. Upon the death of a non-retired member, the beneficiary receives a lump-sum refund of the member's account balance (accumulated contributions and interest). In addition, the beneficiary will receive a lump-sum payment from employer funds equal to the account balance, provided one or more of the following contributions are met:
      - member was employed by PERS employer at the time of death,
      - member died within 120 days after termination of PERS covered employment,
      - member died as a result of injury sustained while employed in a PERS-covered job, or
      - member was on an official leave of absence from a PERS-covered job at the time of death.
   iii. **Disability Benefits**. A member with 10 or more years of creditable service who becomes disabled from other than duty-connected causes may receive a non-duty disability benefit. A disability resulting from a job-incurred injury or illness qualifies a member (including PERS judge members) for disability benefits regardless of the length of PERS-covered service. Upon qualifying for either a non-duty or duty disability, service time is computed to age 58 (55 for police and fire members) when determining the monthly benefit.
   iv. **Benefit Changes After Retirement**. Members may choose to continue participation in their variable account after retiring and may experience annual benefit fluctuations due to changes in the fair value of the underlying global equity investments of that account. Under ORS 248.360 monthly benefits are adjusted annually through cost-of-living changes (COLA). The COLA is capped at 2.0 percent.

b. **OPSRP Pension Program (OPSRP DB)**. The ORS Chapter 248A Defined Benefit Pension Program provides benefits to members hired on or after August 29, 2003.

7. Defined Benefit Pension Plan (continued)

i. **Pension Benefits**. This portion of OPSRP provides a life pension funded by employer contributions. Benefits are calculated with the following formula for members who attain normal retirement age:
Police and fire: 1.8 percent is multiplied by the number of years of service and the final average salary. Normal retirement age for police and fire members is age 60 or age 53 with 25 years of retirement credit. To be classified as a police and fire member, the individual must have been employed continuously as a police and fire member for at least five years immediately preceding retirement.
General service: 1.5 percent is multiplied by the number of years of service and the final average salary. Normal retirement age for general service members is age 65, or age 58 with 30 years of retirement credit.
A member of the pension program becomes vested on the earliest of the following dates: the date the member completes 600 hours of service in each of five calendar years, the date the member reaches normal retirement age, and, if the pension program is terminated, the date on which termination becomes effective.

ii. **Death Benefits**. Upon the death of a non-retired member, the spouse or other person who is constitutionally required to be treated in the same manner as the spouse, receives for life 50 percent of the pension that would otherwise have been paid to the deceased member. The surviving spouse may elect to delay payment of the death benefit, but payment must commence no later than December 31 of the calendar year in which the member would have reached 70½ years.

iii. **Disability Benefits**. A member who has accrued 10 or more years of retirement credits before the member becomes disabled or a member who becomes disabled due to job-related injury shall receive a disability benefit of 45 percent of the member's salary determined as of the last full month of employment before the disability occurred.

Contributions – PERS funding policy provides for monthly employer contributions at actuarially determined rates. These contributions, expressed as a percentage of covered payroll, are intended to accumulate sufficient assets to pay benefits when due. The funding policy applies to the PERS Defined Benefit Plan and the Other Postemployment Benefit Plans. Employer contribution rates during the period were based on the December 31, 2022 actuarial valuation, which became effective July 1, 2023. The state of Oregon and certain schools, community colleges, and political subdivision have made unfunded actuarial liability payments and their rates have been reduced. Employer contributions for the year ended June 30, 2024 were $1,005,306, excluding amounts to fund employer specific liabilities. In addition, approximately $350,458 in employee contributions were paid or picked up by the City in fiscal 2024. At June 30, 2024, the City reported a net pension liability of $8,416,699 for its proportionate share of the net pension liability. The pension liability was measured as of June 30, 2023, and the total pension liability used to calculate the net pension liability was determined by an actuarial valuation dated December 31, 2021. The City's proportion of the net pension liability was based on a projection of the City's long-term share of contributions to the pension plan relative to the projected contributions of all participating employers, actuarially determined. As of the measurement date of June 30, 2023 and 2022, the City's proportion was .044 percent and .041 percent, respectively. Pension expense for the year ended June 30, 2024 was $752,470.

The rates in effect for the year ended June 30, 2024 were:

(1)Tier 1/Tier 2 – 19.92%
(2)OPSRP general services – 14.62%
(3)OPSRP Police and Fire – 19.41%

7. Defined Benefit Pension Plan (continued)

The amount of contributions subsequent to the measurement date will be included as a reduction of the net pension liability in the fiscal year ended June 30, 2025.

	Deferred Outflow of Resources	Deferred Inflow of Resources
Difference between expected and actual experience	$ 411,602	$ 33,373
Changes in assumptions	747,690	5,575
Net difference between projected and actual earnings on pension plan investments	151,283	-
Net changes in proportionate share	1,342,165	7,708
Differences between City contributions and proportionate share of contributions	36,243	909,489
Subtotal - Amortized Deferrals (below)	2,688,983	956,145
City contributions subsequent to measuring date	1,005,306	-
Deferred outflow (inflow) of resources	$ 3,694,289	$ 956,145

Amounts reported as deferred outflows or inflows of resources related to pension will be recognized in pension expense as follows:

Year ending June 30,	Amount
2025	$ 404,716
2026	(50,908)
2027	959,629
2028	366,083
2029	53,318
Thereafter	-
Total	$ 1,732,838

All assumptions, methods and plan provisions used in these calculations are described in the Oregon PERS system-wide GASB 68 reporting summary dated February 2, 2024. Oregon PERS produces an independently audited ACFR which can be found at:
https://www.oregon.gov/pers/Documents/Financials/CAFR/2023-Annual-Comprehensive-Financial-Report.pdf

Actuarial Valuations – The employer contribution rates effective July 1, 2023 through June 30, 2025, were set using the entry age normal actuarial cost method. For the Tier One/Tier Two component of the PERS Defined Benefit Plan, this method produced an employer contribution rate consisting of (1) an amount for normal cost (estimated amount necessary to finance benefits earned by employees during the current service year), (2) an amount for the amortization unfunded actuarial accrued liabilities, which are being amortized over a fixed period with new unfunded actuarial liabilities being amortized over 20 years.

For the OPSRP Pension Program component of the PERS Defined Benefit Plan, this method produced an employer rate consisting of (a) an amount for normal cost (the estimated amount necessary to finance benefits earned by the employees during the current service year), (b) an actuarially determined amount for funding a disability benefit component, and (c) an amount for the amortization of unfunded actuarial accrued liabilities,

7. Defined Benefit Pension Plan (continued)

which are being amortized over a fixed period with new unfunded actuarial accrued liabilities being amortized over 16 years.

Actuarial Methods and Assumptions:

Valuation date	December 31, 2021
Experience Study Report	2020, Published July 20, 2021
Actuarial cost method	Entry Age Normal
Amortization method	Level percentage of payroll
Asset valuation method	Fair value
Inflation rate	2.40 percent
Investment rate of return	6.90 percent
Discount rate	6.90 percent
Projected salary increase	3.40 percent
Cost of Living Adjustment	Blend of 2% COLA and graded COLA (1.25%/0.15%) in accordance with *Moro* decision; blend based on service
Mortality	Healthy retirees and beneficiaries: Pub-2010 Healthy Retiree, sex distinct, generational with Unisex, Social Security Data Scale, with job category adjustments and set-backs as described in the valuation. Active members: Pub-2010 Employee, sex distinct, generational with Unisex, Social Security Data Scale, with job category adjustments and set-backs as described in the valuation. Disabled retirees: Pub-2010 Disabled Retiree, sex distinct, generational with Unisex, Social Security Data Scale, with job category adjustments and set-backs as described in the valuation.

Actuarial valuations of an ongoing plan involve estimates of value of reported amounts and assumptions about the probability of events far into the future. Actuarially determined amounts are subject to continual revision as actual results are compared to past expectations and new estimates are made about the future. Experience studies are performed as of December 31 of even numbered years. The method and assumptions shown are based on the 2020 Experience Study which is reviewed for the four-year period ending December 31, 2020.

Assumed Asset Allocation:

Asset Class/Strategy	Low Range	High Range	OIC Target
Debt Securities	20.0%	30.0%	25.0%
Public Equity	22.5%	32.5%	27.5%
Real Estate	9.0%	16.5%	12.5%
Private Equity	17.5%	27.5%	20.0%
Real Assets	2.5%	10.0%	7.5%
Diversifying Strategies	2.5%	10.0%	7.5%
Opportunity Portfolio	0.0%	5.0%	0.0%
Total			100.0%

(Source: June 30, 2023 PERS ACFR; p. 125)

7. Defined Benefit Pension Plan (continued)

Long-Term Expected Rate of Return:

To develop an analytical basis for the selection of the long-term expected rate of return assumption, in January 2023 the PERS Board reviewed long-term assumptions developed by both Milliman's capital market assumptions team and the Oregon Investment Council's (OIC) investment advisors. The table below shows Milliman's assumptions for each of the asset classes in which the plan was invested at that time based on the OIC long-term target asset allocation. The OIC's description of each asset class was used to map the target allocation to the asset classes shown below. Each asset class assumption is based on a consistent set of underlying assumptions, and includes adjustment for the inflation assumption. These assumptions are not based on historical returns, but instead are based on a forward-looking capital market economic model.

Asset Class	Target Allocation	Compound Annual (Geometric) Return
Global Equity	27.50%	7.07%
Private Equity	25.50%	8.83%
Core Fixed Income	25.00%	4.50%
Real Estate	12.25%	5.83%
Master Limited Partnerships	0.75%	6.02%
Infrastructure	1.50%	6.51%
Hedge Fund of Funds - Multistrategy	1.25%	6.27%
Hedge Fund Equity - Hedge	0.63%	6.48%
Hedge Fund - Macro	5.62%	4.83%
Assumed Inflation - Mean		*2.35%*

(Source: June 30, 2023 PERS ACFR; p. 92)

Discount Rate – The discount rate used to measure the total pension liability was 6.90 percent for the Defined Benefit Pension Plan. The projection of cash flows used to determine the discount rate assumed that contributions from the plan members and those of the contributing employers are made at the contractually required rates, as actuarially determined. Based on those assumptions, the pension plan's fiduciary net position was projected to be available to make all projected future benefit payments of current plan members. Therefore, the long-term expected rate of return on pension plan investments for the Defined Benefit Pension Plan was applied to all periods of projected benefit payments to determine the total pension liability.

Sensitivity of the City's proportionate share of the net pension liability to changes in the discount rate – the following presents the City's proportionate share of the net pension liability calculated using the discount rate of 6.90 percent, as well as what the City's proportionate share of the net pension liability would be if it were calculated using a discount rate that is one percent lower (5.90 percent) or one percent higher (7.90 percent) than the current rate.

	1% Decrease (5.90%)	Discount Rate (6.90%)	1% Increase (7.90%)
Proportionate share of the net pension liability	$ 13,902,803	$ 8,416,699	$ 3,825,412

7. Defined Benefit Pension Plan (continued)

Changes Subsequent to the Measurement Date

As described above, GASB 67 and GASB 68 require the Total Pension Liability to be determined based on the benefit terms in effect at the Measurement Date. Any changes to benefit terms that occurs after that date are reflected in amounts reported for the subsequent Measurement Date. However, Paragraph 80f of GASB 68 requires employers to briefly describe any changes between the Measurement Date and the employer's reporting date that are expected to have a significant effect on the employer's share of the collective Net Pension Liability, along with an estimate of the resulting change, if available.

There are no changes subsequent to the June 30, 2023 Measurement Date that meet this requirement and thus would require a brief description under the GASB standard.

Deferred Compensation Plan

A deferred compensation plan is available to employees wherein they may execute an individual agreement with the City for amounts earned by them to not be paid until a future date when certain circumstances are met. These circumstances are: termination by reason of resignation, death, disability, or retirement; unforeseeable emergency; or by requesting a de minimis distribution from inactive accounts valued less than $5,000. Payment to the employee will be made over a period not to exceed 15 years. The deferred compensation plan is one which is authorized under IRC Section 457 and has been approved in its specifics by a private ruling from the Internal Revenue Service. The assets of the plan are held by the administrator for the sole benefit of the plan participants and are not considered assets or liabilities of the City.

OPSRP Individual Account Program (OPSRP IAP)

Plan Description:
Employees of the City are provided with pensions through OPERS. All the benefits of OPERS are established by the Oregon legislature pursuant to Oregon Revised Statute (ORS) Chapters 248 and 248A. Chapter 248 Defined Benefit Pension Plan is closed to new members hired on or after August 29, 2003. Chapter 248A created the Oregon Public Service Retirement Plan (OPSRP), which consists of the Defined Benefit Pension Program and the Individual Account Program (IAP). Membership includes public employees hired on or after August 29, 2003. PERS members retain their existing defined benefit plan accounts, but member contributions are deposited into the member's IAP account. OPSRP is part of OPERS, and is administered by the OPERS Board.

Pension Benefits:
Participants in OPERS defined benefit pension plans also participate in their defined contribution plan. An IAP member becomes vested on the date the employee account is established or on the date the rollover account was established. If the employer makes optional employer contributions for a member, the member becomes vested on the earliest of the following dates: the date the member completes 600 hours of service in each of five calendar years, the date the member reaches normal retirement age, the date the IAP is terminated, the date the active member becomes disabled, or the date the active member dies. Upon retirement, a member of the OPSRP IAP may receive the amounts in his or her employee account, rollover account, and vested employer account as a lump-sum payment or in equal installments over a 5-, 10-, 15-, 20-year period or an anticipated life span option. Each distribution option has a $200 minimum distribution limit.

7. Defined Benefit Pension Plan (continued)

Death Benefits:
Upon the death of a non-retired member, the beneficiary receives in a lump sum the member's account balance, rollover account balance, and vested employer optional contribution account balance. If a retired member dies before the installment payments are completed, the beneficiary may receive the remaining installment payments or choose a lump-sum payment.

Contributions:
Employees of the City pay six (6) percent of their covered payroll. Effective July 1, 2020, currently employed Tier 1/Tier 2 and OPSRP members earning $2,500 or more per month (increased to $3,333 per month in 2023) will have a portion of their 6 percent monthly IAP contributions redirected to an Employee Pension Stability Account. The Employee Pension Stability Account will be used to pay part of the member's future benefit. Of the 6 percent monthly IAP contribution, Tier 1/Tier 2 will have 2.5 percent redirected to the Employee Pension Stability Account and OPSRP will have 0.75 percent redirected to the Employee Pension Stability Account, with the remaining going to the member's existing IAP account. Members may voluntarily choose to make additional after-tax contributions into their IAP account to make a full 6 percent contribution to the IAP. The City did not make any optional contributions to member IAP accounts for the year ended June 30, 2024.

Additional disclosures related to Oregon PERS not applicable to specific employers are available online, or by contacting PERS at the following address: PO Box 24700 Tigard, OR 97281-3700.

http://www.oregon.gov/pers/EMP/Pages/GASB.aspx

8. Risk Management

The City is exposed to various risks of loss related to torts; theft of, damage to, and destruction of assets; errors and omissions; injuries to employees and natural disasters. Except for unemployment compensation, the City purchases commercial insurance to minimize its exposure to these risks. There was no change in commercial insurance coverage from fiscal year 2023 to 2024. Workers compensation claims are insured through incurred loss retrospective policies. Settled claims have not exceeded this commercial coverage for any of the past three years. Liabilities are reported when it is probable that a loss has occurred and the amount of the loss can be reasonably estimated.

9. Other Information

Deferred Compensation Plan

The City has a deferred compensation plan created in accordance with the Internal Revenue Code Section 457(g). The plan is administered by independent plan administrators through administrative service agreements. The plan is available to all employees of the City. Employees may defer a portion of their salary until future years. Deferred compensation is not available to employees until termination, retirement, death, or financial hardship. The plan's assets are held in a custodial account for the exclusive benefit of participants and beneficiaries, and are not subject to the claims of the City's creditors, nor can they be used by the City for any purpose other than the payment of benefits to the plan participants. Accordingly, these plan assets and related liability are not recorded in the City's basic financial statements.

10. Fund Balances

Below is a schedule of fund balances as of June 30, 2024, based on GASB Statement No. 54 implementation:

Fund Balances:	General Fund	Emergency Dispatch Fund	Transportation Fund	Transportation SDC Fund	POB Debt Service Fund	Total
Restricted:						
Highways and stree	$ -	$ -	$ 839,637	$ 2,430,096	$ -	$ 3,269,733
	-	-	839,637	2,430,096	-	3,269,733
Committed to:						
Public safety	-	1,902,347	-	-	-	1,902,347
Debt service	-	-	-	-	2,184,240	2,184,240
	-	1,902,347	-	-	2,184,240	4,086,587
Assigned to: Other purposes	248,505	-	-	-	-	248,505
Unassigned:	6,842,202	-	-	-	-	6,842,202
Total	$ 7,090,707	$ 1,902,347	$ 839,637	$ 2,430,096	$ 2,184,240	$ 14,447,027

11. Property Tax Abatements

As of June 30, 2024, the City provides tax abatements through two programs: Long-Term Rural Enterprise Zone Facilities, ORS 285C.400 and Levy Exemption, ORS 307.519.

The Oregon Long-Term Rural Enterprise Zone Facilities program is a State of Oregon economic development program established, that allows for property tax exemptions for up to fifteen years. In exchange for receiving property tax exemption, participating firms are required to meet the program requirements set by state statute and the local sponsor. This program is only available in counties with chronic low income or chronic unemployment.

The Enterprise Zone program allows industrial firms that will be making a substantial new capital investment a waiver of 100 percent of the amount of real property taxes attributable to the new investment for up to a 15-year period after completion. Land or existing machinery or equipment is not tax exempt; therefore, there is no loss of current property tax levies to local taxing jurisdiction.

For the fiscal year ended June 30, 2024, the City abated property taxes totaling $17,999,827 and $2,317 under the Enterprise Zone and Levy Exemption, respectively. The City also had $12,623 in other miscellaneous exemptions.

12. Other Post-Employment Benefits

Post-employment Health Insurance Subsidy

Plan Description

The City administers a single-employer defined benefit healthcare plan that covers both active and retired participants. The plan provides post-retirement healthcare benefits for eligible retirees and their dependents through the City's group health insurance plans. The City's post-retirement plan was established in accordance with Oregon Revised Statutes (ORS) 243.303 which states, in part, that for the purposes of establishing healthcare premiums, the calculated rate must be based on the cost of all plan members, including both active employees and retirees. Because claim costs are generally higher for retiree groups than for active members, the premium amount does not represent the full cost of coverage for retirees. The resulting additional cost, or implicit subsidy, is required to be valued under GASB Statement 75 related to Other Post-Employment Benefits (OPEB). Calculations are based on the OPEB benefits provided under the terms of the substantive plan in effect at the time of each valuation and on the pattern of sharing of costs between the employer and plan members to that point. Actuarial valuations for OPEB plans involve estimates of the value of reported amounts and assumptions about the probability of events far into the future, and actuarially determined amounts are subject to continual revision as results are compared to past expectations and new estimates are made about the future. Actuarial calculations of the OPEB plan reflect a long-term perspective. The valuation date was July 1, 2022 and the measurement date was June 30, 2023.

Funding Policy

The City has not established a trust fund to finance the cost of post-employment health care benefits related to implicit rate subsidies. Premiums are paid by retirees based on the rates established for active employees. Additional costs related to an implicit subsidy are paid by the City on a pay-as-you-go basis. There is no obligation on the part of the City to fund these benefits in advance. The City considered the liability to be solely the responsibility of the City as a whole and it is allocated to the governmental statements.

Actuarial Methods and Assumptions

The City engaged an actuary to perform a valuation as of July 1, 2022 using the Entry Age Normal, level percent of salary Actuarial Cost Method. Mortality rates were based on the Pub-2010 General and Safety Employee Healthy Retiree tables, sex distinct for members and dependents, with a one-year setback for male general service employees and female safety employees. Mortality is projected on a generational basis using Generational Unisex Social Security Data Scale. Demographic assumptions regarding retirement, mortality, and turnover are based on Oregon PERS valuation assumptions as of December 31, 2022. Election rate and lapse assumptions are based on experience implied by valuation data for this and other Oregon public employers.

12. Other Post-Employment Benefits (continued)

Health Care Cost Trend	Medical and vision: Year / Pre-65 Trend 2022 4.25% 2023 6.75% 2024 6.50% 2025 6.00% 2026 5.25% 2027 5.00% 2028-2029 4.75% 2030 4.50% 2031-2065 4.25% 2066-2071 4.00% 2072+ 3.75% Dental: 4.00% per year Health care cost trend affects both the projected health care costs as well as the projected health care
General Inflation	2.40% per year, used to develop other economic assumptions
Annual Pay Increases	3.40% per year, based on general inflation and the likelihood of raises throughout participants' careers
Mortality	Pub-2010 General and Safety Employee and Healthy Retiree tables, sex distinct for members and dependents, with a one-year setback for male general service employees and female safety employees.
Disability	Not used
Withdrawal	Based on Oregon PERS assumptions. Annual rates are based on employment classification, gender, and duration from hire date.
Retirement	Based on Oregon PERS assumptions. Annual rates are based on age, Tier/OPSRP, duration of service, and employment classification.

12. Other Post-Employment Benefits (continued)

Changes in the Net OPEB Liability

	Increase/ (Decrease)
Total OPEB Liability at June 30, 2023	$ 533,287
Changes for the year:	
Service cost	22,797
Interest	18,860
Changes in benefit terms	-
Differences between expected and actual experience	-
Changes of assumptions or other input	(4,409)
Benefit payments	(47,026)
Balance as of June 30, 2024	$ 523,509

Sensitivity of the Net OPEB Liability to Changes in the Discount Rate and Trend Rates

The following analysis presents the net OPEB liability using a discount rate of 3.65%, as well as what the City's net OPEB liability would be if it was calculated using a discount rate that is one percentage point lower (2.65%) or one percentage point higher (4.65%) than the current rate, a similar sensitivity analysis is presented for the changes in the healthcare trend assumption:

	1% Decrease 2.65%	Current Discount Rate 3.65%	1% Increase 4.65%
Total OPEB Liability	$ 564,842	$ 523,509	$ 486,055

	1% Decrease Healthcare	Current Trend Rate Healthcare	1% Increase Healthcare
Total OPEB Liability	$ 477,628	$ 523,509	$ 577,164

Deferred Outflows of Resources and Deferred Inflows of Resources Related to OPEB Benefits

The City reports information on deferred outflows and deferred inflows of resources at year end as well as a schedule of amounts of those deferred outflows of resources and deferred inflows of resources that will be recognized in other post-employment benefit expense for the following five years.

	Deferred Inflows of Resources	Deferred Outflows of Resources
Difference between expected and actual experience	$ -	$ 187,255
Changes in assumptions or other input	(63,340)	5,564
Benefit Payments	-	52,088
Deferred outflow (inflow) of resources	$ (63,340)	$ 244,907

Amounts reported as deferred outflows or inflow of resources related to pension will be recognized in pension expense as follows:

12. Other Post-Employment Benefits (continued)

Year ending June 30,	Amount
2025	$ 19,331
2026	19,331
2027	19,331
2028	21,921
2029	23,277
Thereafter	26,288
Total	$ 129,479

RHIA

Plan Description:
As a member of Oregon Public Employees Retirement System (OPERS) the City contributes to the Retirement Health Insurance Account (RHIA) for each of its eligible employees. RHIA is a cost-sharing multiple-employer defined benefit other postemployment benefit plan administered by OPERS. RHIA pays a monthly contribution toward the cost of Medicare companion health insurance premiums of eligible retirees. Oregon Revised Statute (ORS) 248.420 established this trust fund. Authority to establish and amend the benefit provisions of RHIA reside with the Oregon Legislature. The plan is closed to new entrants after January 1, 2004. OPERS issues a publicly available financial report that includes financial statements and required supplementary information. That report may be obtained by writing to Oregon Public Employees Retirement System, PO Box 24700, Tigard, OR 97281-3700.

Funding Policy:
Because RHIA was created by enabling legislation (ORS 248.420), contribution requirements of the plan members and the participating employers were established and may be amended only by the Oregon Legislature. ORS require that an amount equal to $60 dollars or the total monthly cost of Medicare companion health insurance premiums coverage, whichever is less, shall be paid from the Retirement Health Insurance Account established by the employer, and any monthly cost in excess of $60 dollars shall be paid by the eligible retired member in the manner provided in ORS 248.410. To be eligible to receive this monthly payment toward the premium cost the member must: (1) have eight years or more of qualifying service in OPERS at the time of retirement or receive a disability allowance as if the member had eight years or more of creditable service in OPERS, (2) receive both Medicare Parts A and B coverage, and (3) enroll in an OPERS-sponsored health plan. A surviving spouse or dependent of a deceased OPERS retiree who was eligible to receive the subsidy is eligible to receive the subsidy if he or she (1) is receiving a retirement benefit or allowance from OPERS or (2) was insured at the time the member died and the member retired before May 1, 1991.

Participating cities are contractually required to contribute to RHIA at a rate assessed each year by OPERS, and the City currently contributes 0.53% of annual covered OPERF payroll and 0.45% of OPSRP payroll under a contractual requirement in effect until June 30, 2024. Consistent with GASB Statement 75, the OPERS Board of Trustees sets the employer contribution rates as a measure of the proportionate relationship of the employer to all employers consistent with the manner in which contributions to the OPEB plan are determined. The basis for the employer's portion is determined by comparing the employer's actual, legally required contributions made during the fiscal year to the plan with the total actual contributions made in the fiscal year of all employers. The City's contributions to RHIA for the years ended June 30, 2022, 2023 and 2024 were, $806, $229, and $43, respectively, which equaled the required contributions each year.

At June 30, 2024, the City's net OPEB liability / (asset) and deferred inflows and outflows were not considered significant by management and were not accrued on the government wide statements.

13. Leases

For the year ended June 30, 2024, the financial statements include GASB Statement No. 87, Leases. The primary objective of this statement is to enhance the relevance and consistency of information about governments' leasing activities. This statement establishes a single model for lease accounting based on the principle that leases are financings of the right to use an underlying asset. Under this Statement, a lessee is required to recognize a lease liability and an intangible right-to-use lease asset, and a lessor is required to recognize a lease receivable and a deferred inflow of resources. For additional information, refer to the disclosures below.

As of June 30, 2024, Prineville, OR had 5 active leases. The leases have payments that range from $1,867 to $31,902 and interest rates that range from 0.7270% to .89%. As of 06/30/2024, the total combined value of the lease liability is $15,203, the total combined value of the short-term lease liability is $12,287. The combined value of the right to use asset, as of 06/30/2024 is $168,771 with accumulated amortization of $155,084 is included within the Lease Class activities table found below. The leases had $0 of Variable Payments and $0 of Other Payments, not included in the Lease Liability, within the Fiscal Year.

Governmental Activities Lease Liablity	Balance as of July 1, 2023	Additions	Reductions	Balance as of June 30, 2024
Equipment	$ 66,981	$ -	$ 51,778	$ 15,203

Right to Use Lease Assets	Balance as of July 1, 2023	Additions	Reductions	Balance as of June 30, 2024
Equipment	$ 168,771	$ -	$ -	$ 168,771
Lease Accumulated Amortization				
Equipment	128,991	26,093	-	155,084
Total Governmental Lease Assets, Net	$ 39,780			$ 13,687

Future lease payments are as follows:

Year	Principal	Interest
2025	$ 12,287	$ 1,967
2026	2,916	137
TOTALS	$ 15,203	$ 2,104

13. Leases (continued)

Governmental Activities	Balance as of July 1, 2023	Additions	Reductions	Balance as of June 30, 2024
Deferred Inflow of Resources				
Land	$ 272,989	$ -	$ 26,318	$ 246,671
Lease Receivable				
Land	$ 286,490	$ -	$ 21,951	$ 264,539

Future payments expected to be received are as follows:

Year	Principal	Interest
2025	$ 22,910	$ 5,045
2026	24,197	4,597
2027	25,555	4,103
2028	26,967	3,581
2028	28,433	3,031
2030-2034	108,446	7,353
2035-2039	28,031	542
TOTALS	$ 264,539	$ 28,252

Business-Type Activities	Balance as of July 1, 2023	Additions	Reductions	Balance as of June 30, 2024
Deferred Inflow of Resources				
Buildings	$ 2,225,565	$ 165,190	$ 247,129	$ 2,143,626
Land	354,949	201,652	74,944	481,657
Total Deferred Inflow of Resources	$ 2,580,514	$ 366,842	$ 322,073	$ 2,625,283
Lease Receivable				
Buildings	$ 2,312,267	$ 165,190	$ 234,076	$ 2,243,381
Land	356,511	171,827	59,782	468,556
Total Lease Receivable	$ 2,668,778	$ 337,017	$ 293,858	$ 2,711,937

13. Leases (continued)

Future payments expected to be received are as follows:

Year	Principal	Interest
2025	$ 364,400	$ 46,580
2026	356,425	40,481
2027	342,837	34,024
2028	289,924	27,895
2028	250,965	23,096
2029-2033	909,147	60,669
2034-2038	177,173	2,226
2039-2041	21,067	22
TOTALS	$ 2,711,938	$ 234,993

14. Subscriptions Payable

For the year ended June 30, 2024, the financial statements include GASB Statement No. 96, Subscription-Based Information Technology Arrangements. The primary objective of this statement is to enhance the relevance and consistency of information about governments' subscription activities. This statement establishes a single model for subscription accounting based on the principle that subscriptions are financings of the right to use an underlying asset. Under this Statement, an organization is required to recognize a subscription liability and an intangible right-to-use subscription asset. For additional information, refer to the disclosures below.

As of June 30, 2024, City of Prineville, OR had 2 active subscriptions. The subscriptions have payments that range from $4,200 to $13,000 and interest rates that range from 2.0240% to 2.4700%. As of June 30, 2024, the total combined value of the subscription liability is $0, and the total combined value of the short-term subscription liability is $0. The combined value of the right to use asset, as of June 30, 2024 of $25,687 with accumulated amortization of $14,841 is included within the Subscription Class activities table found below. The subscriptions had $0 of Variable Payments and $0 of Other Payments, not included in the Subscription Liability, within the Fiscal Year.

Amount of Subscription Assets by Major Classes of Underlying Asset

	As of Fiscal Year-end	
Asset Class	Subscription Asset Value	Accumulated Amortization
Software	$ 25,687	$ 14,841

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Financial Section

Required Supplementary Information

Schedule of Contributions and the Proportionate Share of the Net Pension Liability

General Fund
Emergency Dispatch Fund
Transportation Fund

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City of Prineville

Schedule of Contributions and the Proportionate Share of Net Pension Liability

Proprietary Funds

Year Ended June 30, 2024

OREGON PERS - GASB 68:

SCHEDULE OF THE PROPORTIONATE SHARE OF THE NET PENSION LIABILITY

Year Ended June 30,	(a) Employer's proportion of the net pension liability (NPL)	(b) Employer's proportionate share of the net pension liability (NPL)	(c) covered payroll	(b/c) NPL as a percentage of covered payroll	Plan fiduciary net position as a percentage of the total pension liability
2024	0.04 %	$ 8,416,699	$ 5,708,463	147.4 %	81.7 %
2023	0.04 %	$ 6,215,116	$ 5,478,259	113.5 %	84.5 %
2022	0.03 %	$ 4,496,265	$ 5,174,833	86.9 %	87.6 %
2021	0.03 %	$ 7,058,678	$ 5,045,719	139.9 %	75.8 %
2020	0.03 %	$ 5,156,670	$ 4,770,384	108.1 %	80.2 %
2019	0.03 %	$ 4,773,656	$ 4,416,769	108.1 %	82.1 %
2018	0.03 %	$ 4,179,097	$ 4,060,780	102.9 %	83.1 %
2017	0.03 %	$ 4,368,284	$ 4,020,150	108.7 %	80.5 %
2016	0.05 %	$ 2,939,113	$ 3,748,420	78.4 %	91.9 %
2015	0.05 %	$ (1,142,184)	$ 3,895,646	(29.3) %	103.6 %

SCHEDULE OF CONTRIBUTIONS

Year Ended June 30,	Statutorily required contribution	Contributions in relation to the statutorily required contribution	Contribution deficiency (excess)	Employer's covered payroll	Contributions as a percent of covered payroll
2024	$ 1,005,306	$ 1,005,306	$ -	$ 5,975,905	16.82 %
2023	$ 842,626	$ 842,626	$ -	$ 5,708,463	14.76 %
2022	$ 814,907	$ 814,907	$ -	$ 5,478,259	14.88 %
2021	$ 522,707	$ 522,707	$ -	$ 5,174,833	10.10 %
2020	$ 480,766	$ 480,766	$ -	$ 5,045,719	9.53 %
2019	$ 361,228	$ 361,228	$ -	$ 4,770,384	7.57 %
2018	$ 334,346	$ 334,346	$ -	$ 4,416,769	7.57 %
2017	$ 434,885	$ 434,885	$ -	$ 4,060,780	10.71 %
2016	$ 444,858	$ 444,858	$ -	$ 4,020,150	11.07 %
2015	$ 317,320	$ 317,320	$ -	$ 3,748,420	8.5 %

The amounts presented for each fiscal year were actuarial determined at 12/31 and rolled forward to the measurement date.
There are no assets accumulated in a trust that meets the criteria of GASB codification P22.101 or P52.101 to pay related benfits for the pension or OPEB plan

IMPLICIT RATE SUBSIDY - GASB 75:

	2024	2023	2022	2021	2020	2019	2018
Total Other Post Employment Benefits Liability, Beginning	**$ 533,287**	**$ 480,242**	**$ 477,142**	**$ 299,227**	**$ 276,551**	**$ 285,912**	**$ 285,356**
Changes for the year:							
Service Cost	22,797	34,737	33,721	20,846	18,597	25,209	26,568
Interest	18,860	10,598	10,816	10,863	11,113	10,775	8,646
Differences between expected and actual experience	-	109,811	-	168,235	-	3,983	-
Changes in assumptions or other input	(4,409)	(53,211)	1,745	(2,439)	9,083	(28,890)	(17,461)
Employer Contributions	-	-	-	-	-	-	-
Benefit Payments	(47,026)	(48,890)	(43,182)	(19,590)	(16,117)	(20,438)	(17,197)
Net changes for the year	(9,778)	53,045	3,100	177,915	22,676	(9,361)	556
Total Other Post Employment Benefits Liability End of Year	**$ 523,509**	**$ 533,287**	**$ 480,242**	**$ 477,142**	**$ 299,227**	**$ 276,551**	**$ 285,912**
Fiduciary Net Position - Beginning	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Contributions - Employer	47,026	48,890	43,182	19,590	16,117	20,438	17,197
Contributions - Employee	-	-	-	-	-	-	-
Net Investment Income	-	-	-	-	-	-	-
Benefit Payments	(47,026)	(48,890)	(43,182)	(19,590)	(16,117)	(20,438)	(17,197)
Administrative Expense	-	-	-	-	-	-	-
Net changes for the year	-	-	-	-	-	-	-
Fiduciary Net Position - Ending	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Net Liability for Other Post Employment Benefits - End of Year	**$ 523,509**	**$ 533,287**	**$ 480,242**	**$ 477,142**	**$ 299,227**	**$ 276,551**	**$ 285,912**
Fiduciary Net Position as a percentage of the total Single Employer Pension Liability	0%	0%	0%	0%	0%	0%	0%
Covered Payroll	$ 5,975,905	$ 5,708,463	$ 5,478,259	$ 5,174,833	$ 5,045,719	$ 5,158,323	$ 5,158,323
Net Single Employer Pension Plan as a Percentage of Covered Payroll	9%	9%	9%	9%	6%	5%	5%

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

General Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-2024	Variance with Final Budget
Revenues					
Property taxes	$ 5,695,100	$ 5,695,100		$ 2,919,537	$ (2,775,563)
Transient room taxes	1,200,000	1,200,000		453,004	(746,996)
Franchise taxes	8,424,500	8,424,500		7,685,591	(738,909)
Licenses and permits	12,200	12,200		6,276	(5,924)
Intergovernmental	2,113,600	2,113,600		1,122,698	(990,902)
Charges for service	690,000	690,000		416,995	(273,005)
Interest	70,000	70,000		259,800	189,800
Miscellaneous	127,000	127,000		394,255	267,255
Total revenues	18,332,400	18,332,400		13,258,156	(5,074,244)
Expenditures					
Current					
Police	9,978,150	9,978,150	(1)	4,986,334	4,991,816
Non-departmental	2,046,000	2,046,000	(1)	1,005,455	1,040,545
Contingency	1,508,931	1,508,931	(1)	-	1,508,931
Total expenditures	13,533,081	13,533,081		5,991,789	7,541,292
Excess of revenues over/ (under) expenditures	4,799,319	4,799,319		7,266,367	2,467,048
Other financing sources/(uses)					
Transfers in	-	-		-	-
Transfers out	(7,409,400)	(7,409,400)	(1)	(3,656,160)	3,753,240
Total other financing sources (uses)	(7,409,400)	(7,409,400)		(3,656,160)	3,753,240
Net change in fund balance	(2,610,081)	(2,610,081)		3,610,207	6,220,288
Fund balance, July 1, 2023	2,610,081	2,610,081		3,231,995	621,914
Fund balance, June 30, 2024	$ -	$ -		6,842,202	$ 6,842,202
Reconciliation to GAAP fund balance:					
Consolidation of community development fund balance				248,505	
Total fund balance				$ 7,090,707	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Transportation Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Franchise taxes	$ 908,700	$ 908,700		$ 504,700	$ (404,000)
Licenses and permits	-	-		13,817	13,817
Intergovernmental	2,243,400	2,243,400		1,144,488	(1,098,912)
Interest	11,300	11,300		39,311	28,011
Miscellaneous	137,000	137,000		45,411	(91,589)
Total revenues	3,300,400	3,300,400		1,747,727	(1,552,673)
Expenditures					
Current					
Personal services	593,200	593,200	(1)	274,263	318,937
Materials and services	956,500	956,500	(1)	369,757	586,743
Capital outlay	1,675,000	1,675,000	(1)	846,235	828,765
Contingency	313,698	313,698	(1)	-	313,698
Total expenditures	3,538,398	3,538,398		1,490,255	2,048,143
Excess of revenue over/ (under) expenditures	(237,998)	(237,998)		257,472	495,470
Other financing sources/(uses)					
Transfers in	800,000	800,000		400,000	(400,000)
Transfers out	(1,049,200)	(1,049,200)	(1)	(519,900)	529,300
Total other financing sources (uses)	(249,200)	(249,200)		(119,900)	129,300
Net change in fund balance	(487,198)	(487,198)		137,572	624,770
Fund balance, July 1, 2023	487,198	487,198		702,065	214,867
Fund balance, June 30, 2024	$ -	$ -		$ 839,637	$ 839,637

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Emergency Dispatch Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ 3,225,500	$ 3,225,500		$ 1,674,105	$ (1,551,395)
Miscellaneous	6,000	6,000		-	(6,000)
Interest	12,000	12,000		74,725	62,725
Total revenues	3,243,500	3,243,500		1,748,830	(1,494,670)
Expenditures					
Current					
Personal services	3,323,300	3,323,300	(1)	1,022,658	2,300,642
Materials and services	679,900	679,900	(1)	248,162	431,738
Capital outlay	1,082,000	1,082,000	(1)	564,678	517,322
Contingency	411,340	411,340	(1)	-	411,340
Total expenditures	5,496,540	5,496,540		1,835,498	3,661,042
Excess of revenues over/ (under) expenditures	(2,253,040)	(2,253,040)		(86,668)	2,166,372
Other financing sources (uses)					
Transfers out	(481,800)	(481,800)	(1)	(235,800)	246,000
Transfers in	1,627,500	1,627,500		824,300	(803,200)
Total other financing sources (uses)	1,145,700	1,145,700		588,500	(557,200)
Net change in fund balance	(1,107,340)	(1,107,340)		501,832	1,609,172
Fund balance, July 1, 2023	1,107,340	1,107,340		1,400,515	293,175
Fund balance, June 30, 2024	$ -	$ -		$ 1,902,347	$ 1,902,347

(1) Appropriation level for the biennial period beginning July 1, 2023

Financial Section

Supplementary Information

Governmental Funds

Community Development Fund
Transportation SDC Fund
Pension Obligation Debt Service Fund

Proprietary Funds

Enterprise Funds

Water Fund
Wastewater Fund
Railroad Fund
Airport Fund
Golf Course Fund

Internal Service Funds

Internal Service Funds
Building Facilities Funds
Public Works Support Services Fund

Other Financial Schedules

Property Tax Collection
Future Debt Service Requirements

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City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Community Development Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Licenses and permits	$ 75,000	$ 75,000		$ 39,135	$ (35,865)
Intergovernmental	10,000	10,000		1,901	(8,099)
Charges for services	141,400	141,400		8,247	(133,153)
Interest	4,000	4,000		14,359	10,359
Total revenues	230,400	230,400		63,642	(166,758)
Expenditures					
Current					
Personal services	585,200	585,200	(1)	264,922	320,278
Materials and services	84,700	184,700	(1)	73,981	110,719
Contingency	141,951	41,951	(1)	-	41,951
Total expenditures	811,851	811,851		338,903	472,948
Excess of revenues over/ (under) expenditures	(581,451)	(581,451)		(275,261)	306,190
Other financing sources (uses)					
Transfers out	(356,900)	(356,900)	(1)	(174,700)	182,200
Transfers in	720,000	720,000		441,767	(278,233)
Total other financing sources (uses)	363,100	363,100		267,067	(96,033)
Net change in fund balance	(218,351)	(218,351)		(8,194)	210,157
Fund balance, July 1, 2023	218,351	218,351		256,699	38,348
Fund balance, June 30, 2024	$ -	$ -		248,505	$ 248,505
Reconciliation to GAAP fund balance:					
Consolidation of fund balance with general fund				(248,505)	
Total fund balance				$ -	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Transportation SDC Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ 14,000,000	$ 14,000,000		$ 665,172	$ (13,334,828)
Interest	175,000	175,000		529,806	354,806
System development charges	900,000	900,000		674,365	(225,635)
Other revenue	-	-		-	-
Total revenues	15,075,000	15,075,000		1,869,343	(13,205,657)
Expenditures					
Current					
Materials and services	30,000	30,000	(1)	-	30,000
Capital outlay	5,490,000	5,490,000	(1)	729,171	4,760,829
Contingency	20,564,372	20,564,372	(1)	-	20,564,372
Total expenditures	26,084,372	26,084,372		729,171	25,355,201
Excess of revenues over/ (under) expenditures	(11,009,372)	(11,009,372)		1,140,172	12,149,544
Other financing sources (uses)					
Transfers out	(45,000)	(45,000)	(1)	(33,718)	11,282
Net change in fund balance	(11,054,372)	(11,054,372)		1,106,454	12,160,826
Fund balance, July 1, 2023	11,054,372	11,054,372		1,323,642	(9,730,730)
Fund balance, June 30, 2024	$ -	$ -		$ 2,430,096	$ 2,430,096

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Pension Obligation Debt Service Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget	Second Year Actual FY 2023-24	Variance with Final Budget
Revenues				
Charges for Services	$ 1,088,900	$ 1,088,900	$ 548,000	$ (540,900)
Interest	40,000	40,000	96,413	56,413
Total revenues	1,128,900	1,128,900	644,413	(484,487)
Expenditures				
Debt service				
Principal	577,700	577,700 (2)	277,643	300,057
Interest	97,100	97,100 (2)	53,671	43,429
Contingency	2,252,657	2,252,657 (1)	-	2,252,657
Total expenditures	2,927,457	2,927,457	331,314	2,596,143
Excess of revenues over/ (under) expenditures	(1,798,557)	(1,798,557)	313,099	2,111,656
Other financing sources/(uses)				
Transfers in	371,200	371,200	50,000	(321,200)
Total other financing sources (uses)	371,200	371,200	50,000	(321,200)
Net change in fund balance	(1,427,357)	(1,427,357)	363,099	1,790,456
Fund balance, July 1, 2023	1,427,357	1,427,357	1,821,141	393,784
Fund balance, June 30, 2024	$ -	$ -	$ 2,184,240	$ 2,184,240

(1) Appropriation level for the biennial period beginning July 1, 2023

(2) Principal and interest are budgeted together as one line item

City of Prineville

Combining Schedule of Net Position

Water Fund

June 30, 2024

	Water Fund	Water SDC Fund	Totals
Assets			
Current assets			
Cash and investments	$ 964,927	$ (1,257,583)	$ (292,656)
Accounts receivable	858,223	1,867,217	2,725,440
Inventory	134,554	-	134,554
Total current assets	1,957,704	609,634	2,567,338
Non-current assets			
Capital assets:			
Non-depreciable	6,361,481	-	6,361,481
Other capital assets, Net of accumulated depreciation	35,540,185	-	35,540,185
Net non-current assets	41,901,666	-	41,901,666
Total assets	$ 43,859,370	$ 609,634	$ 44,469,004
Liabilities and net position			
Current liabilities			
Accounts payable	$ 92,201	$ 493,147	$ 585,348
Deposits	30,705	-	30,705
Accrued interest	25,413	-	25,413
Notes payable, current portion	163,383	-	163,383
Total current liabilities	311,702	493,147	804,849
Long-term liabilities			
Notes payable, net of current portion	4,266,533	-	4,266,533
Total long-term liabilities	4,266,533	-	4,266,533
Total liabilities	4,578,235	493,147	5,071,382
Net position			
Net Investment in Capital Assets	37,471,750	-	37,471,750
Unrestricted	1,809,385	116,487	1,925,872
Total net position	39,281,135	116,487	39,397,622
Total liabilities and net position	$ 43,859,370	$ 609,634	$ 44,469,004

City of Prineville

Combining Schedule of Revenues, Expenses and Changes in Net Position

Water Fund

Year Ended June 30, 2024

	Water Fund	Water SDC Fund	Totals
Operating revenue			
Charges for services	$ 3,609,432	$ 342,601	$ 3,952,033
Other	374,660	5,051,398	5,426,058
Total operating revenue	3,984,092	5,393,999	9,378,091
Operating expenses			
Materials and services	1,323,873	-	1,323,873
Depreciation	1,187,723	-	1,187,723
Total operating expenses	2,511,596	-	2,511,596
Operating income (loss)	1,472,496	5,393,999	6,866,495
Non-operating revenues (expenses)			
Interest income	46,202	-	46,202
Interest expense	(42,472)	-	(42,472)
Transfers in	172,100	-	172,100
Transfers out	(1,676,000)	(683,858)	(2,359,858)
Total non-operating revenues (expenses)	(1,500,170)	(683,858)	(2,184,028)
Other non-operating items			
Contributed capital - system development charges	-	516,527	516,527
Contributed capital	5,026,283	(5,026,283)	-
Total non-operating items	5,026,283	(4,509,756)	516,527
Change in net position	4,998,609	200,385	5,198,994
Net position, July 1, 2023	34,282,526	(83,898)	34,198,628
Net position, June 30, 2024	$ 39,281,135	$ 116,487	$ 39,397,622

City of Prineville

Combining Schedule of Cash Flows

Water Fund

Year Ended June 30, 2024

	Water Fund	Water SDC Fund	Totals
Cash flows from operating activities			
Cash received from customers	$ 3,889,870	$ 4,482,412	$ 8,372,282
Cash payments for goods and services	(1,350,007)	426,679	(923,328)
Net cash flows from operating activities	2,539,863	4,909,091	7,448,954
Cash flows from non-capital financing activities			
System development charges	-	516,527	516,527
Transfers out	(1,676,000)	(683,858)	(2,359,858)
Transfers in	172,100	-	172,100
Interfund loan repayments	-	-	-
Net cash flows from non-capital financing activities	(1,503,900)	(167,331)	(1,671,231)
Cash flows from capital financing activities			
Debt proceeds	-	-	-
Acquisition of capital assets	(1,028,135)	(5,026,083)	(6,054,218)
Debt reduction	(159,039)	-	(159,039)
Interest paid on debt	(58,027)	-	(58,027)
Net cash flows from capital financing activities	(1,245,201)	(5,026,083)	(6,271,284)
Cash flows from investing activities			
Interest earned	46,202	-	46,202
Net increase (decrease) in cash	(163,036)	(284,323)	(447,359)
Cash - July 1, 2023	1,127,963	(973,260)	154,703
Cash - June 30, 2024	$ 964,927	$ (1,257,583)	$ (292,656)
Reconciliation of operating income to net cash flows from operatings			
Operating income (loss)	$ 1,472,496	$ 5,393,999	$ 6,866,495
Adjustments to reconcile operating income to net cash flows from operating activities			
Depreciation	1,187,723	-	1,187,723
Changes in assets and liabilities			
Increase/(decrease) in accounts payable	5,745	426,679	432,424
Increase/(decrease) in deposits	3,260	-	3,260
Decrease/(increase) in inventory	(31,879)	-	(31,879)
Decrease/(increase) in accounts receivable	(97,482)	(911,587)	(1,009,069)
Total adjustments	1,067,367	(484,908)	582,459
Net cash from operating activities	$ 2,539,863	$ 4,909,091	$ 7,448,954
Noncash investing, capital, and financing activities			
Contributions of capital assets	5,026,283	(5,026,283)	-

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Water Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ -	$ -		$ 305,803	$ 305,803
Charges for service	7,106,600	7,106,600		3,609,432	(3,497,168)
Interest	16,000	16,000		46,202	30,202
Other	20,000	20,000		68,857	48,857
Total revenues	7,142,600	7,142,600		4,030,294	(3,112,306)
Expenditures					
Materials and services	2,632,900	2,632,900	(1)	1,764,438	868,462
Capital outlay	1,300,000	1,300,000	(1)	587,370	712,630
Debt service					
Principal	469,500	469,500	(2)	159,039	310,461
Interest	167,900	167,900	(2)	42,473	125,427
Contingency	1,004,817	1,004,817	(1)	-	1,004,817
Total expenditures	5,575,117	5,575,117		2,553,320	5,575,117
Excess of revenues over/ (under) expenditures	1,567,483	1,567,483		1,476,974	(1,567,483)
Other financing sources (uses)					
Transfers in	346,100	346,100		172,100	(174,000)
Transfers out	(3,405,400)	(3,405,400)	(1)	(1,676,000)	1,729,400
Total other financing sources (uses)	(3,059,300)	(3,059,300)		(1,503,900)	1,555,400
Net change in fund balance	(1,491,817)	(1,491,817)		(26,926)	1,464,891
Fund balance, July 1, 2023	1,491,817	1,491,817		1,836,311	344,494
Fund balance, June 30, 2024	$ -	$ -		1,809,385	$ 1,809,385
Reconciliation to net position - GAAP Basis:					
Adjustment for capital assets, net of accumulated depreciation				41,901,666	
Adjustment for note payable - due within one year				(163,383)	
Adjustment for note payable				(4,266,533)	
Net position - GAAP Basis				$ 39,281,135	

(1) Appropriation level for the biennial period beginning July 1, 2023

(2) Appropriation level is Principal and Interest Combined

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Water SDC Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ -	$ -		$ 342,601	$ 342,601
Interest	15,000	15,000		-	(15,000)
Miscellaneous	11,000,000	11,000,000		5,051,398	(5,948,602)
System development charges	750,000	750,000		516,527	(233,473)
Total revenues	11,765,000	11,765,000		5,910,526	(5,854,474)
Expenditures					
Capital outlay	10,230,000	10,230,000	(1)	5,026,283	5,203,717
Contingency	344,113	344,113	(1)	-	344,113
Total expenditures	10,574,113	10,574,113		5,026,283	5,547,830
Excess of revenues over/ (under) expenditures	1,190,887	1,190,887		884,243	(306,644)
Other financing sources (uses)					
Transfers out	(1,371,800)	(1,371,800)	(1)	(683,858)	687,942
Total other financing sources (uses)	(1,371,800)	(1,371,800)		(683,858)	687,942
Net change in fund balance	(180,913)	(180,913)		200,385	381,298
Fund balance, July 1, 2023	180,913	180,913		(83,898)	(264,811)
Fund balance, June 30, 2024	$ -	$ -		116,487	$ 116,487
Reconciliation to net position - GAAP Basis:				-	
Net position - GAAP Basis				$ 116,487	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Combining Schedule of Net Position

Wastewater Fund

June 30, 2024

	Wastewater Fund	Wastewater SDC Fund	Totals
Assets			
Current assets			
Cash and investments	$ 1,399,213	$ 190,006	$ 1,589,219
Accounts receivable	640,197		640,197
Inventory	85,127	-	85,127
Lease receivable	185,509	-	185,509
Total current assets	2,310,046	190,006	2,500,052
Non-current assets			
Restricted cash and investments	302,560	-	302,560
Capital assets:			
Non-depreciable	1,259,017	-	1,259,017
Other capital assets, Net of accumulated depreciation	34,981,944	-	34,981,944
Net non-current assets	36,543,521	-	36,543,521
Total assets	$ 38,853,567	$ 190,006	$ 39,043,573
Liabilities and net position			
Current liabilities			
Accounts payable	$ 94,051	$ 3,234	$ 97,285
Accrued interest	53,960	-	53,960
Deposits	51,320	-	51,320
Accrued compensated absenses	30,291	-	30,291
Notes payable, current portion	772,296	-	772,296
Bonds payable, current portion	66,087	-	66,087
Total current liabilities	1,068,005	3,234	1,071,239
Long-term liabilities			
Notes Payable	2,868,877	-	2,868,877
Bonds payable, net of current portion	3,572,920	-	3,572,920
Total long-term liabilities	6,441,797	-	6,441,797
Total liabilities	7,509,802	3,234	7,513,036
Deferred inflows of resources			
Leases	198,041	-	198,041
Net position			
Net Investment in Capital Assets	28,960,781	-	28,960,781
Restricted for debt service	944,915	-	944,915
Restricted for SLARRA	37,585	-	37,585
Restricted for capital projects	-	186,772	186,772
Unrestricted	1,202,443	-	1,202,443
Total net position	31,145,724	186,772	31,332,496
Total liabilities, deferred inflows, and net position	$ 38,853,567	$ 190,006	$ 39,043,573

City of Prineville

Combining Schedule of Revenues, Expenses and Changes in Net Position

Wastewater Fund

Year Ended June 30, 2024

	Wastewater Fund	Wastewater SDC Fund	Totals
Operating revenue			
Charges for services	$ 4,472,106	$ -	$ 4,472,106
Other	294,018	18,750	312,768
Total operating revenue	4,766,124	18,750	4,784,874
Operating expenses			
Salaries and fringe benefits	261,648	-	261,648
Materials and services	1,440,245	-	1,440,245
Depreciation	1,243,069	-	1,243,069
Total operating expenses	2,944,962	-	2,944,962
Operating income (loss)	1,821,162	18,750	1,839,912
Non-operating revenues (expenses)			
Interest income	89,042	9,237	98,279
Interest expense	(151,407)	-	(151,407)
Transfers in	165,239	-	165,239
Transfers out	(1,731,700)	(177,895)	(1,909,595)
Total non-operating revenues (expenses)	(1,628,826)	(168,658)	(1,797,484)
Other non-operating items			
Contributed capital - system development charges	-	257,050	257,050
Contributed capital	989,309	(40,069)	949,240
Change in net position	1,181,645	67,073	1,248,718
Net position, July 1, 2023	29,964,079	119,699	30,083,778
Net position, June 30, 2024	$ 31,145,724	$ 186,772	$ 31,332,496

City of Prineville

Combining Schedule of Cash Flows

Wastewater Fund

Year Ended June 30, 2024

	Wastewater Fund	Wastewater SDC Fund	Totals
Cash flows from operating activities			
Cash received from customers	$ 4,729,625	$ 46,875	$ 4,776,500
Cash payments for goods and services	(1,423,561)	(24,218)	(1,447,779)
Cash payments to employees	(255,541)	-	(255,541)
Net cash flows from operating activities	3,050,523	22,657	3,073,180
Cash flows from non-capital financing activities			
System development charges	-	257,050	257,050
Transfers out	(1,731,700)	(177,895)	(1,909,595)
Transfers in	165,239	-	165,239
Net cash flows from non-capital activities	(1,566,461)	79,155	(1,487,306)
Cash flows from capital financing activities			
Acquisition of capital assets	(533,873)	(40,069)	(573,942)
Debt proceeds	-	-	-
Debt reduction	(827,484)	-	(827,484)
Interest paid on debt	(151,408)	-	(151,408)
Net cash flows from capital financing activities	(1,512,765)	(40,069)	(1,552,834)
Cash flows from investing activities			
Interest earned	89,042	9,237	98,279
Net decrease in cash	60,339	70,980	131,319
Cash - July 1, 2023	1,641,434	119,026	1,760,460
Cash - June 30, 2024	$ 1,701,773	$ 190,006	$ 1,891,779
Reconciliation of operating income to net cash flows from operatings			
Operating income	$ 1,821,162	$ 18,750	1,839,912
Adjustments to reconcile operating income to net cash flows from operating activities			
Depreciation	1,243,069	-	1,243,069
Changes in assets and liabilities			
Increase/(decrease) in accounts payable	41,722	(24,218)	17,504
Increase/(decrease) in other liabilities	(2,421)	-	(2,421)
Decrease/(increase) lease receivable	(170,822)	-	(170,822)
Increase/(decrease) in deferred inflows - leases	184,217	-	184,217
Increase/(decrease) in accrued expenses	8,528	-	8,528
Increase/(decrease) in deposits	(4,640)	-	(4,640)
Decrease/(increase) in accounts receivable	(45,254)	28,125	(17,129)
Decrease/(increase) in inventory	(25,038)	-	(25,038)
Total adjustments	1,229,361	3,907	1,233,268
Net cash from operating activities	$ 3,050,523	$ 22,657	$ 3,073,180
Noncash investing, capital, and financing activities			
Contributions of capital assets	989,309	(40,069)	949,240

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Wastewater Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Charges for service	$ 8,825,000	$ 8,825,000		$ 4,472,106	$ (4,352,894)
Interest	50,000	50,000		89,042	39,042
Other	148,400	148,400		123,195	(25,205)
Total revenues	9,023,400	9,023,400		4,684,343	(4,339,057)
Expenditures					
Personal services	530,100	530,100	(1)	261,648	268,452
Materials and services	2,533,300	2,533,300	(1)	1,256,027	1,277,273
Capital outlay	1,142,600	1,142,600	(1)	533,873	608,727
Debt service					
Principal	1,666,200	1,666,200	(2)	827,484	838,716
Interest	296,900	296,900	(2)	151,408	145,492
Contingency	327,372	327,372	(1)	-	327,372
Total expenditures	6,496,472	6,496,472		3,030,440	3,466,032
Excess of revenues over/ (under) expenditures	2,526,928	2,526,928		1,653,903	(873,025)
Other financing sources (uses)					
Transfers in	193,600	193,600		165,239	(28,361)
Transfers out	(3,497,100)	(3,497,100)	(1)	(1,731,700)	1,765,400
Total other financing sources (uses)	(3,303,500)	(3,303,500)		(1,566,461)	1,737,039
Net change in fund balance	(776,572)	(776,572)		87,442	864,014
Fund balance, July 1, 2023	1,752,887	1,752,887		2,110,033	357,146
Fund balance, June 30, 2024	976,315	976,315		2,197,475	1,221,160
Other requirements					
Restricted for debt service	976,315	976,315		982,500	6,185
Ending unassigned, unrestricted fund balanc	$ -	$ -		1,214,975	$ 1,214,975
Reconciliation to fund balance - modified accrual budgetary basis					
Adjustment for beginning fund balance				21,763	
Adjustment for current year change in accrued absences				8,528	
Fund balance - modified accrual budgetary basis				2,227,766	
Reconciliation to net position - GAAP Basis:					
Adjustment for capital assets, net of accumulated depreciation				36,240,961	
Adjustment for deferred inflow of resources - lease				(198,041)	
Adjustment for lease receivable				185,509	
Adjustment for accrued compensated absences payable				(30,291)	
Adjustment for note payable and bonds payable - due within one year				(838,383)	
Adjustment for notes and bonds payable				(6,441,797)	
Net position - GAAP Basis				$ 31,145,724	

(1) Appropriation level for the biennial period beginning July 1, 2023

(2) Appropriation level is Principal and Interest Combined

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Wastewater SDC Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Interest	$ 2,000	$ 2,000		$ 9,237	$ 7,237
Miscellaneous	-	50,000		18,750	(31,250)
System development charges	300,000	420,000		257,050	(162,950)
Total revenues	302,000	472,000		285,037	(186,963)
Expenditures					
Material and services	20,000	20,000	(1)	-	20,000
Capital outlay	50,000	120,000	(1)	40,069	79,931
Contingency	31,710	31,710	(1)	-	31,710
Total expenditures	101,710	171,710		40,069	131,641
Excess of revenues over/ (under) expenditures	200,290	300,290		244,968	(55,322)
Other financing sources (uses)					
Transfers out	(208,000)	(308,000)	(1)	(177,895)	130,105
Total other financing sources (uses)	(208,000)	(308,000)		(177,895)	130,105
Net change in fund balance	(7,710)	(7,710)		67,073	74,783
Fund balance, July 1, 2023	7,710	7,710		119,699	111,989
Fund balance, June 30, 2024	$ -	$ -		$ 186,772	$ 186,772

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Railroad Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget	Actual FY 23-24	Variance with Final Budget
Revenues				
Charges for services	$ 1,682,000	$ 1,682,000	$ 955,708	$ 726,292
Interest	-	-	44,970	(44,970)
Miscellaneous	379,000	379,000	152,698	226,302
Total revenues	2,061,000	2,061,000	1,153,376	907,624
Expenditures				
Personal services	984,000	1,035,000 (1)	493,149	541,851
Materials and services	625,800	670,000 (1)	337,463	332,537
Capital outlay	240,000	515,000 (1)	450,495	64,505
Contingency	1,363,724	993,524 (1)	-	993,524
Total expenditures	3,213,524	3,213,524	1,281,107	1,932,417
Excess of revenues over/ (under) expenditures	(1,152,524)	(1,152,524)	(127,731)	1,024,793
Other financing sources (uses)				
Transfers out	(202,100)	(202,100) (1)	(99,100)	103,000
Total other financing sources (uses)	(202,100)	(202,100)	(99,100)	103,000
Net change in fund balance	(1,354,624)	(1,354,624)	(226,831)	1,127,793
Fund balance, July 1, 2023	1,354,624	1,354,624	1,259,728	(94,896)
Fund balance, June 30, 2024	$ -	$ -	1,032,897	$ 1,032,897
Reconciliation to fund balance - modified accrual budgetary basis				
Adjustment for beginning fund balance			112,622	
Adjustment for current year change in accrued absences			(3,856)	
Fund balance - modified accrual budgetary basis			1,141,663	
Reconciliation to net position - GAAP Basis:				
Adjustment for capital assets, net of accumulated depreciation			7,123,398	
Adjustment for deferred inflow of resources - lease			(2,371,980)	
Adjustment for lease receivable			2,469,772	
Adjustment for accrued compensated absences payable			(108,766)	
Adjustment for amount due to general fund			(771,851)	
Net position - GAAP Basis			$ 7,482,236	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Airport Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ 170,000	$ 170,000		$ 31,023	$ (138,977)
Charges for services	1,391,000	1,391,000		295,293	(1,095,707)
Interest	1,000	1,000		2,757	1,757
Total revenues	1,562,000	1,562,000		329,073	(1,232,927)
Expenditures					
Personal services	360,600	360,600	(1)	196,974	163,626
Materials and services	1,230,600	1,230,600	(1)	276,097	954,503
Debt Service	-	-	(1)	-	-
Capital outlay	100	100	(1)	-	100
Contingency	108,568	108,568	(1)	-	108,568
Total expenditures	1,699,868	1,699,868		473,071	1,226,797
Excess of revenues over/ (under) expenditures	(137,868)	(137,868)		(143,998)	(6,130)
Other financing sources (uses)					
Transfers in	170,000	170,000		30,360	(139,640)
Transfers out	(132,200)	(132,200)	(1)	(32,000)	100,200
Total other financing sources (uses)	37,800	37,800		(1,640)	(39,440)
Net change in fund balance	(100,068)	(100,068)		(145,638)	(45,570)
Fund balance, July 1, 2023	100,068	100,068		145,669	45,601
Fund balance, June 30, 2024	$ -	$ -		31	$ 31
Reconciliation to fund balance - modified accrual budgetary basis					
Adjustment for beginning fund balance				27,514	
Adjustment for current year change in accrued absences				6,146	
Fund balance - modified accrual budgetary basis				33,691	
Reconciliation to net position - GAAP Basis:					
Adjustment for accrued compensated absences				(33,660)	
Adjustment for capital assets, net of accumulated depreciation				8,162	
Net position - GAAP Basis				$ 8,193	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Golf Course Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Charges for service	$ 2,607,000	$ 2,607,000		$ 1,502,651	$ (1,104,349)
Interest	24,000	24,000		53,763	29,763
Miscellaneous	21,000	21,000		9,537	(11,463)
Total revenues	2,652,000	2,652,000		1,565,951	(1,086,049)
Expenditures					
Waste disposal	1,512,100	1,512,100	(1)	750,898	761,202
Golf course	1,651,500	1,651,500	(1)	908,293	743,207
Restaurant	68,100	68,100	(1)	33,890	34,210
Debt service: Principal	247,100	247,100	(2)	123,493	123,607
Debt service: Interest	7,500	7,500	(2)	4,234	3,266
Contingency	575,992	575,992	(1)	-	575,992
Total expenditures	4,062,292	4,062,292		1,820,808	2,241,484
Excess of revenues over/ (under) expenditures	(1,410,292)	(1,410,292)		(254,857)	1,155,435
Other financing sources (uses)					
Transfers in	740,000	740,000		370,000	(370,000)
Transfers out	(348,400)	(348,400)	(1)	(165,800)	182,600
Total other financing sources (uses)	391,600	391,600		204,200	(187,400)
Net change in fund balance	(1,018,692)	(1,018,692)		(50,657)	968,035
Fund balance, July 1, 2023	1,018,692	1,018,692		1,109,422	90,730
Fund balance, June 30, 2024	$ -	$ -		1,058,765	$ 1,058,765
Reconciliation to fund balance - modified accrual budgetary basis					
Adjustment for beginning fund balance				103,722	
Adjustment for current year change in accrued absences				12,753	
Fund balance - modified accrual budgetary basis				1,175,240	
Reconciliation to net position - GAAP Basis:					
Adjustment for capital assets, net of accumulated depreciation				2,717,088	
Adjustment for accrued compensated absences payable				(116,475)	
Adjustment for deferred inflow of resources - lease				(55,262)	
Adjustment for lease receivable				56,656	
Adjustment for note payable				(246,062)	
Net position - GAAP Basis				$ 3,531,185	

(1) Appropriation level for the biennial period beginning July 1, 2023

(2) Appropriation level is Principal and Interest Combined

City of Prineville

Combining Balance Sheet

Internal Service Funds

June 30, 2024

	Governmental Type Activities Internal Services Funds			
	Administrative Services Fund	Building Facilities Funds	Public Works Support Services	Total
Assets				
Current assets				
Cash and investments	$ 524,069	$ 972,650	$ 662,689	$ 2,159,408
Accounts receivable	194	-	-	194
Inventory	-	-	26,591	26,591
Lease receivable	264,539	-	-	264,539
Capital asset - subscription asset (net of amortizatic	10,846	-	-	10,846
Capital asset - lease assets (net of amortization)	13,687	-	-	13,687
Total current assets	813,335	972,650	689,280	2,475,265
Capital Assets (net of accumulated depreciation	148,206	992,247	1,046,013	2,186,466
Total assets	961,541	1,964,897	1,735,293	4,661,731
Deferred outflows of resources				
Pension related deferrals	680,527	-	680,527	1,361,054
Total assets and deferred outflows	1,642,068	1,964,897	2,415,820	6,022,785
Liabilities				
Current liabilities				
Accounts payable	130,312	7,704	69,017	207,033
Accrued interest payable	-	8,190	3,267	11,457
Accrued compensated absences payable	250,680	-	216,604	467,284
Current portion notes payable	-	428,854	36,959	465,813
Current portion of subscription liability	-	-	-	-
Current portion lease liability	12,287	-	-	12,287
Proportionate share of net pension liability	1,550,445	-	1,550,445	3,100,890
Total current liabilities	1,943,724	444,748	1,876,292	4,264,764
Long-term liabilities				
Lease liability	2,916	-	-	2,916
Notes payable	-	5,057,337	77,097	5,134,434
Total long-term liabilities	2,916	5,057,337	77,097	5,137,350
Total liabilities	1,946,640	5,502,085	1,953,389	9,402,114
Deferred inflows of resources				
Leases	246,671	-	-	246,671
Pension related deferrals	176,132	-	176,132	352,264
Total deferred inflows of resources	422,803	-	176,132	598,935
Net Position				
Net investment in capital assets	148,206	992,247	931,957	2,072,410
Unrestricted				
Unassigned	(875,581)	(4,529,435)	(645,658)	(6,050,674)
Total net position	(727,375)	(3,537,188)	286,299	(3,978,264)
Total liabilities, deferred inflows and net positio	$ 1,642,068	$ 1,964,897	$ 2,415,820	$ 6,022,785

City of Prineville

Combining Schedule of Revenues, Expenses and Changes in Net Position

Internal Service Funds

Year Ended June 30, 2024

	Governmental Type Activities Internal Services Funds			
	Administrative Services Fund	Building Facilities Funds	Public Works Support Services	Totals
Operating revenue				
Intergovernmental	$ -	$ 62,381	$ 145,103	$ 207,484
Charges for services	352,653	-	-	352,653
Other operating revenues	2,478	9,302	3,321	15,101
Total operating revenue	355,131	71,683	148,424	575,238
Operating expenses				
Salaries and fringe benefits	2,161,034	-	2,212,403	4,373,437
Materials and services	1,740,581	458,666	282,674	2,481,921
Depreciation	71,883	86,282	237,545	395,710
Subscription amortization	16,740	-	-	16,740
Lease amortization	26,091	-	-	26,091
Total operating expenses	4,016,329	544,948	2,732,622	7,293,899
Operating income (loss)	(3,661,198)	(473,265)	(2,584,198)	(6,718,661)
Non-operating revenues (expenses)				
Interest income	20,770	46,297	29,246	96,313
Interest expense	-	(97,445)	(3,267)	(100,712)
Transfer to other funds	(156,400)	(69,688)	(74,500)	(300,588)
Transfers from other funds	3,434,750	1,170,388	2,428,315	7,033,453
Total non-operating revenue (expense)	3,299,120	1,049,552	2,379,794	6,728,466
Change in net position	(362,078)	576,287	(204,404)	9,805
Net position, July 1, 2023	(365,297)	(4,113,475)	490,703	(3,988,069)
Net position, June 30, 2024	$ (727,375)	$ (3,537,188)	$ 286,299	$ (3,978,264)

City of Prineville

Combining Schedule of Cash Flows

Internal Service Funds

Year Ended June 30, 2024

	Governmental Type Activities Internal Service Funds			
	Admin Services	Building Facilities Funds	Public Works Services	Totals
Cash flows from operating activities				
Cash received from customers	$ 351,298	$ 196,683	$ 289,024	$ 837,005
Cash payments for goods and services	(1,855,966)	(491,801)	(306,332)	(2,654,099)
Cash payments to employees	(1,983,219)	-	(2,046,477)	(4,029,696)
Net cash flows from operating activities	(3,487,887)	(295,118)	(2,063,785)	(5,846,790)
Cash flows from non-capital activities				
Transfers from other funds	3,434,750	1,170,388	2,428,315	7,033,453
Transfers to other funds	(156,400)	(69,688)	(74,500)	(300,588)
Net cash flows from non-capital activities	3,278,350	1,100,700	2,353,815	6,732,865
Cash flows from capital financing activities				
Acquisition of capital assets	(48,415)	-	(519,985)	(568,400)
Debt proceeds	-	-	-	-
Debt reduction	-	(411,133)	(35,938)	(447,071)
Interest paid on loans	-	(98,054)	(4,260)	(102,314)
Net cash flows from capital financing activities	(48,415)	(509,187)	(560,183)	(1,117,785)
Cash flows from investing activities				
Interest earned	20,701	46,297	29,246	96,244
Net increase (decrease) in cash	(237,251)	342,692	(240,907)	(135,466)
Cash - July 1, 2023	761,320	629,958	903,596	2,294,874
Cash - June 30, 2024	$ 524,069	$ 972,650	$ 662,689	$ 2,159,408
Reconciliation of operating income to net cash flows from operatings				
Operating income (loss)	$ (3,661,198)	$ (473,265)	$ (2,584,198)	$ (6,718,661)
Adjustments to reconcile operating income to net cash flows from operating activities				
Depreciation	71,883	86,282	237,545	395,710
Amortization - subscriptions	16,740	-	-	16,740
Amortization - leases	26,091	-	-	26,091
Changes in assets and liabilities				
Increase/(decrease) in accounts payable	(46,804)	(33,135)	(23,637)	(103,576)
Increase/(decrease) in subscriptions payable	(16,803)			(16,803)
Increase/(decrease) in leases payable	(51,778)	-	-	(51,778)
Decrease/(increase) in Net Pension Asset, Deferred Outflows	(40,112)	-	(40,112)	(80,224)
Increase/(decrease) in Net Pension Liabilities, Deferred Inflows	178,726	-	178,726	357,452
Decrease/(increase) lease deferred inflows	(26,318)	-	-	(26,318)
Decrease/(increase) in lease receivable	21,951	-	-	21,951
Decrease/(increase) in accounts receivable	534	125,000	140,600	266,134
Decrease/(increase) in inventory	-	-	(21)	(21)
Increase (decrease) in accrued expenses	39,201	-	27,312	66,513
Net cash flows from operating activities	$ (3,487,887)	$ (295,118)	$ (2,063,785)	$ (5,846,790)

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Administrative Services Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Charges for service	$ 690,200	$ 690,200		$ 374,604	$ (315,596)
Interest	20,000	20,000		20,770	770
Miscellaneous income	-	-		2,478	2,478
Total revenues	710,200	710,200		397,852	(312,348)
Expenditures					
City Council	95,600	95,600	(1)	42,553	53,047
Administration/team services	2,013,700	2,013,700	(1)	1,053,671	960,029
Financial services	2,258,700	2,258,700	(1)	1,123,204	1,135,496
Information technology	2,767,900	2,767,900	(1)	1,686,887	1,081,013
Contingency	539,799	539,799	(1)	-	539,799
Total expenditures	7,675,699	7,675,699		3,906,315	3,769,384
Excess of revenues over/ (under) expenditures	(6,965,499)	(6,965,499)		(3,508,463)	3,457,036
Other financing sources (uses)					
Transfers in	6,648,200	6,648,200		3,434,750	(3,213,450)
Transfers out	(322,400)	(322,400)	(1)	(156,400)	166,000
Total other financing sources (uses)	6,325,800	6,325,800		3,278,350	(3,047,450)
Net change in fund balance	(639,699)	(639,699)		(230,113)	409,586
Fund balance, July 1, 2023	639,699	639,699		373,384	(266,315)
Fund balance, June 30, 2024	$ -	$ -		$ 143,271	$ 143,271

Reconciliation to fund balance - modified accrual budgetary basis	
Adjustment for beginning fund balance	39,201
Adjustment for current year change in accrued absences	211,479
Fund balance - modified accrual budgetary basis	393,951
Reconciliation to net position - GAAP Basis:	
Adjustment for accrued compensated absences	(250,680)
Adjustment for proportionate share of net pension asset, deferred outflows	680,527
Adjustment for proportionate share of net pension liability, deferred inflows	(1,726,577)
Adjustment for deferred infow of resources, leases	(246,671)
Adjustment for capital assets - subscription assets, net of accumulated ammortizati	10,846
Adjustment for subscription liability	-
Adjustment for capital assets - lease assets, net of accumulated ammortization	13,687
Adjustment for lease liability	(15,203)
Adjustment for lease receivable	264,539
Adjustment for capital assets, net of accumulated depreciation	148,206
Net position - GAAP Basis	$ (727,375)

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Combining Balance Sheet
Building Facilities Funds
June 30, 2024

	Building Facilities	Plaza Maintenance	Total
Assets			
Current assets			
Cash and investments	$ 923,010	$ 49,640	$ 972,650
Accounts Receivable	-	-	-
Total current assets	923,010	49,640	972,650
Non-current assets			
Capital assets:			
Improvements	2,357,617	-	2,357,617
Accumulated depreciation	(1,365,370)	-	(1,365,370)
Net non-current assets	992,247	-	992,247
Total assets	$ 1,915,257	$ 49,640	$ 1,964,897
Liabilities			
Current liabilities			
Accounts payable	$ 7,704	$ -	$ 7,704
Accrued interest payable	8,190	-	8,190
Notes payable, current portion	428,854	-	428,854
Total current liabilities	444,748	-	444,748
Long-term liabilities			
Notes payable, net of current portion	5,057,337	-	5,057,337
Total liabilities	5,502,085	-	5,502,085
Net position			
Net Investment in Capital Assets	992,247	-	992,247
Unrestricted			
Unreserved	(4,579,075)	49,640	(4,529,435)
Total net position	(3,586,828)	49,640	(3,537,188)
Total liabilities and net position	$ 1,915,257	$ 49,640	$ 1,964,897

City of Prineville

Combining Schedule of Revenues, Expenses and Changes in Net Position

Building Facilities Funds

Year Ended June 30, 2024

	Building Facilities	Plaza Maintenance	Total
Operating revenue			
Intergovernmental	$ 52,693	$ 9,688	$ 62,381
Other	9,302	-	9,302
Total operating revenue	61,995	9,688	71,683
Operating expenses			
Materials and services	449,190	9,476	458,666
Depreciation	86,282	-	86,282
Total operating expenses	535,472	9,476	544,948
Operating income (loss)	(473,477)	212	(473,265)
Non-operating revenues (expenses)			
Interest income	43,910	2,387	46,297
Interest expense	(97,445)	-	(97,445)
Transfers from other funds	1,160,700	9,688	1,170,388
Transfers to other funds	(67,688)	(2,000)	(69,688)
Total non-operating revenues (expenses)	1,039,477	10,075	1,049,552
Change in net position	566,000	10,287	576,287
Net position, July 1, 2023	(4,152,828)	39,353	(4,113,475)
Net position, June 30, 2024	$ (3,586,828)	$ 49,640	$ (3,537,188)

City of Prineville

Combining Schedule of Cash Flows

Building Facilities Funds

Year Ended June 30, 2024

	Building Facilities	Plaza Maintenance	Total
Cash flows from operating activities			
Cash received from customers	$ 186,995	$ 9,688	$ 196,683
Cash payments for goods and services	(482,325)	(9,476)	(491,801)
Net cash flows from operating activities	(295,330)	212	(295,118)
Cash flows from non-capital activities			
Transfers from other funds	1,160,700	9,688	1,170,388
Transfers to other funds	(67,688)	(2,000)	(69,688)
Net cash flows from non-capital activities	1,093,012	7,688	1,100,700
Cash flows from capital financing activities			
Debt reduction	(411,133)	-	(411,133)
Interest paid on loans	(98,054)	-	(98,054)
Net cash flows from capital financing activities	(509,187)	-	(509,187)
Cash flows from investing activities			
Interest earned	43,910	2,387	46,297
Net decrease in cash	332,405	10,287	342,692
Cash - July 1, 2023	590,605	39,353	629,958
Cash - June 30, 2024	$ 923,010	$ 49,640	$ 972,650
Reconciliation of operating income to net cash flows from operatings			
Operating income/(loss)	$ (473,477)	$ 212	$ (473,265)
Adjustments to reconcile operating income to net cash flows from operating activities			
Depreciation	86,282	-	86,282
Changes in assets and liabilities			
Increase/(decrease) in accounts payable	(33,135)	-	(33,135)
Decrease/(increase) in accounts receivable	125,000	-	125,000
(Increase) in prepaid expense	-	-	-
Net cash flows from operating activities	$ (295,330)	$ 212	$ (295,118)

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Building Facility Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ 450,000	$ 450,000		$ 52,693	$ (397,307)
Interest	10,000	10,000		43,910	33,910
Miscellaneous income	471,500	471,500		9,302	(462,198)
Total revenues	931,500	931,500		105,905	(825,595)
Expenditures					
City Hall Facilities	568,300	568,300	(1)	174,854	393,446
Police Facilities	1,364,200	1,364,200	(1)	717,336	646,864
Public Works Facilities	82,500	82,500	(1)	39,769	42,731
Barnes Butte Property	500,000	500,000	(1)	25,779	474,221
Debt service reserve	533,000	533,000	(1)	-	533,000
Contingency	155,597	155,597	(1)	-	155,597
Total expenditures	3,203,597	3,203,597		957,738	2,245,859
Excess of revenues over/ (under) expenditures	(2,272,097)	(2,272,097)		(851,833)	1,420,264
Other financing sources (uses)					
Transfers out	(139,000)	(139,000)	(1)	(67,688)	71,312
Transfers in	1,859,900	1,859,900		1,160,700	(699,200)
Total other financing sources (uses)	1,720,900	1,720,900		1,093,012	(627,888)
Net change in fund balance	(551,197)	(551,197)		241,179	792,376
Fund balance, July 1, 2023	551,197	551,197		665,937	114,740
Fund balance, June 30, 2024	$ -	$ -		907,116	$ 907,116
Reconciliation to net position - GAAP Basis:					
Adjustment for capital assets, net of accumulated depreciation				992,247	
Adjustment for note payable - due within one year				(428,854)	
Adjustment for note payable				(5,057,337)	
Net position - GAAP Basis				$ (3,586,828)	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Plaza Maintenance Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Intergovernmental	$ 20,000	$ 20,000		$ 9,688	$ (10,312)
Interest	400	400		2,387	1,987
Total revenues	20,400	20,400		12,075	(8,325)
Expenditures					
Materials and services	43,200	43,200	(1)	9,476	33,724
Contingency	22,473	22,473	(1)	-	22,473
Total expenditures	65,673	65,673		9,476	56,197
Excess of revenues over/ (under) expenditures	(45,273)	(45,273)		2,599	47,872
Other financing sources (uses)					
Transfers out	(4,000)	(4,000)	(1)	(2,000)	2,000
Transfers in	20,000	20,000		9,688	(10,312)
Total other financing sources (uses)	16,000	16,000		7,688	(8,312)
Net change in fund balance	(29,273)	(29,273)		10,287	39,560
Fund balance, July 1, 2023	29,273	29,273		39,353	10,080
Fund balance, June 30, 2024	$ -	$ -		$ 49,640	$ 49,640
Reconciliation to net position - GAAP Basis:					
No adjustment				-	
Net position - GAAP Basis				$ 49,640	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Revenues, Expenditures and Changes in Fund Balance – Budget and Actual

Public Works Support Services Fund

Year Ended June 30, 2024

	Original Budget	Final Amended Budget		Actual FY 2023-24	Variance with Final Budget
Revenues					
Interest	$ 4,000	$ 4,000		$ 29,246	$ 25,246
Intergovernmental	220,000	220,000		145,103	(74,897)
Other	20,000	20,000		3,321	(16,679)
Total revenues	244,000	244,000		177,670	(66,330)
Expenditures					
Public works support services	4,069,300	4,069,300	(1)	2,136,448	1,932,852
Public works fleet and vehicles	981,000	981,000	(1)	779,205	201,795
Contingency	521,152	521,152	(1)	-	521,152
Total expenditures	5,571,452	5,571,452		2,915,653	2,655,799
Excess of revenues over/ (under) expenditures	(5,327,452)	(5,327,452)		(2,737,983)	2,589,469
Other financing sources (uses)					
Debt Proceeds	-	-		-	-
Transfers out	(155,500)	(155,500)	(1)	(74,500)	81,000
Transfers in	4,962,200	4,962,200		2,428,315	(2,533,885)
Total other financing sources (uses)	4,806,700	4,806,700		2,353,815	(2,452,885)
Net change in fund balance	(520,752)	(520,752)		(384,168)	136,584
Fund balance, July 1, 2023	520,752	520,752		784,560	263,808
Fund balance, June 30, 2024	$ -	$ -		400,392	$ 400,392
Reconciliation to fund balance - modified accrual budgetary basis					
Adjustment for beginning fund balance				27,312	
Adjustment for current year change in accrued absences				189,292	
Fund balance - modified accrual budgetary basis				616,996	
Reconciliation to net position - GAAP Basis:					
Adjustment for accrued compensated absences				(216,604)	
Adjustment for note payable				(114,056)	
Adjustment for proportionate share of net pension asset, deferred outflows				680,527	
Adjustment for proportionate share of net pension liability, deferred inflows				(1,726,577)	
Adjustment for capital assets, net of accumulated depreciation				1,046,013	
Net position - GAAP Basis				$ 286,299	

(1) Appropriation level for the biennial period beginning July 1, 2023

City of Prineville

Schedule of Property Tax Transactions

Year Ended June 30, 2024

Tax Year	Beginning Balance and Current Levy	Adjustments	Interest (Discounts)	Turnovers from County Treasurer	Taxes Receivable June 30, 2024
2023-24	$ 3,026,476	$ (3,874)	$ (76,334)	$ 2,859,104	$ 87,164
2022-23	62,804	(274)	1,736	34,445	29,821
2021-22	21,667	(94)	1,061	9,826	12,808
2020-21	11,062	(92)	1,135	7,016	5,089
2019-20	2,851	(90)	466	2,494	733
Prior	7,905	(180)	193	665	7,253
	$ 3,132,765	$ (4,604)	$ (71,743)	2,913,550	$ 142,868

Reconciliation to Revenue	
Tax accrual	
June 30, 2023	(11,244)
June 30, 2024	17,231
	$ 2,919,537

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City of Prineville

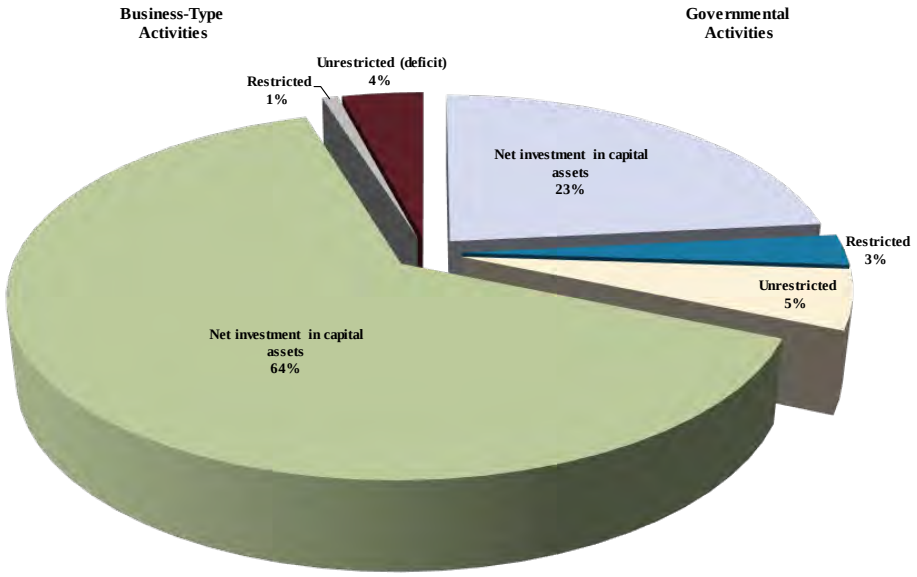
Net Position by Components

For the Last 10 Fiscal Years

	Fiscal year ended									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Governmental activities										
Net investment in capital assets	$ 9,892,711	$ 11,345,910	$ 13,042,818	$ 14,763,230	$ 14,105,369	$ 16,368,057	$ 19,915,918	$ 23,994,251	$ 25,840,188	$ 27,822,248
Restricted	574,874	868,940	893,567	1,391,944	1,995,054	1,578,437	1,345,140	1,878,500	2,025,707	3,269,733
Unrestricted	2,234,187	(107,036)	(625,384)	(1,147,099)	852,715	2,836,615	1,891,458	1,197,658	2,310,121	6,328,738
Total governmental activities net position	**$ 12,701,772**	**$ 12,107,814**	**$ 13,311,001**	**$ 15,008,075**	**$ 16,953,138**	**$ 20,783,109**	**$ 23,152,516**	**$ 27,070,409**	**$ 30,176,016**	**$ 37,420,719**
Business-type activities										
Net investment in capital assets	$ 30,067,137	$ 31,448,889	$ 37,382,458	$ 43,578,856	$ 55,548,911	$ 60,554,604	$ 67,276,279	$ 68,469,618	$ 69,602,537	$ 76,035,117
Restricted	530,699	374,107	351,491	1,955,523	2,180,997	4,144,167	1,168,515	1,259,743	909,699	915,118
Unrestricted (deficit)	3,599,021	4,218,984	3,856,220	5,733,630	8,395,232	4,423,762	4,067,026	4,939,421	4,903,678	4,801,497
Total business-type activities net position	**$ 34,196,857**	**$ 36,041,980**	**$ 41,590,169**	**$ 51,268,009**	**$ 66,125,140**	**$ 69,122,533**	**$ 72,511,820**	**$ 74,668,782**	**$ 75,415,914**	**$ 81,751,732**
Primary government										
Net investment in capital assets	$ 39,959,848	$ 42,794,799	$ 50,425,276	$ 58,342,086	$ 69,654,280	$ 76,922,661	$ 87,192,197	$ 92,463,869	$ 95,442,725	$ 103,857,365
Restricted	1,105,573	1,243,047	1,245,058	3,347,467	4,176,051	5,722,604	2,513,655	3,138,243	2,935,406	4,184,851
Unrestricted (deficit)	5,833,208	4,111,948	3,230,836	4,586,531	9,247,947	7,260,377	5,958,484	6,137,079	7,213,799	11,130,235
Total primary government net position	**$ 46,898,629**	**$ 48,149,794**	**$ 54,901,170**	**$ 66,276,084**	**$ 83,078,278**	**$ 89,905,642**	**$ 95,664,336**	**$ 101,739,191**	**$ 105,591,930**	**$ 119,172,451**

Source: Annual financial statements of the City of Prineville

Net Position by Components FY 24



City of Prineville

Changes in Net Position

For the Last 10 Fiscal Years

	Fiscal year ended									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Expenses										
Governmental activities										
General government	$ 416,640	$ 1,111,185	$ 2,142,141	$ 1,000,996	$ 2,695,309	$ 1,212,158	$ 1,665,835	$ 1,834,062	$ 4,580,968	$ 2,592,017
Public safety	2,921,115	7,639,414	6,412,132	7,961,382	8,113,155	9,014,325	9,531,868	9,195,610	9,504,018	12,064,233
Highways and streets	1,112,590	1,273,699	790,414	732,512	877,535	820,924	951,207	948,788	1,070,694	1,241,716
Interest on long-term debt	189,358	132,677	127,172	187,046	209,483	143,568	259,869	175,937	170,876	145,001
Unallocated deprecation	-	-	-	-	-	-	-	-	-	-
Total governmental activities expenses	**$ 4,639,703**	**$ 10,156,975**	**$ 9,471,859**	**$ 9,881,936**	**$ 11,895,482**	**$ 11,190,975**	**$ 12,408,779**	**$ 12,154,397**	**$ 15,326,556**	**$ 16,042,967**
Business-type activities										
Railroad	$ 797,044	$ 906,269	$ 990,133	$ 1,014,557	$ 838,289	$ 959,900	$ 1,187,241	$ 950,640	$ 1,127,496	$ 957,872
Water	916,365	957,293	1,052,820	1,177,361	1,628,957	1,263,628	1,530,614	1,846,757	2,508,764	2,554,068
Wastewater	1,653,325	1,695,870	1,859,666	2,293,751	2,161,516	2,177,440	2,194,325	3,545,904	2,731,182	3,096,369
Golf and restaurant	1,305,927	1,361,170	1,285,732	1,367,914	1,231,167	1,000,895	1,075,416	1,418,212	1,440,016	1,714,697
Airport	685,166	699,764	716,900	745,602	771,943	1,274,742	709,452	935,499	913,647	483,002
Total business-type activities expenses	5,357,827	5,620,366	5,905,251	6,599,185	6,631,872	6,676,605	6,697,048	8,697,012	8,721,105	8,806,008
Total primary government expenses	**$ 9,997,530**	**$ 15,777,341**	**$ 15,377,110**	**$ 16,481,121**	**$ 18,527,354**	**$ 17,867,580**	**$ 19,105,827**	**$ 20,851,409**	**$ 24,047,661**	**$ 24,848,975**
Program revenues										
Governmental activities										
Charges for service										
General government	$ 165,927	$ 203,993	$ 224,543	$ 113,703	$ 123,930	$ 53,053	$ 98,754	$ 184,739	$ 60,222	$ 135,425
Public safety	37,884	33,671	-	-	21,694	242,979	194,223	195,606	98,307	322,337
Highways and streets	353,328	494,830	346,623	536,820	602,966	649,820	801,781	603,017	816,053	674,365
Operating grants and contributions	1,637,916	1,646,108	1,950,468	2,010,594	2,772,407	3,505,211	2,467,404	4,701,211	4,119,992	3,268,111
Capital grants and contributions	-	-	-	-	-	-	-	-	99,668	-
Total governmental activities program revenue	**$ 2,195,055**	**$ 2,378,602**	**$ 2,521,634**	**$ 2,661,117**	**$ 3,520,997**	**$ 4,451,063**	**$ 3,562,162**	**$ 5,684,573**	**$ 5,194,242**	**$ 4,400,238**
Business-type activities										
Charges for service										
Railroad	$ 586,937	$ 943,182	$ 1,160,350	$ 799,732	$ 733,948	$ 896,864	$ 1,063,283	$ 1,002,912	$ 980,556	$ 1,000,455
Water	2,183,160	2,554,213	2,597,543	6,537,222	8,522,709	8,796,006	3,547,702	3,469,917	4,567,116	9,378,091
Wastewater	3,208,361	3,952,199	5,850,679	9,251,289	11,757,992	3,823,007	4,126,595	4,357,392	4,250,103	4,784,874
Golf and restaurant	1,132,478	1,143,167	1,092,074	1,123,087	1,038,266	845,887	1,156,390	1,248,477	1,330,672	1,512,188
Airport	803,978	517,629	1,973,312	815,257	2,177,627	1,052,957	694,117	1,067,244	1,042,417	326,316
Operating grants and contributions	-	186,718	-	-	-	-	-	-	-	-
Capital grants and contributions	-	355,644	796,804	296,225	81,606	251,922	2,458,780	1,563,531	580,766	1,722,817
Total business-type activities program revenue	7,914,914	9,652,752	13,470,762	18,822,812	24,312,148	15,666,643	13,046,867	12,709,473	12,751,630	18,724,741
Total primary government program revenues	**$ 10,109,969**	**$ 12,031,354**	**$ 15,992,396**	**$ 21,483,929**	**$ 27,833,145**	**$ 20,117,706**	**$ 16,609,029**	**$ 18,394,046**	**$ 17,945,872**	**$ 23,124,979**
Net (expense) revenue										
Governmental activities	$ (2,444,648)	$ (7,778,373)	$ (6,950,225)	$ (7,220,819)	$ (8,374,485)	$ (6,739,912)	$ (8,846,617)	$ (6,469,824)	$ (10,132,314)	$ (11,642,729)
Business-type activities	2,557,087	4,032,386	7,565,511	12,223,627	17,680,276	8,990,038	6,349,819	4,012,461	4,030,525	9,918,733
Total primary government expenses	**$ 112,439**	**$ (3,745,987)**	**$ 615,286**	**$ 5,002,808**	**$ 9,305,791**	**$ 2,250,126**	**$ (2,496,798)**	**$ (2,457,363)**	**$ (6,101,789)**	**$ (1,723,996)**
General revenues and other changes in net position										
Governmental activities										
Property taxes levied for										
General purposes	$ 1,777,841	$ 1,842,104	$ 1,966,681	$ 2,067,373	$ 2,181,966	$ 2,287,509	$ 2,443,843	$ 2,564,620	$ 2,771,257	$ 2,950,128
Debt service	-	-	-	-	-	-	-	-	-	-
Transient room taxes	253,174	315,677	329,514	339,003	432,343	312,000	400,036	521,451	499,799	453,004
Franchise fees	1,864,413	2,085,847	2,756,972	2,913,102	3,461,496	3,592,674	4,113,149	4,166,707	5,157,475	8,190,291
Earnings on investments	11,268	12,324	25,758	56,637	121,691	177,325	62,483	(87,578)	556,065	1,110,727
Intergovernmental	-	-	-	-	-	-	-	-	-	-
Miscellaneous	375,864	811,036	908,805	1,039,410	1,011,071	1,260,373	1,185,012	1,335,984	802,414	2,354,628
Total governmental activities	**$ 4,282,560**	**$ 5,066,988**	**$ 5,987,730**	**$ 6,415,525**	**$ 7,208,567**	**$ 7,629,881**	**$ 8,204,523**	**$ 8,501,184**	**$ 9,787,010**	**$ 15,058,778**
Business-type activities										
Earnings on investments	$ 13,812	$ 18,290	$ 29,878	$ 104,594	$ 287,836	$ 182,193	$ 50,969	$ 73,122	$ 158,218	$ 245,740
Miscellaneous	487,394	(88,126)	118,482	137,343	-	(3,234,836)	-	(42,089)	9,300	-
Total business-type activities	501,206	(69,836)	148,360	241,937	287,836	(3,052,643)	50,969	31,033	167,518	245,740
Total primary government	**$ 4,783,766**	**$ 4,997,152**	**$ 6,136,090**	**$ 6,657,462**	**$ 7,496,403**	**$ 4,577,238**	**$ 8,255,492**	**$ 8,532,217**	**$ 9,954,528**	**$ 15,304,518**
Transfers										
Governmental activities	$ 2,150,338	$ 2,117,427	$ 2,165,682	$ 2,787,724	$ 3,110,981	$ 2,940,002	$ 3,011,501	$ 1,886,533	$ 3,450,911	3,828,654
Business-type activities	(2,150,338)	(2,117,427)	(2,165,682)	(2,787,724)	(3,110,981)	(2,940,002)	(3,011,501)	(1,886,533)	(3,450,911)	$ (3,828,654)
Total Transfers	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Change in net position										
Governmental activities	$ 3,988,250	$ (593,958)	$ 1,203,187	$ 1,982,430	$ 1,945,063	$ 3,829,971	$ 2,369,407	$ 3,917,893	$ 3,105,607	$ 7,244,703
Business-type activities	907,955	1,845,123	5,548,189	9,677,840	14,857,131	2,997,393	3,389,287	2,156,961	747,132	6,335,819
Total primary government	**$ 4,896,205**	**$ 1,251,165**	**$ 6,751,376**	**$ 11,660,270**	**$ 16,802,194**	**$ 6,827,364**	**$ 5,758,694**	**$ 6,074,854**	**$ 3,852,739**	**$ 13,580,522**

Source: Annual financial statements of the City of Prineville

Purpose: Changes in net position is intended to provide the user with summary data to analyze changes in the activities.

City of Prineville

Fund Balances of Governmental Funds

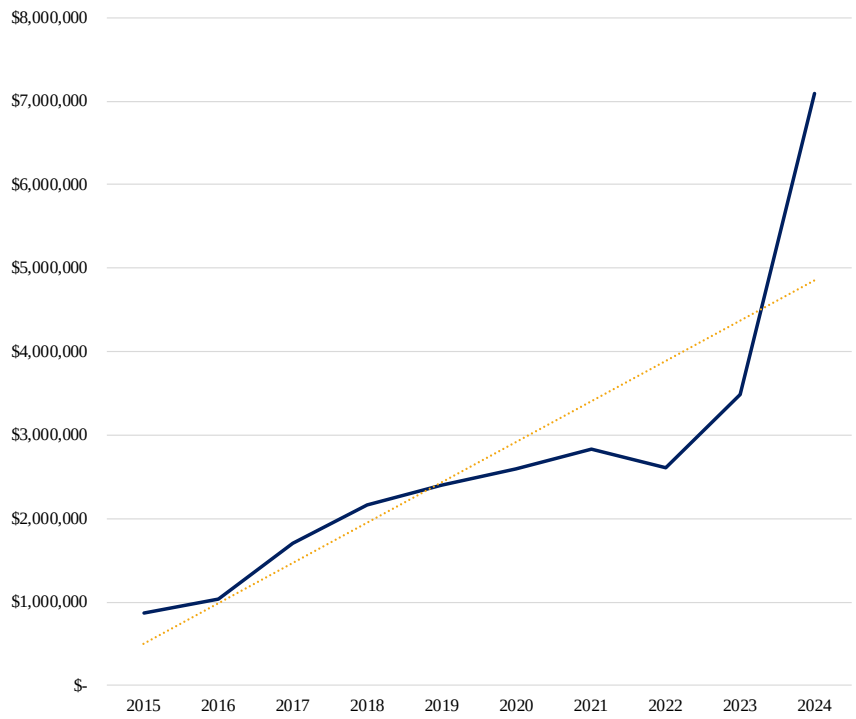
Unaudited (Modified Accrual Basis of Accounting)

For the Last 10 Fiscal Years

	Fiscal year ended									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
General Fund										
Nonspendable	$ -	$ -	$ -	$ -	$ -	$ -	$ 76,363	$ -	$ -	$ -
Restricted	-	-	-	-	-	-	-	-	-	-
Committed	-	-	-	-	-	-	-	-	-	-
Assigned	78,380	78,021	121,280	248,158	241,205	90,723	135,505	194,341	256,699	248,505
Unassigned	797,059	963,851	1,583,740	1,918,886	2,153,326	2,500,771	2,613,538	2,421,184	3,231,995	6,842,202
Total General Fund	**$ 875,439**	**$ 1,041,872**	**$ 1,705,020**	**$ 2,167,044**	**$ 2,394,531**	**$ 2,591,494**	**$ 2,825,406**	**$ 2,615,525**	**$ 3,488,694**	**$ 7,090,707**
All other governmental funds										
Nonspendable	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Restricted	469,874	763,940	788,567	1,286,944	1,890,054	1,473,437	1,240,140	1,878,500	2,025,707	3,269,733
Committed	480,014	693,551	1,000,747	1,267,547	1,099,902	1,696,534	2,437,175	2,297,997	3,221,656	4,086,587
Assigned	-	-	-	-	-	-	-	-	-	-
Unassigned	-	-	-	-	-	-	-	-	-	-
Total all other governmental funds	**$ 949,888**	**$ 1,457,491**	**$ 1,789,314**	**$ 2,554,491**	**$ 2,989,956**	**$ 3,169,971**	**$ 3,677,315**	**$ 4,176,497**	**$ 5,247,363**	**$ 7,356,320**
Total all funds	**$ 1,825,327**	**$ 2,499,363**	**$ 3,494,334**	**$ 4,721,535**	**$ 5,384,487**	**$ 5,761,465**	**$ 6,502,721**	**$ 6,792,022**	**$ 8,736,057**	**$ 14,447,027**

Source: Annual financial statements of the City of Prineville

Changes in Fund Balance General Fund



City of Prineville

Changes in Fund Balances of Governmental Funds

Unaudited (Modified Accrual Basis of Accounting)

For the Last 10 Fiscal Years

	Fiscal year ended									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Revenue										
Taxes	$ 2,046,911	$ 2,159,083	$ 2,292,563	$ 2,410,508	$ 2,626,451	$ 2,609,494	$ 2,865,315	$ 3,084,471	$ 3,258,016	$ 3,372,541
Intergovernmental	1,785,004	1,803,827	2,105,618	2,198,466	2,921,110	3,859,787	2,643,329	4,909,193	4,446,869	4,608,364
Franchise fees	1,864,413	2,085,847	2,756,972	2,913,102	3,461,496	3,592,674	4,113,149	4,166,707	5,157,475	8,190,291
Licenses and permits	59,926	67,301	78,617	67,960	58,875	58,279	74,954	85,283	71,288	59,228
Charges for services	425,954	584,742	715,955	527,149	571,512	567,963	773,393	688,712	524,266	973,242
System development fees	328,922	486,025	334,548	525,075	593,125	633,346	783,401	592,747	804,987	674,365
Interest	11,268	12,324	25,758	56,637	121,691	102,958	43,262	(105,379)	488,586	1,014,414
Miscellaneous	205,938	223,159	1,349,845	381,877	387,446	416,213	472,097	439,195	472,673	439,666
Total revenue	**$ 6,728,336**	**$ 7,422,308**	**$ 9,659,876**	**$ 9,080,774**	**$10,741,706**	**$11,840,714**	**$11,768,900**	**$13,860,929**	**$15,224,160**	**$19,332,111**
Expenditures										
General government	$ 432,270	$ 509,906	$ 1,228,918	$ 594,601	$ 1,477,154	$ 649,169	$ 835,351	$ 1,029,703	$ 1,661,465	$ 1,344,358
Public safety	3,461,452	3,505,611	3,678,555	4,731,767	4,446,384	4,827,603	4,779,857	5,162,720	5,979,849	6,257,154
Highways and streets	392,512	584,481	453,450	435,361	480,930	439,644	476,993	532,681	549,925	644,020
Capital outlay	967,133	541,551	992,829	838,030	1,648,661	3,383,636	2,102,369	1,963,094	1,995,612	2,140,084
Total general expenditures	5,253,367	5,141,549	6,353,752	6,599,759	8,053,129	9,300,052	8,194,570	8,688,198	10,186,851	10,385,616
Debt service										
Principal	$ 224,417	$ 240,906	$ 1,348,405	$ 181,736	$ 260,153	$ 285,287	$ 306,298	$ 327,079	$ 352,621	$ 277,643
Interest	223,417	211,988	202,624	246,635	111,017	97,979	88,076	77,415	66,005	53,671
Total debt service expenditures	447,834	452,894	1,551,029	428,371	371,170	383,266	394,374	404,494	418,626	331,314
Total expenditures	**$ 5,701,201**	**$ 5,594,443**	**$ 7,904,781**	**$ 7,028,130**	**$ 8,424,299**	**$ 9,683,318**	**$ 8,588,944**	**$ 9,092,692**	**$10,605,477**	**$10,716,930**
Debt service as a percentage of noncapital expenditures	9.46%	8.96%	24.45%	9.50%	7.34%	8.03%	11.90%	7.09%	5.21%	4.34%
Excess of revenues over (under) expenditures	**$ 1,027,135**	**$ 1,827,865**	**$ 1,755,095**	**$ 2,052,644**	**$ 2,317,407**	**$ 2,157,396**	**$ 3,179,956**	**$ 4,768,237**	**$ 4,618,683**	**$ 8,615,181**
Other financing sources (uses)										
Proceeds - issuance of debt	$ -	$ -	$ 720,000	$ 433,000	$ -	$ -	$ -	$ -	$ -	$ -
Refunding bonds issued	-	-	-	2,549,000	-	-	-	-	-	-
Payment on refunding bonds	-	-	-	(2,570,000)	-	-	-	-	-	-
Operating transfer in	671,453	652,670	719,278	1,579,796	1,640,602	1,292,280	1,648,100	1,331,588	1,763,762	1,716,067
Operating transfer out	(1,765,844)	(1,806,499)	(2,199,402)	(2,817,239)	(3,295,057)	(3,072,698)	(4,086,800)	(5,810,524)	(4,438,410)	(4,620,278)
Transfers to record as amount due General Fund	-	-	-	-	-	-	-	-	-	-
Total other financing sources (uses	(1,094,391)	(1,153,829)	(760,124)	(825,443)	(1,654,455)	(1,780,418)	(2,438,700)	(4,478,936)	(2,674,648)	(2,904,211)
Net changes in fund balance	**$ (67,256)**	**$ 674,036**	**$ 994,971**	**$ 1,227,201**	**$ 662,952**	**$ 376,978**	**$ 741,256**	**$ 289,301**	**$ 1,944,035**	**$ 5,710,970**

Source: Annual financial statements of the City of Prineville

Proceeds from the issuance of debt are as follows: UAL Pension Obligation (OPERS 2014), Barnes Butte property purchase (Iron Horse Note Payable 2017) and Police Cars (Note Payable 2018).

City of Prineville

Program Revenue by Function/Program

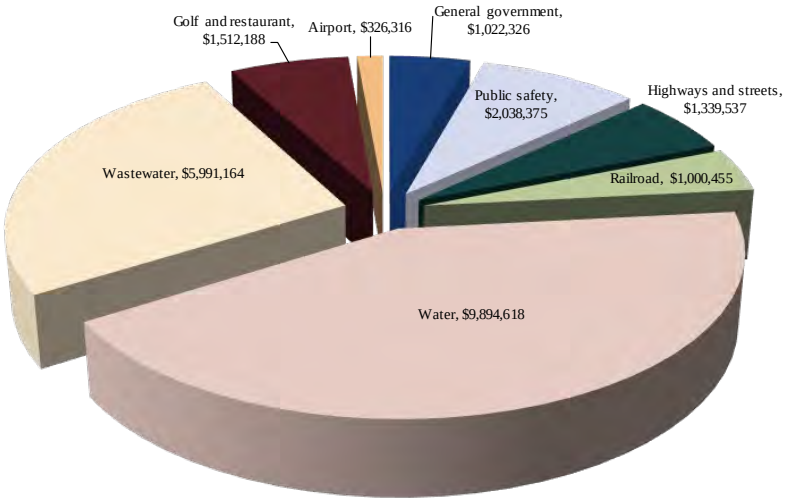
Unaudited (Modified Accrual Basis of Accounting)

For the Last 10 Fiscal Years

	Fiscal year ended									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Governmental activities										
General government	$ 165,927	$ 203,993	$ 224,543	$ 113,703	$ 123,930	$ 73,136	$ 403,874	$ 1,776,239	$ 1,536,181	$ 1,022,326
Public safety	807,171	811,367	997,562	1,042,513	1,201,413	1,259,384	1,369,205	1,188,560	1,467,795	2,038,375
Highways and streets	1,221,957	1,363,242	1,299,529	1,504,901	2,195,654	3,118,543	1,789,083	2,719,774	2,190,266	1,339,537
Total governmental activities	**$ 2,195,055**	**$ 2,378,602**	**$ 2,521,634**	**$ 2,661,117**	**$ 3,520,997**	**$ 4,451,063**	**$ 3,562,162**	**$ 5,684,573**	**$ 5,194,242**	**$ 4,400,238**
Business-type activities										
Railroad	$ 586,937	$ 943,182	$ 1,160,350	$ 799,732	$ 733,948	$ 896,864	$ 1,063,283	$ 1,002,912	$ 980,556	$ 1,000,455
Water	2,183,160	2,781,035	2,976,606	6,689,985	8,591,461	8,900,458	5,725,714	4,389,539	4,914,608	9,894,618
Wastewater	3,208,361	4,081,021	6,268,420	9,394,751	11,770,846	3,970,477	4,407,363	5,001,301	4,483,377	5,991,164
Golf and restaurant	1,132,478	1,143,167	1,092,074	1,123,087	1,038,266	845,887	1,156,390	1,248,477	1,330,672	1,512,188
Airport	803,978	704,347	1,973,312	815,257	2,177,627	1,052,957	694,117	1,067,244	1,042,417	326,316
Other non-major	-	-	-	-	-	-	-	-	-	
Total business-type activities	**$ 7,914,914**	**$ 9,652,752**	**$ 13,470,762**	**$ 18,822,812**	**$ 24,312,148**	**$ 15,666,643**	**$ 13,046,867**	**$ 12,709,473**	**$ 12,751,630**	**$ 18,724,741**
Total primary government	**$ 10,109,969**	**$ 12,031,354**	**$ 15,992,396**	**$ 21,483,929**	**$ 27,833,145**	**$ 20,117,706**	**$ 16,609,029**	**$ 18,394,046**	**$ 17,945,872**	**$ 23,124,979**

Source: Annual financial statements of the City of Prineville

Program Revenues by Function / Program for FY 24



City of Prineville

Governmental Activities Tax Revenue by Source

Unaudited (Modified Accrual Basis of Accounting)

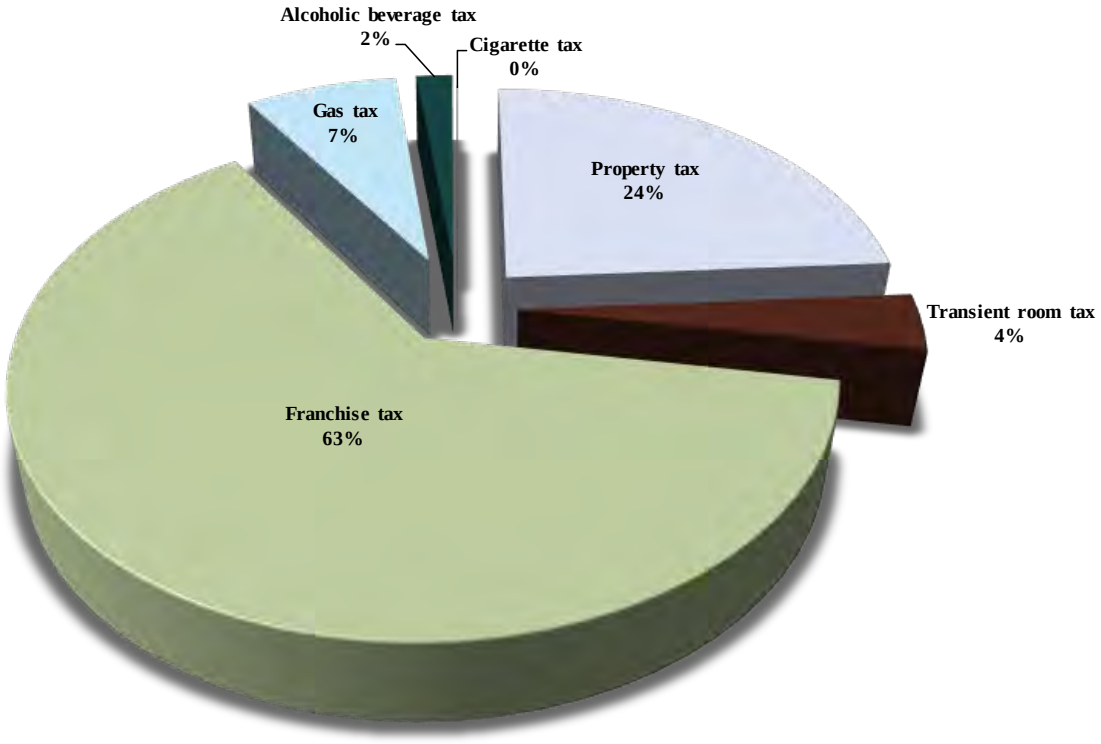
For the Last 10 Fiscal Years

Fiscal year	Property tax	Transient room tax	Franchise tax	Gas tax	Alcoholic beverage tax	Cigarette tax	Total
2015	1,793,737	253,174	1,864,413	539,215	134,370	12,449	$ 4,597,357
2016	1,843,406	315,677	2,085,847	557,424	135,430	12,430	$ 4,950,215
2017	1,963,049	329,514	2,479,972	572,260	146,868	12,132	$ 5,503,796
2018	2,071,555	339,003	2,740,102	631,145	156,046	12,033	$ 5,949,884
2019	2,194,108	432,343	3,031,496	729,216	165,904	11,432	$ 6,564,498
2020	2,297,494	312,000	3,265,674	693,043	180,434	10,999	$ 6,759,644
2021	2,465,279	400,036	3,775,149	765,979	184,786	9,860	$ 7,601,090
2022	2,563,020	521,451	3,826,707	862,108	217,842	8,693	$ 7,999,821
2023	2,758,217	499,799	4,804,475	886,874	222,244	8,213	$ 9,179,823
2024	2,919,537	453,004	7,685,591	905,729	217,064	7,576	$ 12,188,502

Source: Annual financial statements of the City of Prineville.

Gas, alcohol, and cigarette taxes are not directly assessed by the City of Prineville, but rather by the State of Oregon. A portion is then allocated to the City based upon population.

FY 24 Governmental Activities Tax Revenues by Source



City of Prineville

Assessed Value and Actual Value of Taxable Property

Unaudited

For the Last 10 Fiscal Years

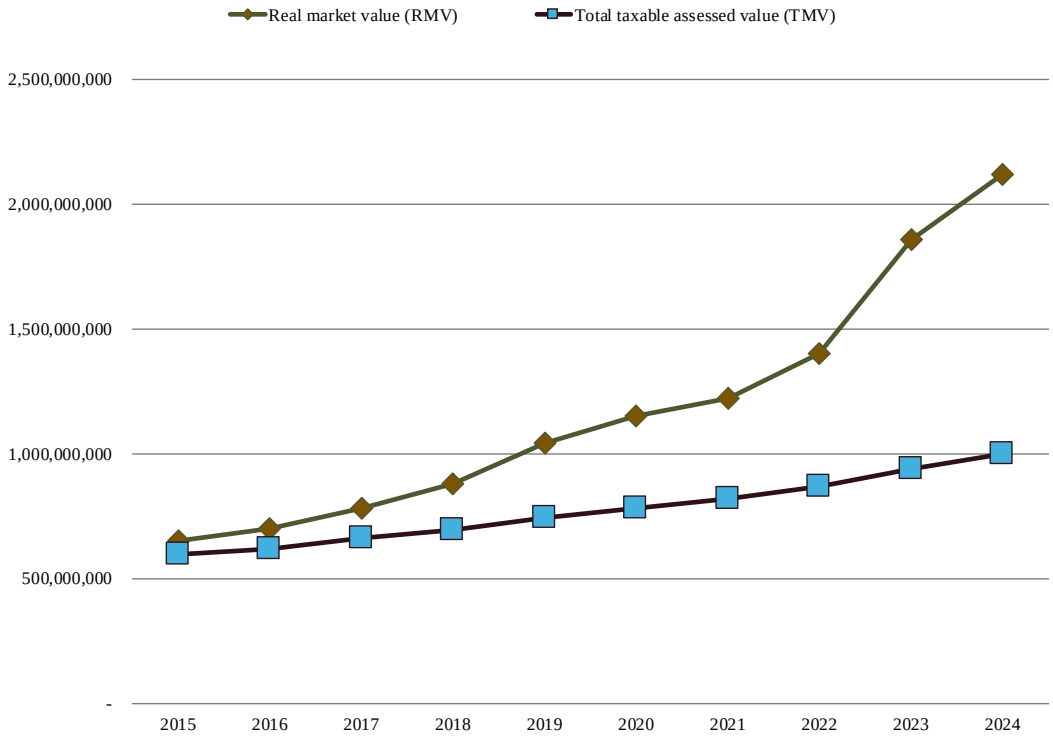
Fiscal year	Real property	Personal property	Manufactured property	Utility property	Total taxable assessed value (TMV)	Total direct tax rate	Real market value (RMV)	Assessed value as a % of real market value (RMV)
2015	552,573,421	21,488,831	2,999,145	17,852,000	594,913,397	3.0225	651,077,035	91.374%
2016	573,856,718	22,761,299	2,983,543	21,811,200	621,412,760	3.0225	698,143,446	89.009%
2017	609,351,601	25,730,561	3,669,789	20,968,800	659,720,751	3.0225	784,464,701	84.098%
2018	641,938,478	25,452,991	4,036,980	22,496,618	693,925,067	3.0225	877,909,589	79.043%
2019	686,225,060	27,945,603	5,116,303	23,106,200	742,393,166	3.0225	1,045,480,783	71.010%
2020	716,274,861	35,215,826	5,151,601	22,691,100	779,333,388	3.0225	1,152,433,106	67.625%
2021	753,435,303	33,579,676	5,601,395	29,856,100	822,472,474	3.0225	1,221,416,506	67.338%
2022	798,729,809	32,773,787	6,022,661	30,660,900	868,187,157	3.0225	1,403,649,949	61.852%
2023	861,061,983	36,200,504	6,248,100	34,321,400	937,831,987	3.0225	1,857,475,547	50.490%
2024	913,265,380	47,868,300	6,434,997	31,312,872	998,881,549	3.0225	2,120,199,355	47.113%

Source: Crook County Assessor.

Note: The City's permanent tax rate is $3.0225 per $1,000 of assessed value.

The debt service levy is set annually in the amount required to fulfill debt obligations and is the difference between the total direct tax rate and the permanent tax rate.

The City did not have an additional tax levy in FY 15 through FY 24.



City of Prineville

Property Tax Rates – Direct and Overlapping Governments

Unaudited

For the Last 10 Fiscal Years

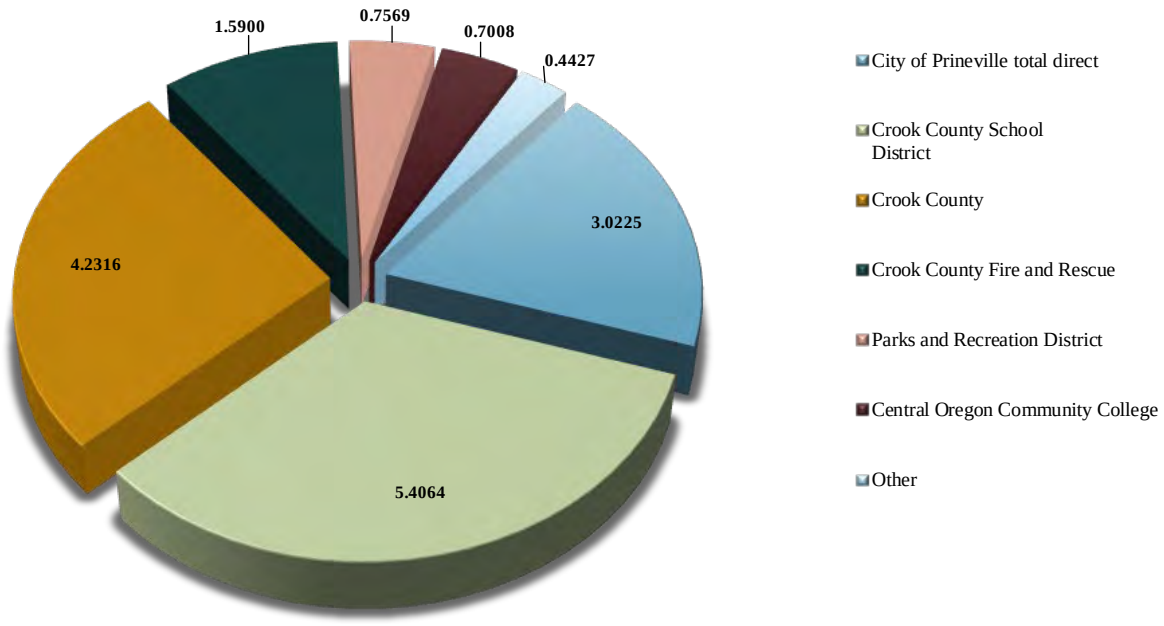
	City direct rates			Overlapping rates **						
Fiscal year	Permanent tax rate	Bond debt tax rate *	City of Prineville total direct	Crook County School District	Crook County	Crook County Fire and Rescue	Parks and Recreation District	Central Oregon Community College	Other	Total direct and overlapping rate
2015	3.0225	0.0000	3.0225	5.3817	4.5263	1.5900	0.7569	0.7400	0.6226	16.6400
2016	3.0225	0.0000	3.0225	5.5606	4.7052	1.5900	0.7569	0.7376	0.5754	16.9482
2017	3.0225	0.0000	3.0225	5.7504	4.1320	1.5900	0.7569	0.7425	0.4751	16.4694
2018	3.0225	0.0000	3.0225	5.7262	4.3765	1.5900	0.7569	0.7410	0.5035	16.7166
2019	3.0225	0.0000	3.0225	5.6630	4.2692	1.5900	0.7569	0.7318	0.4766	16.5100
2020	3.0225	0.0000	3.0225	5.6293	4.2551	1.5900	0.7569	0.7297	0.4853	16.4688
2021	3.0225	0.0000	3.0225	5.7045	4.2475	1.5900	0.7569	0.7240	0.4795	16.5249
2022	3.0225	0.0000	3.0225	5.7045	4.2475	1.5900	0.7569	0.7240	0.4795	16.5249
2023	3.0225	0.0000	3.0225	5.4064	4.2316	1.5900	0.7569	0.7008	0.4427	16.1509
2024	3.0225	0.0000	3.0225	5.4064	4.2316	1.5900	0.7569	0.7008	0.4427	16.1509

Source: Crook County Assessor's Office

** The bonded debt service levy is set annually in the amount required to fulfill debt obligations and is the difference between the total direct tax rate and the permanent rate.*

*** Overlapping rates are those of local and county governments that apply to property owners within the City of Prineville. All of the above overlapping rates apply to the City of Prineville.*

Property Tax Percentage Split by Government Type FY 24



City of Prineville

Principal Property Taxpayers

Unaudited

Current and Nine Years Ago

	FY 2024			FY 2015		
Taxpayer	Taxable assessed value *	Rank	Percentage of total city taxable assessed value **	Taxable assessed value *	Rank	Percentage of total city taxable assessed value **
LS Propdrop LLC (Les Schwab)	$ 22,058,770	1	2.208%	$ 21,605,273	1	3.877%
Property & Revenue Tax Manager (Pacificorp)	14,968,444	2	1.499%			
Apple Inc.	10,375,490	3	1.039%	5,254,909	4	0.943%
Harrison Industries LLC	8,322,580	4	0.833%			
ET 101 LLC (formally Contact Industries)	8,228,530	5	0.824%	15,448,807	2	2.772%
Vitesse LLC	8,125,500	6	0.813%			
Three Sisters Holdings LLC	5,543,120	7	0.555%			
Les Schwab Warehouse Center Inc	5,873,750	8	0.588%			
Colony Capital - Healthcare	5,583,730	9	0.559%			
Rickabaugh Construction	5,549,610	10	0.556%			
WG Prineville LLC				6,190,764	3	1.111%
New Systems Venture				4,460,446	5	0.800%
GA HC Reit II Prineville OR ALF LLC				4,203,450	6	0.754%
Amity Mtn. Development LLC				3,144,260	9	0.564%
Barney Brian and Laura				3,089,901	8	0.554%
Porfily Ventures Et al.				2,321,813	10	0.417%
Ochoco Lumber				3,182,161	7	0.571%
Total	$ 94,629,524		9.474%	$ 68,901,784		12.363%
City assessed value	$ 998,881,549			$ 557,331,328		

Purpose: This schedule provides the user with basic information about the City's most significant revenue payers and the degree of dependence on a small number of payers.

** Taxable assessed values only include property taxes with the City of Prineville city limits and are estimates based on records provided by Crook County and research through the property assessment taxation website at http://apps.lanecounty.org/PropertyAssessmentTaxationSearch/crook*

*** Percentage of total city taxable assessed value = taxable assessed value / city assessed value*

City of Prineville

Property Tax Levies and Collections

Unaudited

For the Last 10 Fiscal Years

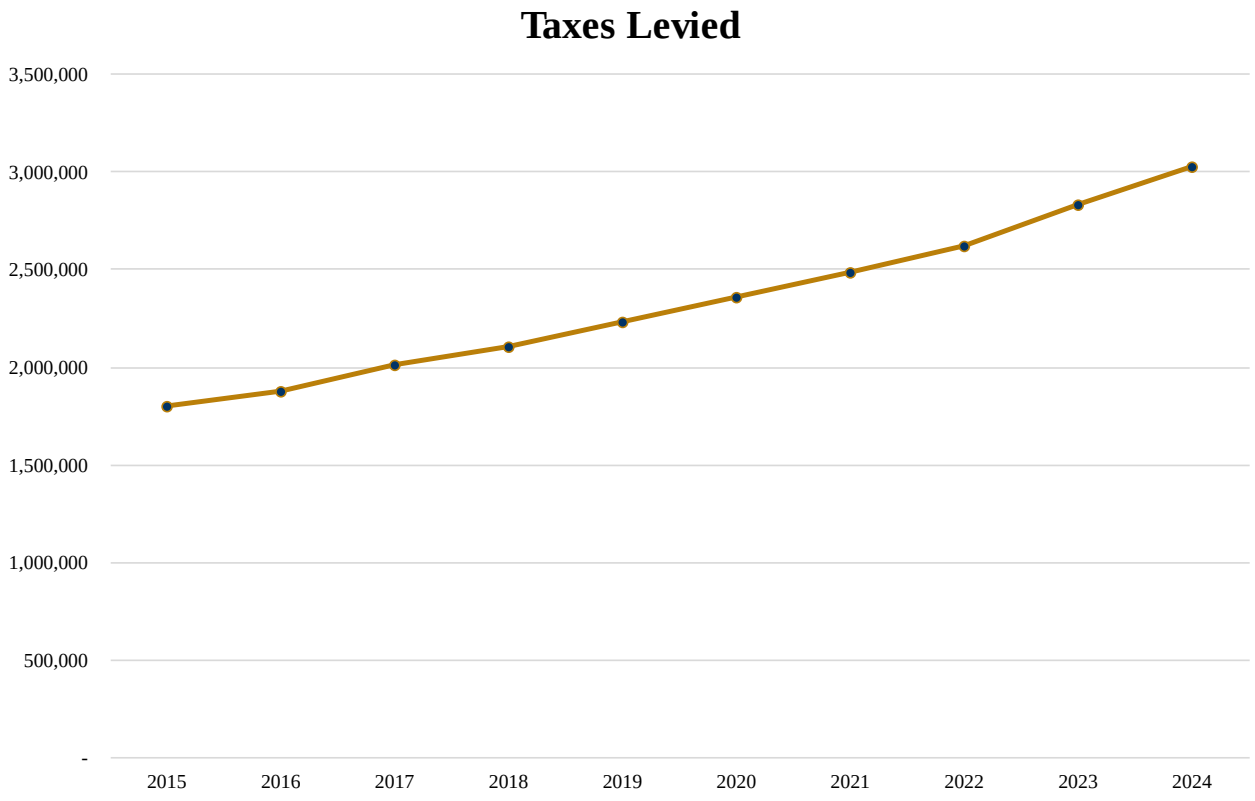
Fiscal year	Taxes levied for the fiscal year	Collected within the fiscal year of the levy		Collections in subsequent years	Total collections to date	
		Amount	Percentage of levy (a)		Amount	Percentage of levy (b)
2015	1,803,653	1,713,778	95%	67,520	1,781,298	99%
2016	1,880,116	1,783,248	95%	72,463	1,855,711	99%
2017	2,009,479	1,900,706	95%	74,411	1,975,117	98%
2018	2,106,576	2,006,116	95%	75,113	2,081,229	99%
2019	2,234,192	2,131,765	95%	71,400	2,203,165	99%
2020	2,358,978	2,239,654	95%	84,737	2,324,392	99%
2021	2,486,305	2,369,264	95%	47,851	2,417,115	97%
2022	2,624,096	2,512,738	96%	33,669	2,546,408	97%
2023	2,834,597	2,706,314	95%	34,445	2,740,759	97%
2024	3,026,476	2,859,104	94%	-	2,859,104	94%

Source: Annual financial statements of the City of Prineville and Crook County Assessor

(a) Property tax levy adjustments include discounts taken plus or minus roll adjustments. Property taxpayers are granted a statutory 3% discount when taxes are paid in full by the November 15th due date.

(b) Calculated as a percentage of the current year tax levy.

Purpose: Property taxes are the City's most significant own source of revenue. This schedule provides the user with basic information concerning property tax levy and collection ratios over time.



City of Prineville

Ratios of Outstanding Debt by Type

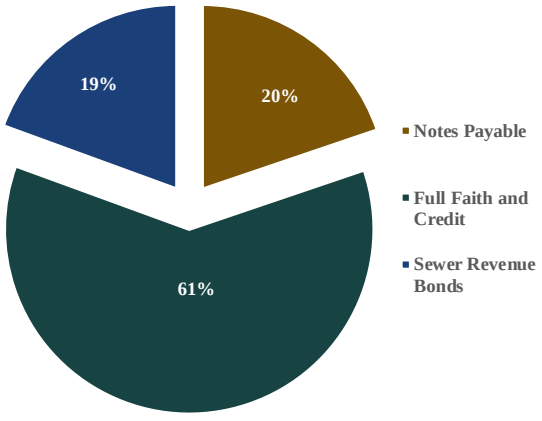
Unaudited

For the Last 10 Fiscal Years

	Governmental activities						
Fiscal year	General obligation bonds	Special assessment bonds	Leases & SBITA Payable (1)	State agencies	Notes payable	Full faith and credit obligations	Total governmental activities
2015	-	-	-	-	158,311	5,491,382	5,649,693
2016	-	-	-	-	129,824	5,257,078	5,386,902
2017	-	-	-	-	98,555	4,632,720	4,731,275
2018	-	-	-	-	66,508	4,775,466	4,841,974
2019	-	-	-	-	33,663	8,160,953	8,194,616
2020	-	-	-	-	-	9,977,799	9,977,799
2021	-	-	-	-	-	9,280,974	9,280,974
2022	-	-	117,873	-	184,940	8,551,997	8,854,810
2023	-	-	83,784	-	149,994	7,347,857	7,581,635
2024	-	-	55,665		114,056	6,659,081	6,828,801

	Business-type activities						
Fiscal year	Water revenue bonds	Sewer revenue bonds	Full faith and credit obligations	State agencies	Notes payable	Leases & SBITA Payable (1)	Total business-type activities
2014	465,000	6,105,534	7,915,000	-	349,860	-	14,835,394
2015	425,000	5,694,820	7,882,841	-	390,869	-	14,393,530
2016	380,000	5,271,942	7,672,589	-	228,406	-	13,552,937
2017	335,000	4,836,541	7,392,342	-	4,827,208	-	17,391,091
2018	-	4,388,244	5,315,000	-	4,857,331	-	14,560,575
2019	-	3,943,840	5,054,000	-	4,738,987	-	13,736,827
2020	-	3,886,136	4,713,000	-	4,211,116	-	12,810,252
2021	-	3,826,844	4,364,001	-	6,638,564	-	14,829,409
2022	-	3,765,923	6,752,304	-	3,649,165	-	14,167,391
2023	-	3,703,325	5,741,248	-	3,621,601	-	13,066,175
2024	-	3,639,007	4,723,389		3,593,762	-	11,956,158

	Total primary government		
Fiscal year	Total primary government	Percentage of income	Per capita
2014	20,753,928	5.32%	2,211
2015	20,043,223	4.96%	2,119
2016	18,939,839	4.60%	1,964
2017	22,122,366	7.36%	2,228
2018	19,402,549	6.12%	1,938
2019	21,931,443	6.46%	2,146
2020	22,788,051	6.09%	2,107
2021	24,110,383	6.13%	2,200
2022	23,022,201	4.89%	2,069
2023	20,647,810	3.27%	1,819
2024	18,784,959	2.49%	1,638



Source: Annual financial statements of the City of Prineville

Details regarding the City's outstanding debt can be found in the Management's Discussion and Analysis, the Notes to the Financial Statements, and the Other Financial Schedules sections of the report.

(1) GASB 87 Leases was implemented in FY 22 and GASB 96 for SBITA was implemented in FY 23

City of Prineville

Ratios of General Bonded Debt Outstanding

Unaudited

For the Last 10 Fiscal Years

Fiscal year	General bonded debt outstanding: Full faith and credit obligation bonds	General obligations	Limited tax improvement bonds	Total	Amounts restricted for debt service	Net general bonded debt outstanding	Assessed value	Ratio of bonded debt to assessed value	Population	General bonded debt per capita
2015	13,374,223	-	-	13,374,223	105,000	13,269,223	594,913,397	2.25%	9,385	1,425.06
2016	12,929,667	-	-	12,929,667	105,000	12,824,667	621,412,760	2.08%	9,645	1,340.56
2017	12,025,062	-	-	12,025,062	105,000	11,920,062	659,720,751	1.82%	9,928	1,211.23
2018	10,090,466	-	-	10,090,466	105,000	9,985,466	693,925,067	1.45%	10,010	1,008.04
2019	13,214,953	-	-	13,214,953	105,000	13,109,953	742,393,166	1.78%	10,220	1,293.05
2020	14,690,799	-	-	14,690,799	105,000	14,585,799	779,333,388	1.89%	10,335	1,421.46
2021	13,644,975	-	-	13,644,975	105,000	13,539,975	822,472,474	1.66%	11,042	1,235.73
2022	15,304,301	-	-	15,304,301	-	15,304,301	868,187,157	1.76%	11,126	1,375.54
2023	13,089,105	-	-	13,089,105	-	13,089,105	937,831,987	1.40%	11,351	1,153.12
2024	11,438,134	-	-	11,438,134	-	11,438,134	$ 998,881,549	1.15%	11,466	997.57

City of Prineville

Direct and Overlapping Debt

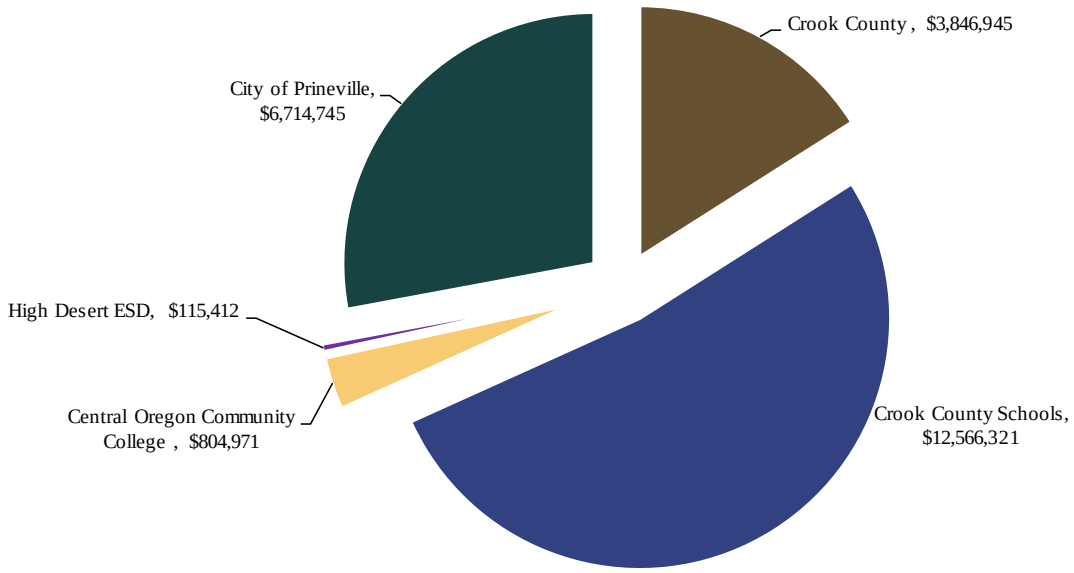
Unaudited

As of June 30, 2024

Governmental unit	Overlapping district real market value	Tax-supported debt outstanding	Estimated percentage applicable	Estimated share of overlapping bebt
Debt repaid with property taxes				
Crook County	$ 7,021,484,227	$ 12,740,000	30.20%	$ 3,846,945
Crook County Schools	7,056,723,799	41,825,000	30.05%	12,566,321
Central Oregon Community College	94,858,713,910	36,015,000	2.24%	804,971
High Desert ESD	88,580,357,034	4,821,899	2.39%	115,412
Crook County Fire and Rescue	6,656,765,121	516,839	31.85%	164,614
Subtotal Overlapping Debt	$ 204,174,044,091	$ 95,918,738		17,498,263
Direct debt outstanding:				
City of Prineville	2,120,199,355	6,714,745	100.00%	6,714,745
Total direct and overlapping debt				$ 24,213,009

Source: Oregon State Treasury Overlapping Debt report for the City of Prineville as of June 30, 2024 and annual financial statements from the City of Prineville

Direct and Overlapping Debt Applicable to the City of Prineville



City of Prineville

Legal Debt Margin Information

Unaudited

For the Last 10 Fiscal Years

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Debt limit	$ 19,532,311	$ 20,944,303	$ 23,533,941	$ 26,337,288	$ 31,364,423	$ 34,572,993	$ 36,642,495	$ 42,109,498	$ 55,724,266	$ 63,605,981
Total net debt applicable to limit	2,695,000	3,993,207	3,409,649	4,610,167	4,569,069	22,683,049	6,533,654	3,834,105	3,771,595	3,707,818
Debt margin	$ 16,837,311	$ 16,951,096	$ 20,124,292	$ 21,727,121	$ 26,795,354	$ 11,889,944	$ 30,108,841	$ 38,275,393	$ 51,952,671	$ 59,898,163
Total net debt applicable to the limit as a percentage of debt limit	13.8%	19.1%	14.5%	17.5%	14.6%	65.6%	17.8%	9.1%	6.8%	5.8%

Legal Debt Margin Calculation for Fiscal Year 2022

Total real market value of real estate within Prineville	2,120,199,355
Debt limitation - 3% of total real market value	3.0%
Legal debt limit	**$ 63,605,981**
Amount of debt applicable to debt limit	$ 18,784,959
Less debt excluded from debt limit:	
Full faith and credit obligations	$ (11,438,134)
Revenue bonds	$ (3,639,007)
Total general obligation bonded debt	$ 3,707,818
Less: amount held for repayment of principal	$ -
Net amount of debt applicable to debt limit	$ 3,707,818
Legal debt margin	**$ 59,898,163**

(1) Oregon Revised Statues (ORS) 287A.050 states: "Unless a lesser limitation upon the issuance of bonds has otherwise been provided by law or charter, no city shall issue or have outstanding at any one time bonds in excess of three percent of real market value of all taxable property within its boundaries, computed in accordance with ORS 308.207, after deducting for outstanding bonds such cash funds and sinking funds as are applicable to the payment of principal thereof."

(2) Oregon Revised Status (ORS) 287A.001(3) states: "Bonds" means (a) a contractual undertaking or instrument of a public body to repay borrowed moneys; (b) does not mean a credit enhancement device.

City of Prineville

Pledged Revenue Coverage

Unaudited

For the Last 10 Fiscal Years

Fiscal year ended June 30,	Gross revenues	Less direct operating expenses	Net revenue available for debt service	Debt service requirements			Coverage
				Principal	Interest	Total	
Wastewater							
2015	3,208,361	1,663,175	1,545,186	490,714	385,642	876,356	1.76
2016	3,952,199	1,731,903	2,220,296	507,878	358,767	866,645	2.56
2017	5,850,679	1,938,683	3,911,996	560,401	352,063	912,464	4.29
2018	9,251,289	2,035,973	7,215,316	6,709,395	380,877	7,090,272	1.02
2019	11,757,992	2,327,502	9,430,490	656,516	313,514	970,030	9.72
2020	3,823,007	2,639,268	1,183,739	719,100	290,572	1,009,672	1.17
2021	4,126,595	2,749,272	1,377,323	739,336	270,253	1,009,589	1.36
2022	4,357,392	4,058,261	299,131	5,704,474	193,343	5,897,817	0.05
2023	4,250,103	3,281,775	968,328	822,628	162,406	985,034	0.98
2024	4,766,124	3,543,962	1,222,162	827,484	151,408	978,892	1.25

Source: Annual financial statements of the City of Prineville

Fiscal year ended June 30,	Gross revenues	Direct operating expenses	Net revenue available for debt service	Debt service requirements			Coverage
				Principal	Interest	Total	
Water							
2015	2,183,160	1,423,363	759,797	140,000	135,541	275,541	2.76
2016	2,554,213	1,491,150	1,063,063	150,000	124,243	274,243	3.88
2017	2,597,543	1,645,144	952,399	160,000	118,676	278,676	3.42
2018	6,537,222	1,672,498	4,864,724	500,408	87,862	588,270	8.27
2019	8,522,709	2,367,439	6,155,270	101,990	60,818	162,808	37.81
2020	8,796,006	1,958,414	6,837,592	136,602	57,614	194,215	35.21
2021	3,547,702	2,231,162	1,316,540	140,293	53,958	194,251	6.78
2022	3,469,917	2,702,467	767,450	2,058,002	51,590	2,109,592	0.36
2023	4,567,116	3,327,740	1,239,376	160,194	97,823	258,018	4.80
2024	9,378,091	3,509,896	5,868,195	159,039	42,473	201,512	29.12

Source: Annual financial statements of the City of Prineville

City of Prineville

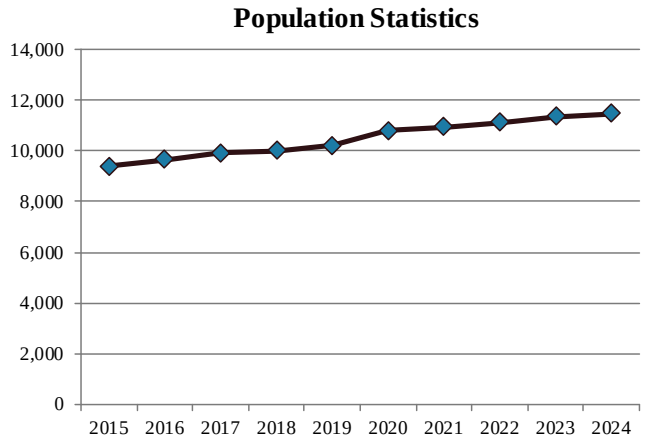
Demographic and Economic Statistics

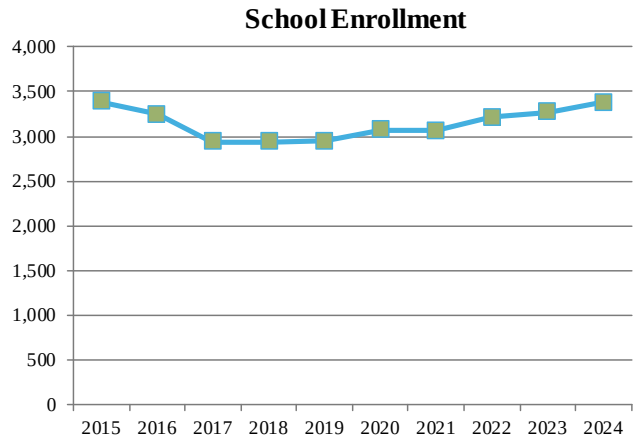
Unaudited

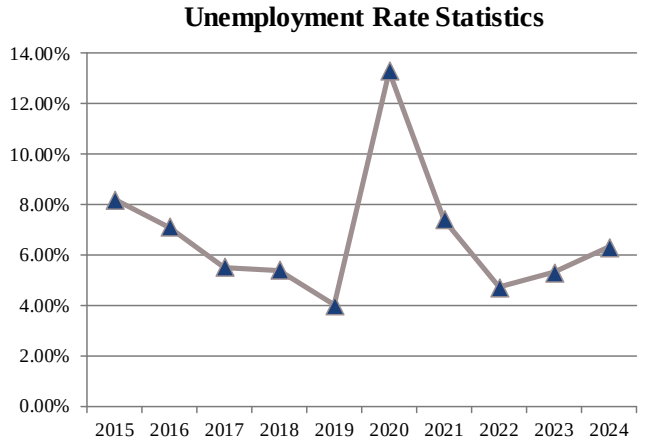
For the Last 10 Fiscal Years

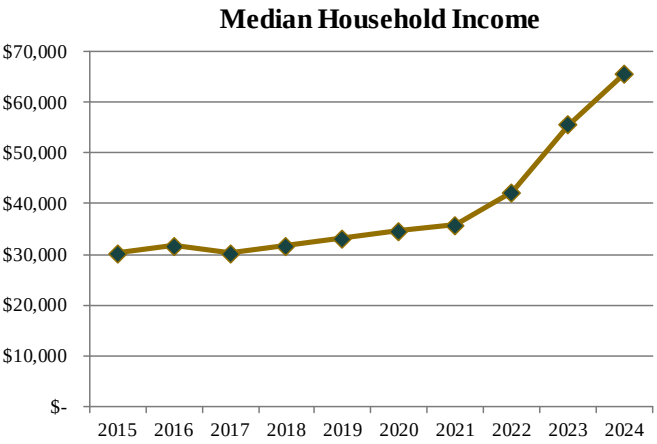
Fiscal year	Population	Total RMV	Median household income	School enrollment	Unemployment rate
2015	9,385	651,077,035	30,291	3,391	8.20%
2016	9,645	698,143,446	31,669	3,250	7.10%
2017	9,928	784,464,701	30,291	2,936	5.50%
2018	10,010	877,909,589	31,669	2,942	5.40%
2019	10,220	1,045,480,783	33,195	2,946	4.00%
2020	10,814	1,152,433,106	34,630	3,071	13.30%
2021	10,957	1,221,416,506	35,871	3,060	7.40%
2022	11,126	1,403,660,999	42,298	3,216	4.70%
2023	11,351	1,857,475,547	55,644	3,272	5.30%
2024	11,466	2,120,199,355	65,736	3,382	6.30%

Source: Crook County Assessor, Economic Development of Central Oregon, Portland State University Population Research Center, Business Oregon, State of Oregon Department of Education, State of Oregon Employment Department and the United States Census Bureau.









City of Prineville

Principal Employers

Unaudited

Current and Nine Years Ago

	2024			2015		
Employer	Employees	Rank	Percentage of Total Employment	Employees	Rank	Percentage of Total Employment
Meta Platforms, Inc. - Facebook Data Center	600	1	10.64%	157	7	4.13%
Crook County School District	556	2	9.86%	334	2	8.79%
Les Schwab Prineville Operations	464	3	8.23%	425	1	11.18%
Endura Products (formerly Contact Industries)	241	4	4.27%			
Crook County	233	5	4.13%	191	5	5.02%
St. Charles Health System	226	6	4.01%			
Ochoco National Forest	175	7	3.10%	178	6	4.68%
Bureau of Land Management	150	8	2.66%	156	8	4.10%
Western Heavy Haul & SMAF	120	9	2.13%	93	9	2.45%
City of Prineville	97	10	1.72%			
Contact Industries				225	3	5.92%
Pioneer Memorial Hospital				208	4	5.47%
Pioneer Cut Stock				64	10	1.68%
Total	2,862		50.75%	2,031		53.43%

Source: Economic Development of Central Oregon

City of Prineville

Full-time Equivalent City Government Employees by Function

Unaudited

For the Last 10 Fiscal Years

	Fiscal year ended									
Function / Program	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Public safety										
Police	18.7	19.1	19.4	19.4	21.4	21.2	22.7	23.0	24.0	26.0
Dispatch	9.1	10.4	11.1	10.8	10.8	10.8	11.3	11.3	11.3	13.3
Planning	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Public works										
Streets	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Water	-	-	-	-	-	-	-	-	-	-
Sewer	2.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0
PW administration	10.3	12.0	12.0	12.0	13.0	14.0	14.0	14.0	14.0	15.0
Railroad	3.0	3.0	3.0	4.0	3.0	4.0	4.0	4.0	4.0	4.0
Freight depot	-	-	-	-	-	-	-	-	-	-
Airport	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0
Golf	7.0	7.0	5.0	5.0	5.0	3.0	3.0	3.0	3.0	4.0
General government										
Administration	11.5	11.5	12.0	12.0	11.0	12.0	13.0	14.0	14.7	14.7
Total FTEs	67.56	69.97	69.47	70.16	70.16	71.00	74.00	76.30	78.00	84.00
City Population	9,385	9,645	9,928	10,010	10,220	10,814	10,957	11,126	11,351	11,466
FTEs per 1,000 of Population	7.20	7.25	7.00	7.01	6.86	6.57	6.75	6.86	6.87	7.33

Source: City of Prineville's Finance department and EDCO website (https://edcoinfo.com/communities/prineville/)

City of Prineville

Operating Indicators by Function

Unaudited

For the Last 10 Fiscal Years

	Fiscal year ended									
Function / Program	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Governmental activities:										
Public safety*										
Seatbelt	23	11	4	8	11	29	32	33	10	3
Speeding	33	17	26	20	36	13	11	47	45	18
Motor vehicle accidents/accidents	270	203	186	162	126	49	9	283	256	105
Community development										
Residential applications	54	76	134	119	129	109	138	152	89	75
Commercial applications	44	27	43	33	33	18	31	41	36	42
SDC fees collected	$ 592,466	$ 843,658	$ 652,333	$ 8,679,175	$ 11,439,765	$ 6,556,939	$ 2,863,827	$ 1,489,897	$ 1,385,753	$ 1,447,942
Business-type activities:										
Water										
Service connections	3,506	3,556	3,665	3,758	3,806	3,947	4,069	4,243	4,346	4,471
Average monthly consumption (units)	54,211	65,674	58,807	61,044	64,523	63,576	77,760	71,787	68,646	63,332
Water rates	$ 17.21	$ 17.73	$ 18.26	$ 18.81	$ 17.87	$ 18.23	$ 19.15	$ 19.53	$ 20.12	$ 20.72
Sanitary sewer										
Service connections	3,615	3,653	3,718	3,791	3,863	3,878	4,019	4,035	4,236	4,338
Average daily sewage treatment	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	1,167,118	1,230,000	1,258,917
Sewer rates	$ 49.70	$ 51.81	$ 53.73	$ 55.72	$ 52.93	$ 52.93	$ 52.93	$ 53.99	$ 55.61	$ 57.28
Golf										
Rounds of play	28,044	27,135	23,313	23,564	23,682	25,920	32,253	33,591	32,899	36,670
Pro shop sales	$ 98,716	$ 94,638	$ 90,725	$ 95,080	$ 110,868	$ 112,303	$ 165,224	$ 183,445	$ 213,972	$ 230,466
Railroad										
Freight revenue	$ 236,040	$ 339,255	$ 336,765	$ 306,355	$ 261,990	$ 262,037	$ 274,330	$ 268,447	$ 303,694	$ 348,779
Airport**										
Fuel sales	$ 507,296	$ 519,490	$ 427,078	$ 403,692	$ 488,283	$ 313,846	$ 468,630	$ 752,006	$ 692,661	$ 232,007

Source: City of Prineville Finance Department, City of Prineville Planning Department and City of Prineville Police Department

These are estimated statistics based upon the best historic information available.

**Public Safety records are based on a calendar year. The information for each FY reflects records for the previous calendar year (Jan 1 - Dec 31).*

***The Airport is a joint venture between the City and Crook County. The operating responsibilities were given to the City in September 2011.*

City of Prineville

Capital Asset Statistics by Activity

Unaudited

For the Last 10 Fiscal Years

	Fiscal year ended									
Activities	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Public Safety										
Station	1	1	1	1	1	1	1	1	1	1
Patrol vehicles	15	15	17	23	20	20	20	21	21	21
Streets										
Street (center lane miles)	56.9	56.9	56.9	57.7	57.7	57.7	57.7	58.9	59.0	59.3
Sidewalks	33.4	35.8	35.8	36.6	36.6	36.6	36.6	38.6	38.6	38.9
Water										
Lineal miles of system	48	48	48	48	48	48	48	80	80	80
Water capacity (MGD)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	9.00	9.2
ASR Treatment capacity (MGD)*							2.88	2.88	2.88	2.88
Sewer										
Lineal miles of system	44	44	44	44	44	48	48	65	65	65
Treatment capacity (MGD)	1.67	1.67	1.67	2.37	2.37	2.37	2.37	2.60	2.60	2.60
Railroad										
Diesel locomotives	4	4	4	4	4	4	4	3	3	4
Steam locomotives**	1	1	1	1	1	1	1	1	1	0
Cars	8	8	8	8	8	8	8	8	8	7
Main track (miles)	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01	18.01
Yard track (miles)	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46
Industrial track (miles)	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45
Transload facilities	2	2	2	2	2	2	2	2	2	2
Public team track (acres)	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	0
Airport***										
Runways	2	2	2	2	2	2	2	2	2	2
Terminal	1	1	1	1	1	1	1	1	1	1
Golf										
Club house	1	1	1	1	1	1	1	1	1	1
18 hole course	1	1	1	1	1	1	1	1	1	1

Source: Capital asset information provided by City of Prineville department heads.

** The ASR Treatment plant was put into service March 2021*

***The Mount Emily Shay #1 Steam Powered Locomotive was operated by the City of Prineville Railway starting in 1994, but is owned by the Oregon Historical Society. It was returned in FY 24.*

****The Prineville / Crook County Airport is a joint venture between the City and the County where the capital assets are owned by the County and the City employs the manager while the operations are leased to a third party. From 1998 to 2011, the Airport was governed by a five member commission created in an agreement between the City and County.*

Compliance Section

Independent Auditors' Report Required by State of Oregon Regulations

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City of Prineville

Independent Auditors' Report Required by State of Oregon Regulations

Year Ended June 30, 2024

PAULY, ROGERS, AND CO., P.C.
12700 SW 72nd Ave. ♦ Tigard, OR 97223
(503) 620-2632 ♦ (503) 684-7523 FAX
www.paulyrogersandcocpas.com

December 9, 2024

Independent Auditors' Report Required by Oregon State Regulations

We have audited the basic financial statements of the City of Prineville as of and for the year ended June 30, 2024, and have issued our report thereon dated December 9, 2024. We conducted our audit in accordance with auditing standards generally accepted in the United States of America and Government Auditing Standards.

Compliance

As part of obtaining reasonable assurance about whether the City of Prineville' financial statements are free of material misstatement, we performed tests of its compliance with certain provisions of laws, regulations, contracts, and grants, including the provisions of Oregon Revised Statues as specified in Oregon Administrative Rules 162-10-000 through 162-10-320 of the Minimum Standards for Audits of Oregon Municipal Corporations, noncompliance with which could have a direct and material effect on the determination of financial statements amounts. However, providing an opinion on compliance with those provisions was not an objective of our audit, and accordingly, we do not express such an opinion.

We performed procedures to the extent we considered necessary to address the required comments and disclosures which included, but were not limited to the following:

- **Deposit of public funds with financial institutions (ORS Chapter 295)**
- **Indebtedness limitations, restrictions and repayment.**
- **Budgets legally required (ORS Chapter 294).**
- **Insurance and fidelity bonds in force or required by law.**
- **Highway revenues used for public highways, roads, and streets.**
- **Authorized investment of surplus funds (ORS Chapter 294).**
- **Public contracts and purchasing (ORS Chapters 279A, 279B, 279C).**
- **Programs funded from outside sources**

In connection with our testing nothing came to our attention that caused us to believe the City of Prineville was not in substantial compliance with certain provisions of laws, regulations, contracts, and grants, including the provisions of Oregon Revised Statutes as specified in Oregon Administrative Rules 162-10-000 through 162-10-320 of the Minimum Standards for Audits of Oregon Municipal Corporations.

OAR 162-10-0240 Internal Control

In planning and performing our audit, we considered the internal controls over financial reporting as a basis for designing our auditing procedures for the purpose of expressing our opinions on the financial statements, but not for the purpose of expressing an opinion on the effectiveness of the internal control over financial reporting. Accordingly, we do not express an opinion on the effectiveness of the internal controls over financial reporting.

City of Prineville

Independent Auditors' Report Required by State of Oregon Regulations

Year Ended June 30, 2024

Independent Auditors' Report Required by Oregon State Regulations

This report is intended solely for the information and use of the council members and management and the Oregon Secretary of State and is not intended to be and should not be used by anyone other than these parties.

Kenneth Allen, CPA
Municipal Auditor
PAULY, ROGERS AND CO., P.C.

City of Prineville

Schedule of Expenditures of Federal Awards

Year Ended June 30, 2024

City of Prineville
SCHEDULE OF EXPENDITURES OF FEDERAL AWARDS
For the Year Ended June 30, 2024

Program Title	Federal Assistance Listing Number	Pass-Through Organization	Identifying Number	Year to Date Disbursements / Expenditures	Passed Through to Subrecipients
US Department of Agriculture					
Federal Financial Assistance Award of Domestic Grant					
Infrastructure and Investment Jobs Act Financial Assistance					
to Facilities that Purchase and Process Byproducts for Ecosystem Restoration					
7/1/2023 - 6/30/2024	10.725	Direct	23-DG-11062765-092	538,500	-
Natural Resources Conservation Service					
Cooperative Agreement					
7/1/23 - 6/30/23	10.904	Ochoco Irrigation District	NR200436XXXXC010	41,620	
Total USDA				580,120	$ -
US Environmental Protection Agency					
Congressionally Mandated Projects					
EPA Mandatory Grant Programs					
7/01/2023-6/30/2024	66.202	Direct	CG - 02J32101 - 0	648,404	-
Total US EPA				648,404	$ -
US Department of Transportation					
National Highway Traffic Safety Administration					
Statewide Distracted Driving Overtime Enforcement Campaign					
10/1/2023 - 6/30/2024	20.616	Oregon Impact	69A3752240000405EORC	1,573	
7/01/2023-9/30/2023	20.616	Oregon Impact	69A3752030000405EORC	999	
Driving Under the Influence of Intoxicants Overtime Enforcement Campaign					
10/1/2023 - 6/30/2024	20.616	Oregon Impact	69A3752240000405DORM	2,216	
7/01/2023-9/30/2023	20.616	Oregon Impact	69A3752030000405DORM	2,131	
Safety Belt Traffic Enforcement					
10/1/2023 - 6/30/2024	20.616-405b	Oregon Department of Transportation	69A3752240000405BORH	958	
7/01/2023-9/30/2023	20.616-405b	Oregon Department of Transportation	69A3752230000405BORH	958	
Speed Overtime Enforcement					
10/1/2023 - 6/30/2024	20.600	Oregon Impact	69A37522400004020ORO	2,752	
7/01/2023-9/30/2023	20.600	Oregon Impact	69A375203000040200RO	1,068	
Federal Transit Administration					
49 USC 5310					
7/1/2023 - 6/30/2024	20.513 (5310)	Oregon Department of Transportation	OR-2023-025	94,020	94,020
Total US Department of Transportation				106,676	94,020
US Department of Justice					
Patrick Leahy Bulletproof Vest Partnership Program					
7/1/2023 - 6/30/2024	16.607	Direct	382007001	3,920	
Total US Department of Justice				3,920	$ -
			Total	1,339,119	$ 94,020

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City of Prineville

Independent Auditors' Report on Internal Control Over Financial Reporting and on Compliance and Other Matters Based on an Audit of Financial Statements Performed in Accordance With Government Auditing Standards

Year Ended June 30, 2024

PAULY, ROGERS, AND CO., P.C.
12700 SW 72nd Ave. ♦ Tigard, OR 97234
(503) 620-2632 ♦ (503) 684-7524 FAX
www.paulyrogersandcocpas.com

December 9, 2024

To the City Council
City of Prineville, Oregon

INDEPENDENT AUDITORS' REPORT ON INTERNAL CONTROL OVER FINANCIAL REPORTING AND ON COMPLIANCE AND OTHER MATTERS BASED ON AN AUDIT OF FINANCIAL STATEMENTS PERFORMED IN ACCORDANCE WITH *GOVERNMENT AUDITING STANDARDS*

We have audited, in accordance with the auditing standards generally accepted in the United States of America and the standards applicable to financial audits contained in *Government Auditing Standards* issued by the Comptroller General of the United States, the financial statements of the governmental activities, the business-type activities, each major fund, and the aggregate remaining fund information of City of Prineville as of and for the year ended June 30, 2024, and the related notes to the financial statements, which collectively comprise the basic financial statements, and have issued our report thereon dated December 9, 2024.

Report on Internal Control over Financial Reporting

In planning and performing our audit of the financial statements, we considered the internal control over financial reporting (internal control) as a basis for designing audit procedures that are appropriate in the circumstances for the purpose of expressing our opinions on the financial statements, but not for the purpose of expressing an opinion on the effectiveness of internal control. Accordingly, we do not express an opinion on the effectiveness of internal control.

A *deficiency in internal control* exists when the design or operation of a control does not allow management or employees, in the normal course of performing their assigned functions, to prevent, or detect and correct, misstatements on a timely basis. A *material weakness* is a deficiency, or a combination of deficiencies, in internal control, such that there is a reasonable possibility that a material misstatement of the financial statements will not be prevented, or detected and corrected, on a timely basis.

A *significant deficiency* is a deficiency, or a combination of deficiencies, in internal control that is less severe than a material weakness, yet important enough to merit attention by those charged with governance.

Our consideration of internal control was for the limited purpose described in the first paragraph of this section and was not designed to identify all deficiencies in internal control that might be material weaknesses or significant deficiencies. Given these limitations, during our audit we did not identify any deficiencies in internal control that we consider to be material weaknesses. However, material weaknesses or significant deficiencies may exist that have not been identified.

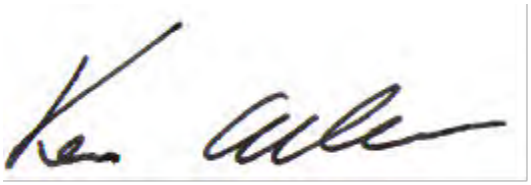
Report on Compliance and Other Matters

As part of obtaining reasonable assurance about whether the financial statements are free from material misstatement, we performed tests of compliance with certain provisions of laws, regulations, contracts, and grant agreements, noncompliance with which could have a direct and material effect on the financial statements.

However, providing an opinion on compliance with those provisions was not an objective of our audit, and accordingly, we do not express such an opinion. The results of our tests disclosed no instances of noncompliance or other matters that are required to be reported under *Government Auditing Standards*.

Purpose of this Report

The purpose of this report is solely to describe the scope of our testing of internal control and compliance and the results of that testing, and not to provide an opinion on the effectiveness of the internal control or on compliance. This report is an integral part of an audit performed in accordance with *Government Auditing Standards* in considering the internal control and compliance. Accordingly, this communication is not suitable for any other purpose.



Kenneth Allen, CPA
Municipal Auditor
PAULY, ROGERS AND CO., P.C

City of Prineville

Independent Auditors' Report on Compliance for Each Major Program and on Internal Control Over Compliance Required by the Uniform Guidance

Year Ended June 30, 2024

PAULY, ROGERS, AND CO., P.C.
12700 SW 72nd Ave. ♦ Tigard, OR 97234
(503) 620-2632 ♦ (503) 684-7524 FAX
www.paulyrogersandcocpas.com

December 9, 2024

To the City Council
City of Prineville, Oregon

INDEPENDENT AUDITORS' REPORT ON COMPLIANCE FOR EACH MAJOR PROGRAM AND ON INTERNAL CONTROL OVER COMPLIANCE REQUIRED BY THE UNIFORM GUIDANCE

Report on Compliance for Each Major Federal Program

Opinion on Each Major Federal Program

We have audited City of Prineville's compliance with the types of compliance requirements identified as subject to audit in the *OMB Compliance Supplement* that could have a direct and material effect on each of the major federal programs for the year ended June 30, 2024. The major federal programs are identified in the summary of auditors' results section of the accompanying schedule of findings and questioned costs.

In our opinion, City of Prineville complied, in all material respects, with the types of compliance requirements referred to above that could have a direct and material effect on each of its major federal programs for the year ended June 30, 2024.

Basis for Opinion on Each Major Federal Program

We conducted our audit of compliance in accordance with auditing standards generally accepted in the United States of America; the standards applicable to financial audits contained in *Government Auditing Standards*, issued by the Comptroller General of the United States; and the audit requirements of Title 2 U.S. Code of Federal Regulations Part 200, Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance). Our responsibilities under those standards and the Uniform Guidance are further described in the Auditors' Responsibilities for the Audit of Compliance section of our report.

We are required to be independent of City of Prineville and to meet our other ethical responsibilities, in accordance with relevant ethical requirements relating to our audit. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion on compliance for each major federal program. Our audit does not provide a legal determination of compliance with the compliance requirements referred to above.

Responsibilities of Management for Compliance

Management is responsible for compliance with the requirements referred to above and for the design, implementation, and maintenance of effective internal control over compliance with the requirements of laws, statutes, regulations, rules, and provisions of contracts or grant agreements applicable to its federal programs.

Auditors' Responsibilities for the Audit of Compliance

Our objectives are to obtain reasonable assurance about whether material noncompliance with the compliance requirements referred to above occurred, whether due to fraud or error, and express an opinion on compliance based on our audit. Reasonable assurance is a high level of assurance but is not absolute assurance and therefore is not a guarantee that an audit conducted in accordance with generally accepted auditing standards, *Government Auditing Standards*, and the Uniform Guidance will always detect material noncompliance when it exists. The risk of not detecting material noncompliance resulting from fraud is higher than for that resulting from error, as

fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control. Noncompliance with the compliance requirements referred to above is considered material if there is a substantial likelihood that, individually or in the aggregate, it would influence the judgment made by a reasonable user of the report on compliance about compliance with the requirements of each major federal program as a whole.

In performing an audit in accordance with generally accepted auditing standards, *Government Auditing Standards*, and the Uniform Guidance, we:

- Exercise professional judgment and maintain professional skepticism throughout the audit.
- Identify and assess the risks of material noncompliance, whether due to fraud or error, and design and perform audit procedures responsive to those risks. Such procedures include examining, on a test basis, evidence regarding compliance with the compliance requirements referred to above and performing such other procedures as we considered necessary in the circumstances.
- Obtain an understanding of internal control over compliance relevant to the audit in order to design audit procedures that are appropriate in the circumstances and to test and report on internal control over compliance in accordance with the Uniform Guidance, but not for the purpose of expressing an opinion on the effectiveness of internal control over compliance. Accordingly, no such opinion is expressed.

We are required to communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and any significant deficiencies and material weaknesses in internal control over compliance that we identified during the audit.

Report on Internal Control over Compliance

A *deficiency in internal control over compliance* exists when the design or operation of a control over compliance does not allow management or employees, in the normal course of performing their assigned functions, to prevent, or detect and correct, noncompliance with a type of compliance requirement of a federal program on a timely basis. A *material weakness in internal control over compliance* is a deficiency, or combination of deficiencies, in internal control over compliance, such that there is a reasonable possibility that material noncompliance with a type of compliance requirement of a federal program will not be prevented, or detected and corrected, on a timely basis. A *significant deficiency in internal control over compliance* is a deficiency, or a combination of deficiencies, in internal control over compliance with a type of compliance requirement of a federal program that is less severe than a material weakness in internal control over compliance, yet important enough to merit attention by those charged with governance.

Our consideration of internal control over compliance was for the limited purpose described in the Auditors' Responsibilities for the Audit of Compliance section above and was not designed to identify all deficiencies in internal control over compliance that might be material weaknesses or significant deficiencies in internal control over compliance. Given these limitations, during our audit we did not identify any deficiencies in internal control over compliance that we consider to be material weaknesses, as defined above. However, material weaknesses or significant deficiencies in internal control over compliance may exist that were not identified.

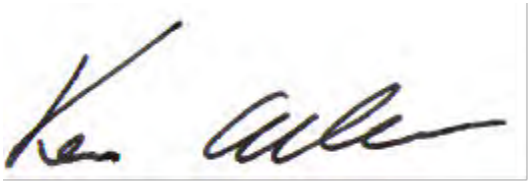
Our audit was not designed for the purpose of expressing an opinion on the effectiveness of internal control over compliance. Accordingly, no such opinion is expressed.

City of Prineville

Independent Auditors' Report on Compliance for Each Major Program and on Internal Control Over Compliance Required by the Uniform Guidance

Year Ended June 30, 2024

The purpose of this report on internal control over compliance is solely to describe the scope of our testing of internal control over compliance and the results of that testing based on the requirements of the Uniform Guidance. Accordingly, this report is not suitable for any other



Kenneth Allen, CPA
Municipal Auditor
PAULY, ROGERS AND CO., P.C

City of Prineville
SCHEDULE OF FINDINGS AND QUESTIONED COSTS
For the Year Ended June 30, 2024

SECTION I – SUMMARY OF AUDITORS' RESULTS

FINANCIAL STATEMENTS

Type of auditors' report issued:	Unmodified			
Internal control over financial reporting:				
Material weakness(es) identified?	☐	yes	☒	no
Significant deficiency(s) identified that are not considered to be material weaknesses?	☐	yes	☒	none reported
Noncompliance material to financial statemetns noted?	☐	yes	☒	no
Any GAGAS audit findings disclosed that are required to be reported reported in accordance with section 515(d)(2) of the Uniform Guidance?	☐	yes	☒	no

FEDERAL AWARDS

Internal control over major programs:				
Material weakness(es) identified?	☐	yes	☒	no
Significant deficiency(s) identified that are not considered to be material weaknesses?	☐	yes	☒	none reported
Type of auditors' report issued on compliance for major programs:	Unmodified			
Any audit findings disclosed that are required to be reported in accordance with section 200.516(a) of the Unifrom Guidance?	☐	yes	☒	no

IDENTIFICATION OF MAJOR PROGRAMS

CFDA NUMBER	NAME OF FEDERAL PROGRAM CLUSTER
66.202	Congressionally Mandated Projects

Dollar threshold used to distinguish between type A and B programs	$750,000			
Auditee qualified as low-risk auditee?	☒	yes	☐	no

City of Prineville

Schedule of Findings and Questioned Costs

For the Year Ended June 30, 2024

SECTION II – FINANCIAL STATEMENT FINDINGS

None

SECTION III – FEDERAL AWARD FINDINGS AND QUESTIONED COSTS

None

NOTES TO THE SCHEDULE OF EXPENDITURES OF FEDERAL EXPENDITURES

1. BASIS OF PRESENTATION

The accompanying schedule of expenditures of federal awards includes federal grant activity under programs of the federal government. The information in this schedule is presented in accordance with the audit requirements of Title 2 U.S. Code of Federal Regulations Part 200, Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance). Because the schedule presents only a selected portion of the operations, it is not intended to and does not present the net position, changes in net position, or cash flows of the entity.

2. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Expenditures reported on the schedule are reported on the modified accrual basis of accounting. Such expenditures are recognized following the cost principles contained in the Uniform Guidance, wherein certain types of expenditures are not allowed or are limited as to reimbursement. Negative amounts shown on the schedule represent adjustments or credits made in the normal course of business to amounts reported as expenditures in prior years. The entity has elected to use the ten percent de minimus indirect cost rate as allowed under Uniform Guidance.

3. FEDERAL LOAN PROGRAMS

The federal loan programs listed subsequently are administered directly by the entity and balances and transactions relating to the programs are included in the entity's basic financial statements. Loans outstanding at the beginning of the year and loans made during the year are included in the federal expenditures presented in the schedule. The balance of loans outstanding as of June 30, 2024 consists of:

CFDA Number	Program Name	Outstanding Balance at 6/30/2024
10.760	Water and Waste Disposal Systems for Rural Communities	$ 3,639,007

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Left blank intentionally

CITY OF
PRINEVILLE
OREGON

FOREVER COUNTRY
PRINEVILLE
CROOK COUNTY CHAMBER & VISITOR CENTER
(https://prinevillechamber.com)

Economic Development

ECONOMIC DEVELOPMENT

WHY PRINEVILLE?

8 REASONS TO DO BUSINESS IN PRINEVILLE, OREGON

Founded in 1981, EDCO is a non-profit corporation supported by private and public members and stakeholders. Our mission is to create a balanced and diverse local economy and strong base of middle class jobs in Central Oregon. To do this we help companies MOVE, START, and GROW here.

Access to regional workforce. Close to geographic center of the region and state as a whole.

Home to national data centers. Find out why Facebook and Apple chose Prineville.

Access to major highway system. Direct transportation connections to border states and newly paved commercial trucking routes.

Access to multi-modal freight. Prineville owns and operates one of the few city-owned railroads in the country with access to two class 1 railroads (Burlington Northern Santa Fe & Union Pacific).

Incentive programs for growing and relocating businesses. Tax al
low cost industrial land, fast-track permitting and fee reductions.

Favorable business costs. Competitive power, lease, wage and tax rates.

Prineville Chamber
Hey there, how can I help you?

Quality of life. Boating, camping, fishing, golfing, hiking, horseback riding, hunting, rock climbing, skiing, swimming, tennis and rafting all within 30 minutes.

Recent investments in education & healthcare. Career and technical training in manufacturing at Crook County High School, newly constructed Central Oregon Community College/Oregon State University Open Campus and new easily accessible St. Charles Health System facility.

WORK WITH EDCO

KELSEY LUCAS

Prineville/Crook County Director,
Economic Development for Central Oregon

kelsey@edcoinfo.com (mailto:kelsey@edcoinfo.com)

541.233.2015 (tel:541.233.2015)

edcoinfo.com (https://edcoinfo.com)

EDCO MOVE START GROW

PRINEVILLE

(https://edcoinfo.com/)

2022 Prineville/Crook County Economic Profile
()

(https://prinevillechamber.com)

© 2024 PRINEVILLE CROOK-COUNTY CHAMBER OF COMMERCE & VISITOR CENTER | PRIVACY & LEGAL (HTTPS://PRINEVILLECHAMBER.COM/PRIVACY-POLICY/) | WEBSITE BY WILD CRITTER MEDIA (HTTPS://WWW.WILDCRITTERMEDIA.COM/) |

City of Prineville - Child Care Fact Sheet

Quality child care during a child's early years of development increases their school readiness, and provides a solid foundation for a their later academic and behavioral success. Access to child care also results in increased workforce participation, particularly with women. Research confirms that greater economic development and more livable communities occur in areas where child care is in sufficient supply.

As Central Oregon continues to experience population growth, the need for increased quantity, quality and cultural responsiveness in child care grows significantly. Families need affordable and accessible child care. There is also a growing need for child care that offers non-traditional hours, is culturally and linguistically appropriate, and provides inclusion of special needs.

Demand grows while supply is limited. Nearly 2/3 of Oregon children have one or both parents employed. (OSU-2018) Yet, only 16% of children in Oregon under age 13 have access to child care. (OSU-2018). 26% of Oregon parents report that child care issues affect their employment. (Kids Count 2012) In 2018, 45% of parents in the United States report missing work due to child care issues, resulting in an average of approximately 8.6 days of work missed annually. That translates to $28.9 billion in wages lost by families nationwide that do not have access to paid leave and affordable child care. (ChildCare Aware)

Our community falls short, meeting only 17% of child care demand for children ages 0-5. As a county, we do worse, with an insufficient supply of only 15% of child care demand for children 0-5 years. In Crook County, with city population expected to continue to grow, and with minimal growth in child care providers; we have become a child care desert. This is an area with so few child care options that there are more than three times as many children as there are child care slots available.

This child care crisis is due to various barriers and limitations. Some problematic issues have been identified to include the following:

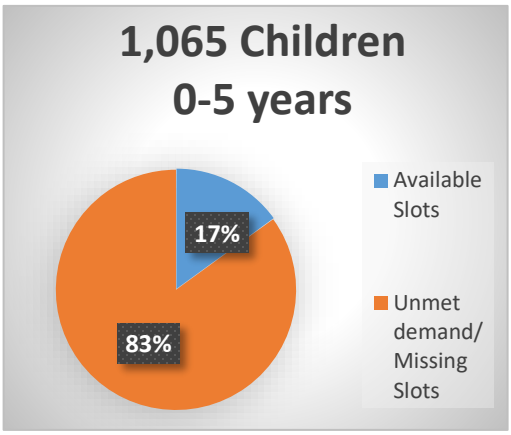
1. **Land**
    - Lack of availability.
    - Cost of land is not affordable.
    - Prohibitive city/county building costs.
    - Building/zoning limitations.

2. **Labor**
    - High attrition rate due to profession demands.
    - Child Care field does not provide a living wage.
    - Providers with increased professional development/education leave field for higher income employment.
    - Child Care providers lack professional development and business education.
    - Market failure (failure of market to efficiently allocate resources) due to spillover benefits. Child care providers can't charge more, and parents can't afford to pay more.

3. **Capital**
    - Expenses are high, while profits are low.
    - State subsidy reimbursement rates are low.

Child Care Supply & Demand

City of Prineville



Supply-

14 total child care providers (Child Care Resource & Referral Naccrraware - September 2018)

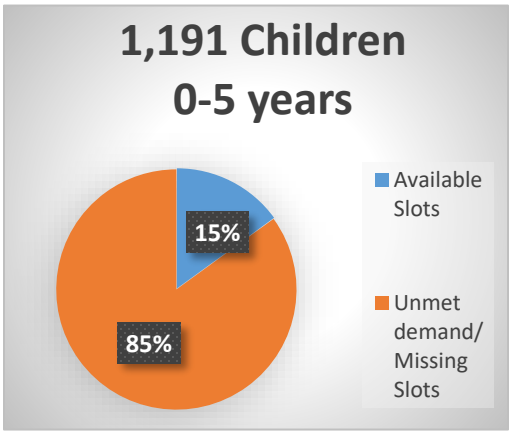
(Including Certified Child Care Centers, Certified and Registered Family Child Care, and Exempt Child Care. **Excluding** Preschool and School Aged programs)

180 available slots (Child Care Resource & Referral Naccrraware (-September 2018)

Demand-

Approx. 1,065 children **0-5** years (213 enrolled kindergarteners multiplied by 5 to determine estimate of 0-5 child population. Crook County School District - September 2018)

Crook County



Supply-

14 total child care providers (Child Care Resource & Referral Naccrraware-September 2018) (Including Certified Child Care Centers, Certified and Registered Family Child Care, and Exempt Child Care. **Excluding** Preschool, Head Start and School-aged programs)

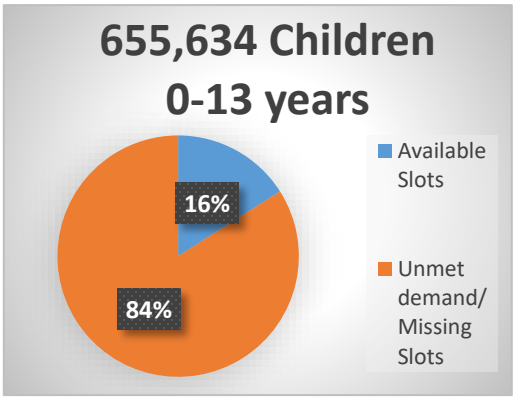
180 desired child capacity/available slots (Child Care Resource & Referral Naccrraware-September 2018)

Demand-

655 children **0-2** years (OSU Early Care & Education Profiles using PSU Center for Population Research-August 2018)

436 children **3-5** years (OSU Early Care & Education Profiles using PSU Center for Population Research-August 2018)

State of Oregon



Supply-

4,669 total child care providers (Child Care Resource & Referral Naccrraware-September 2018) (Including Certified Child Care Centers, Certified and Registered Family Child Care, and Exempt Child Care. **Including** Preschool, Head Start and School-aged programs)

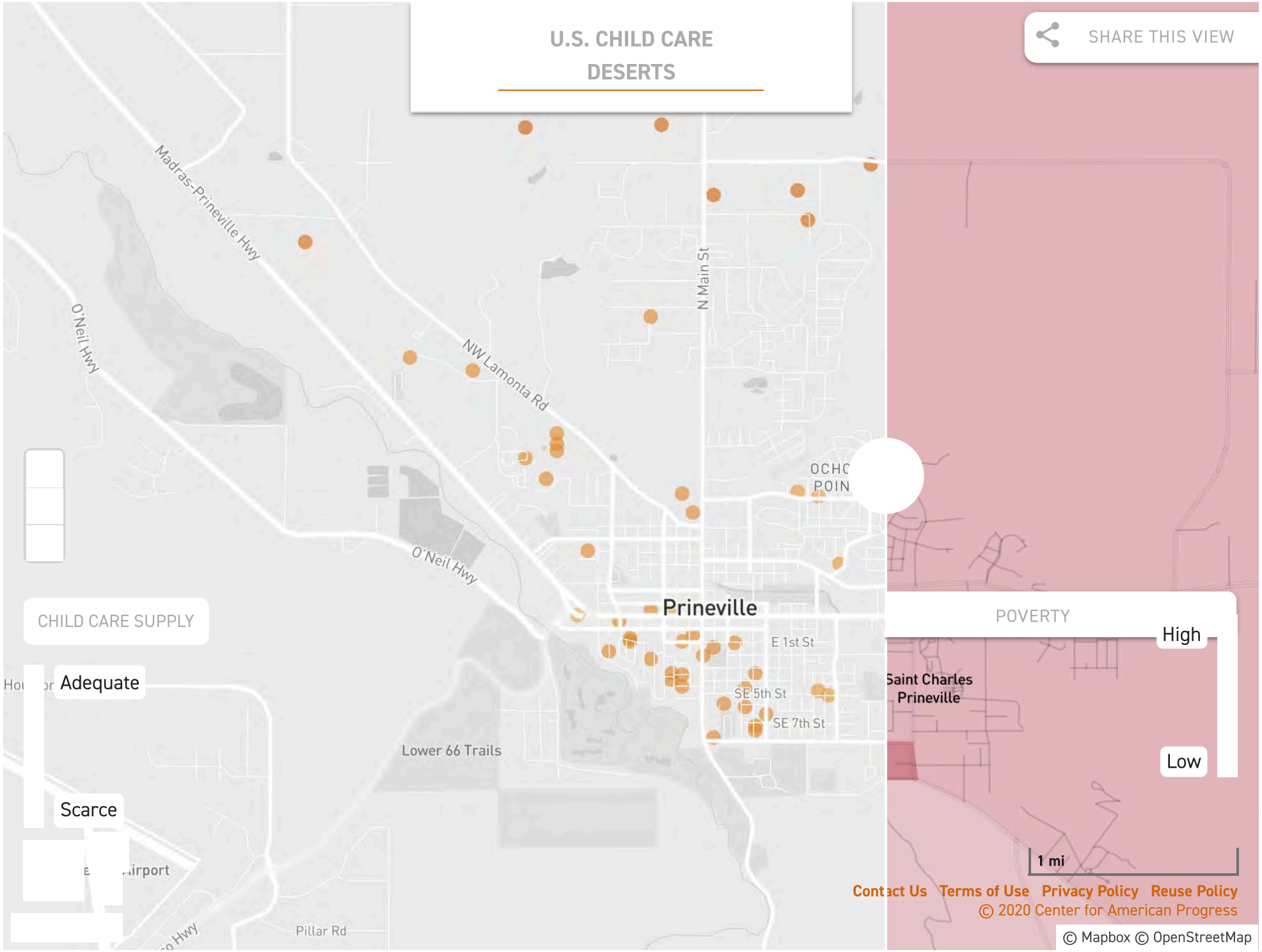
107,269 available slots (OSU-August 2018)

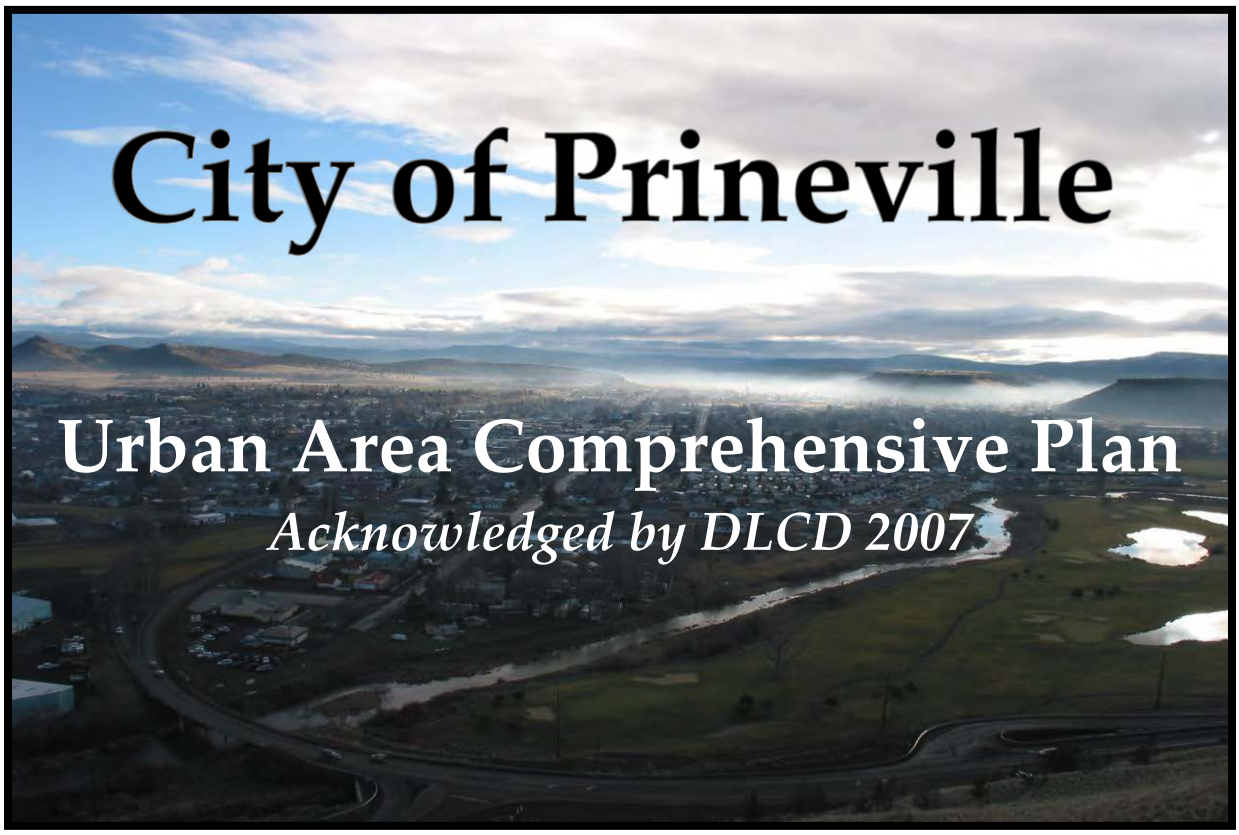
Demand-

153,383 children **0-2** years (OSU-August 2018)

102,255 children **3-5** years (OSU-August 2018)

655,634 children **0-13** years (OSU-August 2018)


U.S. CHILD CARE DESERTS
SHARE THIS VIEW
Madras-Prineville Hwy
O'Neil Hwy
NW Lamonta Rd
N Main St
O'Neil Hwy
Prineville
E 1st St
SE 5th St
SE 7th St
Lower 66 Trails
Pillar Rd
CHILD CARE SUPPLY
Adequate
Scarce
POVERTY
High
Low
Saint Charles
Prineville
1 mi
Contact Us
Terms of Use
Privacy Policy
Reuse Policy
© 2020 Center for American Progress
© Mapbox © OpenStreetMap



The Original Chapters of the Plan incorporates citizen, joint Planning Commissions, City Council, County Staff and other agency comments collected in 2004-2007. Subsequent updates to individual Chapters incorporated their own public process at that time.

Special Note: *This is Prineville's first individual Comprehensive Plan ("Plan"). Currently, the Crook County Comprehensive Plan covers the City. The City began the task to develop its own Comprehensive Plan as part of the State of Oregon Periodic Review Order and subsequent to the City completing the Urban Growth Boundary (UGB) expansion.*

There are many ways to design a City Comprehensive Plan and no two are alike. Prineville's Plan must be unique to Prineville and reflect the vision and expressions of the community. Therefore, this Plan is a "value driven" document. The intent of this format is to clearly incorporate the local values, goals and aspirations of the community. These values are recognized as the driving force behind the land use concepts advocated in the policies and goals contained within the Plan.

This Plan does not repeat unnecessary amounts of technical support data and exhibits that can be better located in an appendix. The result is a concise document that is easier to understand and more useful for citizens. The graphics and text in the plan may be subject to change, as new information is made available. However, it is timely to review the local value statements and other concepts to make sure they accurately reflect the desires of the community before proceeding to develop any implementing ordinances or revisions to local codes.

Special Thanks & Acknowledgements

The City of Prineville Comprehensive Plan could not have been completed without the assistance of our citizens. Their participation was invaluable to the success of the document and was instrumental to developing the values, goals, and policies that are needed to shape the future of Prineville.

Various public bodies and agencies also participated in the process and deserve special recognition for their efforts to refine the document. They are listed as follows:

City of Prineville:
City Council
City Planning Commission
City Staff

Crook County:
County Court
County Planning Commission
Crook County Natural Resources Committee
Crooked River Watershed Council
County Staff

State of Oregon:
Department of Transportation
Department of Land Conservation and Development
Department of Fish and Wildlife

Federal Government:
Bureau of Land Management
US Fish and Wildlife
Corps of Engineers

Private Groups:
Greg Winterowd and Tim Brooks - Winterbrook Planning
Brooks Resources Corporation
Tia Lewis, Esq. - Schwabe Williamson and Wyatt LLP
Laura Cooper, Esq. - Ball Janik LLP

Special Recognition:
Special recognition and gratitude goes to DLCD Representatives Mark Radabaugh and Jon Jinings for their continued assistance in providing guidance to the City on urban and rural interface issues. Their dedication, professionalism, and overall helpfulness was essential in the development of our first, independent, Comprehensive Plan implementing the Statewide Planning Goals. Small cities, like Prineville, could not effectively complete periodic review and goal compliance tasks without assistance from DLCD. To that end, we are also thankful for the grant assistance and consideration of the Salem DLCD staff, Larry French and Rob Halliburton from which funding was provided for this task, and several other key projects.

Prineville's Comprehensive Plan

Table of Contents - Introduction

Chapter 1 – Community Characteristics

Chapter 2 – Urban Land Uses and Zoning

Chapter 3 – Natural Environment

Chapter 4 – Parks, Recreation and Open Space

Chapter 5 – Economy

Chapter 6 – Transportation

Chapter 7 – Housing

Chapter 8 – Public Services and Facilities

Appendix

Amendment Log

Introduction

April 2006

Introduction

Purpose and Intent

The Prineville Urban Area Comprehensive Plan, known from here on out as the "Plan", is a dynamic and inspirational guide for directing and managing growth in the community. This document supersedes the previous Comprehensive Plan with Crook County and Prineville combined. The City of Prineville has chosen to have its own Plan and implementing land use ordinances.

The jurisdiction of the Plan applies to the areas within the Urban Growth Boundary (UGB). The Plan provides for and anticipates community-planning needs for all aspects of the urban environment. The Plan is a dynamic document that will be modified, refined, and changed from time to time when new values are determined. The City of Prineville will strive to manage those changes in a deliberate manner in order to reflect the desires and wishes of Prineville residents. Prineville's residents have made it clear that the small town feel of the community is a key feature of what makes the community livable and desirable. This Plan will focus on preserving this key feature.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The State of Oregon requires that all cities conform to the Statewide Planning Goals as applicable. The foundation of that program is a set of 19 Statewide Planning Goals. The goals express the state's policies on land use and on related topics, such as citizen involvement, housing, and natural resources. Most of the goals are accompanied by ´guidelines, ´ that are suggestions about how a goal may be applied. As noted in Goal 2, guidelines are not mandatory.

Oregon's statewide goals are achieved through local comprehensive planning. State law requires each city and county to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the plan into effect. The local comprehensive plans must be consistent with the Statewide Planning Goals. The State's Land Conservation and Development Commission (LCDC) review plans for such consistency.

When LCDC officially approves a local government's plan, the plan is said to be ´acknowledged. ´ After acknowledgement, the Plan becomes the controlling guide for implementing ordinances. Oregon's planning laws apply not only to local governments but also to special districts and state agencies. The laws strongly emphasize coordination -- keeping plans and programs consistent with each other, with the goals, and with acknowledged local plans.

A Summary of Oregon's Statewide Planning Goals

GOAL 1
CITIZEN INVOLVEMENT Goal 1 calls for "the opportunity for citizens to be involved in all phases of the planning process." It requires each city and county to have a citizen involvement program containing six components specified in the goal. It also requires local governments to have a committee for citizen involvement (CCI) to monitor and encourage public participation in planning.

GOAL 2
LAND USE PLANNING Goal 2 outlines the basic procedures of Oregon's statewide planning program. It says that land use decisions are to be made in accordance with a comprehensive plan, and that suitable "implementation ordinances" to put the plan's policies into effect must be adopted. It requires that plans be based on "factual information"; that local plans and ordinances be coordinated with those of other jurisdictions and agencies; and that plans be reviewed periodically and amended as needed. Goal 2 also contains standards for taking exceptions to statewide goals. An exception may be taken when a statewide goal cannot or should not be applied to a particular area or situation.

GOAL 3
AGRICULTURAL LANDS Goal 3 defines "agricultural lands." It then requires counties to inventory such lands and to "preserve and maintain" them through farm zoning. Details on the uses allowed in farm zones are found in ORS Chapter 215 and in Oregon Administrative Rules, Chapter 660, and Division 33. ***This goal does not apply to land within the Prineville UGB.***

GOAL 4
FOREST LANDS This goal defines forest lands and requires counties to inventory them and adopt policies and ordinances that will "conserve forest lands for forest uses." ***This goal does not apply to land within the Prineville UGB.***

GOAL 5
OPEN SPACES, SCENIC AND HISTORIC AREAS AND NATURAL RESOURCES Goal 5 covers more than a dozen natural and cultural resources such as wildlife habitats and wetlands. It establishes a process for each resource to be inventoried and evaluated. If a resource or site is found to be significant, a local government has three policy choices: preserve the resource, allow proposed uses that conflict with it, or strike some sort of a balance between the resource and the uses that would conflict with it.

GOAL 6
AIR, WATER AND LAND RESOURCES QUALITY This goal requires local comprehensive plans and implementing measures to be consistent with state and federal regulations on matters such as groundwater pollution.

GOAL 7
AREAS SUBJECT TO NATURAL DISASTERS AND HAZARDS Goal 7 deals with development in places subject to natural hazards such as floods or landslides. It requires that jurisdictions apply "appropriate safeguards" (floodplain zoning, for example) when planning for development there.

GOAL 8
RECREATION NEEDS This goal calls for each community to evaluate its areas and facilities for recreation and develop plans to deal with the projected demand for them. It also sets forth detailed standards for expedited siting of destination resorts.

GOAL 9
ECONOMY OF THE STATE Goal 9 calls for diversification and improvement of the economy. It asks communities to inventory commercial and industrial lands, project future needs for such lands, and plan and zone enough land to meet those needs.

GOAL 10
HOUSING This goal specifies that each city must plan for and accommodate needed housing types, such as multifamily and manufactured housing. It requires each city to inventory its buildable residential lands, project future needs for such lands, and plan and zone enough buildable land to meet those needs. It also prohibits local plans from discriminating against needed housing types.

GOAL 11
PUBLIC FACILITIES AND SERVICES Goal 11 calls for efficient planning of public services such as sewers, water, law enforcement, and fire protection. The goal's central concept is that public services should to be planned in accordance with a community's needs and capacities rather than be forced to respond to development as it occurs.

GOAL 12
TRANSPORTATION The goal aims to provide "a safe, convenient and economic transportation system." It requires communities to address the needs of the "transportation disadvantaged."

GOAL 13
ENERGY Goal 13 requires that "land and uses developed on the land shall be managed and controlled so as to maximize the conservation of all forms of energy, based upon sound economic principles."

GOAL 14
URBANIZATION This goal requires cities to estimate future growth and needs for land and then plan and zone enough land to meet those needs. It calls for each city to establish an "urban growth boundary" (UGB) to "identify and separate urbanizable land from rural land." It specifies seven factors that must be considered in drawing up a UGB. It also lists four criteria to be applied when undeveloped land within a UGB is to be converted to urban uses.

GOAL 15
WILLAMETTE GREENWAY Goal 15 sets forth procedures for administering the 300 miles of greenway that protects the Willamette River. ***This goal does not apply to land within the Prineville UGB.***

GOAL 16
ESTUARINE RESOURCES This goal requires local governments to classify Oregon's 22 major estuaries in four categories: natural, conservation, shallow-draft development and deep-draft

development. It then describes types of land uses and activities that are permissible in those "management units." ***This goal does not apply to land within the Prineville UGB.***

GOAL 17
COASTAL SHORELANDS The goal defines a planning area bounded by the ocean beaches on the west and the coast highway (State Route 101) on the east. It specifies how certain types of land and resources there are to be managed: major marshes, for example, are to be protected. Sites best suited for unique coastal land uses (port facilities, for example) are reserved for "water-dependent" or "water related" uses. ***This goal does not apply to land within the Prineville UGB.***

GOAL 18
BEACHES AND DUNES Goal 18 sets planning standards for development on various types of dunes. It prohibits residential development on beaches and active foredunes, but allows some other types of development if they meet key criteria. The goal also deals with dune grading, groundwater drawdown in dunal aquifers and the breaching of foredunes. ***This goal does not apply to land within the Prineville UGB.***

GOAL 19
OCEAN RESOURCES Goal 19 aims "to conserve the long-term values, benefits, and natural resources of the near shore, ocean and the continental shelf." It deals with matters such as dumping of dredge spoils and discharging of waste products into the open sea. Goal 19's main requirements are for state agencies rather than cities and counties. ***This goal does not apply to land within the Prineville UGB.***

The previous Crook County Plan addressed the above goals as required. This document conforms to the Oregon Revised Statutes, Department of Land Conservation and Development rules and regulations as well as the Oregon Administrative Rules governing the Land Conservation and Development Commission. The context of the Plan has been developed in cooperation with Crook County and the Urban Management Agreement provisions contained in the Appendix of this document.

Looking beyond the conventions of law, this Plan exceeds minimum legal requirements to get at what local citizens desire. It describes who lives in the community, reflects upon Prineville's history, documents its use of land, examines its roadways, studies its economics, systems and governance, and assesses its current physical and ecological environment.

This new Plan does much the same as the old Plan except that it is "value driven" and more clearly expresses the vision of the *urban* community. The Plan provides direction to the City decision makers based upon those values. This Plan is intended to serve as a guidebook for city officials, based on the community's real-life conditions by helping its officials make informed decisions.

The advantage to having a "value driven" Plan is that the community goals become the foundation for decision-making on a variety of levels within the local government. Values tend to have more meaning than long lists of temporary tasks that have a limited shelf life and require constant revision. The City of Prineville's Comprehensive Plan values are based upon locally established vision, long range-goals, and clear policies derived from extensive public participation and local knowledge of community leaders. Thus, the Plan contains goals and policies based on the City's values, set in the context of current and potential opportunities, concerns and capabilities. The Plan

is meant to last for the 20-year planning horizon and thus, the values of the community need to be clearly expressed in the Plan before any changes are made to the implementing ordinances.

Ultimately, this Plan is a useful planning tool that will help shape the City's zoning and subdivision regulations, capital improvement programming and budgeting, and other legal and regulatory actions necessary to manage Prineville's physical, social, and environmental character. All of these implementation tools must be consistent with this Plan in order to be consistent with State law.

Some elements of this Plan address several goals in order to retain consistency and ease of review for local citizens. To that end, the Plan contains the following elements:

- **Community Characteristics**
- **Land Uses and Zoning Designations**
- **Natural Environment**
- **Parks and Recreation**
- **Economy**
- **Transportation and Circulation**
- **Housing**
- **Public Services and Facilities**
- **Appendix**

Planning Process

Planning is an ongoing process that requires extensive public input to accurately capture the desires of the community. All too often, we hear about growth creating unwelcome or unanticipated changes that cause anger and frustration. This Plan seeks to resolve some of the issues related to growth by providing clear policies on what the built environment should look like and how it should operate. This requires a significant amount of meaningful public involvement.

The goal of meaningful public involvement requires balancing many individual concerns and goals to arrive at a vision that reflects the unique aspects of Prineville. Meaningful public involvement requires a certain amount of outreach in order to entice busy citizens to get involved. Public involvement does not have to require laborious or extended night meetings. Technology, community websites, varied communication methods and other techniques are readily available as an alternative to numerous meetings as a way to avoid waiting for hours to deliver testimony. Prineville's citizens are perceptive and ready to respond on a variety of levels and local city officials will continue to embrace the concerns of their constituents and taxpayers.

The Decision Makers

The City currently operates a City Manager/Council form of government. Citizens are encouraged to participate in Council meetings and decision-making proceedings. With regard to land use planning, the City Council appoints a 7-member Planning Commission to serve as a quasi-judicial body that acts as a research and fact-finding group to analyze research and make recommendations to the City Council regarding the appropriate use and development of land throughout the municipality. The Planning Commission serves as the primary citizen involvement committee consistent with the requirements of the State Land Use Planning Goal 1.

Local Values and Vision

Land use planning is more of an art than a science, and often fraught with legal jargon and the potential for vast amounts of litigation – yet land use planning can be straightforward and productive if we focus on the elements that make for a quality living environment.

The intent of this Plan requires focus on the planning techniques that replicate and preserve the best of Prineville's small town features. The community has expressed its desire to retain a "small town feel" as growth occurs throughout the community. The focus of this Plan is to make sure that the growth and redevelopment of the community adheres to this concept. One of these techniques requires a careful examination of neighborhoods and the local elements that influence livability.

This Plan will begin with an assessment of what makes Prineville's neighborhoods complete and livable. Prineville's neighborhoods are not just limited to residential areas but those areas necessary so people can work, shop and play within close proximity of their homes. This concept is the foundation of "complete neighborhoods" and often reflects the places we would like to live in. Again, it is understood that there will not be a cookie-cutter approach or attempts at a "one size fits all" template for Prineville. Likewise, this Plan contemplates changes over time that responds to future needs and concepts that are beneficial to the community. The goal of this Plan is to serve the needs of **all** citizens by providing many choices and opportunities for housing, employment, shopping, services, and recreation.

What is the Community Vision?

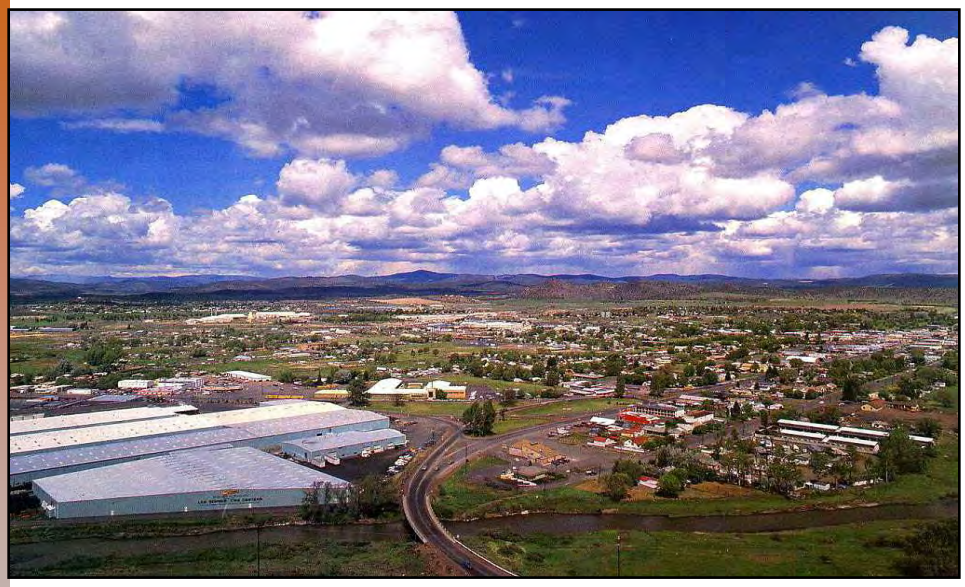
The best way to approach the development of this Plan is to first examine where the community has come from, and where the community wants to go, by beginning with an assessment of current needs and issues and examining previous plans as a basis. The previous County/City Plan expressed a vision of Prineville that was helpful for determining what the community issues were in the past. A vision of the future, based on previous goals in the earlier Plan is a good way to proceed. More current visions [as expressed by community participants in the planning process], is the second step, outlining possible policy directives and the formation of initial goals in response to current and emerging issues.

A more intensive and directed goal-setting exercise follows, followed still by the creation of policies designed to achieve those goals by guiding City and agency behaviors. Programs then emerge to implement the policies, allowing the City to create individual tasks that can be included in annual departmental budgets. As the years pass, the community can then review the execution of the Plan's programs, evaluating progress and revising the plan as necessary.

Planning, through a structured and deliberate process, creates and tests future scenarios. The results are a preferred course of action to achieve a desired result. The policies and programs included in this Plan reflect the Prineville resident's preferred direction and instruct community leaders on how to achieve the community's long-range goals. Thus, the Plan focuses on basic principles:

> ***Goals form policies, policies form programs and budgets, implementation occurs, and the result is accomplishment.***

The Prineville Comprehensive Plan must have solid community involvement during its review and preparation. Likewise, the Plan will function better if there is as much support as possible throughout its implementation. Prineville has used an array of public involvement techniques including a series of community workshops, design charrettes, a telephone survey, informational pamphlets in utility mailings, full-size posters and an interactive Web site to solicit and receive community comments on the plan, its vision, goals, policies and programs.



1

Community Characteristics

Prineville's Comprehensive Plan

Table of Contents - Chapter 1

Purpose and Intent

Incorporation of Prineville

Railroad History

Crook County

Early Community Growth

Population

Recent Development

Livability

Climate

Environment and Geology

Issues, Goals, Policies, and Programs

Desired Community Development Characteristics

Complete Neighborhoods are Key to the Success of Prineville

Residential Neighborhood Values and Policies

Commercial and Industrial Area Values and Policies

Local Business Incentives, Values and Policies

Tourism and Visitor Values and Policies

Community Characteristics

April 2006

Chapter 1 Community Characteristics

Purpose and Intent

This chapter examines the community history and defines a variety of local urban elements that are essential for a high quality of livability. Those elements are then transformed into goals, policies and programs necessary to guide community growth and the visual aspects of the community.

What is our history and how has it shaped our past? How can you know where you are going until you know where you have come from?

The visual aspects of the Prineville community are unique. Dramatic geological features frame the community setting. The area is rich in history and contains many structures retained to provide a vital link between the past and the future. The community cherishes its' history and small town characteristics.

Incorporation of Prineville

Established in 1868, Prineville is the oldest community in the Central Oregon region, and one of the state's first incorporated cities. Prineville was incorporated in Wasco County that later became Crook County. The historic Crook County Courthouse, which has been in continuous use since its construction in 1909, stands as the community's dominant landmark. Like other towns in the region, Prineville's origins are tied to the land – agriculture and forest products manufacturing. In addition, like other communities in the region, it has diversified into other industries while keeping its well-established manufacturing heritage alive and well. In 1882, the Legislative Assembly established Prineville as the county seat. The voters confirmed the choice of Prineville, the only incorporated town in the county, in the 1884 general election. Prineville was named in honor of the town's first merchant, Barney Prine.

Barney Prine settled on the banks of Crooked River, where he built a blacksmith shop and a store-saloon. Prineville was the first and, for many years, the only town in the 10,000 square mile County, bounded by The Dalles on the north, Linkville (Klamath Falls) on the South, Eugene City on the west and Canyon City on the east. Before 1902, when the first high school was organized, anyone wanting an education beyond the 8th grade had to go to The Dalles or Eugene City. In March of 1877, Monroe Hodges rode horseback to The Dalles to file the first plat of Prineville. Prineville maintained its place as the trade center of Central Oregon until 1911, when the Union Pacific and Oregon Trunk Railways were extended south from the Columbia River to Bend. In 1917, recognizing that Prineville would fade unless adequate transportation was available, the citizens of the city voted to build their own railroad to join the OT and UP north of Redmond. Through years of low revenues and high costs, the City operated the railway. Finally, in the late 1930s and early 1940s, sawmills began to reap the harvest of the vast stands of Ponderosa Pine from the Ochoco Mountains. The lumber was shipped over the City of Prineville Railway, resulting in the title of, "The Largest Ponderosa Pine Shipping Center in the World". Therefore, the C of P Railway became an asset to the city, and further gained the distinction of being the only city-owned and operated railroad in the U.S.

Railroad History

The City of Prineville Railway is the last operating railroad company of a type of railroad that used to be quite common in the state of Oregon: a civic connection railroad

In the early years, railroad transportation was everything to a city. However, the large long distance railroads could not be responsible for building railroads to all of the tiny cities, some of which were quite insignificant points on the map. Therefore, as railroads were built, various groups of concerned citizens in the cities that were left out of the long distance railroad plans built their own connections to the large railroads.

Prineville was at one time the largest city in Central Oregon. However, neither the Oregon Trunk nor the Union Pacific backed Deschutes Railroad was planning to build a railroad to that city due to its location relative to the Deschutes river canyon. Therefore, in 1911 the Prineville & Eastern Railway was incorporated by concerned citizens. However, little came of the proposal. In 1916, the city council of Prineville decided to take things into their own hands. Voters passed the bond measure 355 to 1. The terms were not attractive to investors, but they were purchased later under slightly changed terms. Grading of the line began in 1916. By 1917 the company had a used steam locomotive on hand, and by 1918 the line had started offering freight and passenger service from a connection with the Oregon Trunk and the Des Chutes Railroad at Prineville Junction and the city of Prineville. The early years were difficult due to the small amount of traffic hauled. During the depression, the city defaulted on the bonds. Passenger service over the railroad ceased in 1939. During the 1930's, some hope did arrive. There were several small lumber mills built in Prineville. In the 1950's and 1960's, there was so much traffic on the line that the city tax rate was one of the lowest in Oregon due to the income from the railroad. It is still in operation, and is still owned by the city of Prineville. It is managed by a commission appointed by the city council. Passenger service over the line was put back in the mid 1990's in the form of the Crooked River Dinner Train. They are now operating steam as well, with a logging locomotive that is owned by the Oregon Historical Society.

Excerpt from A Brief History of the City of Prineville Railroad by Glenn Laubaugh

Crook County

Crook County was established on October 24, 1882. It was created from the southern part of Wasco County and named after U.S. Army Major-General George Crook, a hero of the Snake Indian Wars. Crook County is situated in the geographic center of Oregon. It has been reduced from its original size of 8,600 square miles to 2,986 square miles by the creation of Jefferson County in 1914 and Deschutes County in 1916. The current boundaries were established in 1927. Jefferson and Wheeler Counties bound Crook County to the north, Grant and Harney Counties to the east, and Deschutes County to the south and west.

Early Community Growth

Early routes over the Cascades were difficult to find and traverse, thus delaying development in the area until access was more developed. The first effort was in 1862 when a supply train with cattle crossed the Scott Trail. This was also the first group of non-natives to spend the winter in central Oregon. The discovery and development of the Santiam Pass in the 1860s made development of the area much easier. Today, the economy of the county continues to reflect certain elements of agriculture and forestry, but these resources are diminishing. Agriculture is supported by the development of irrigation districts, which permits the raising of hay, grain, mint, potatoes, and seed.

Range and forestlands allow grazing for a sizable livestock industry. The Ochoco National Forest's stand of ponderosa pine is the main source of lumber. As the lumber industry suffers with restricted timber harvest, tourism, recreation, and homebuilding are helping to strengthen the economy.

Population

The first census in 1890 showed a population of 3,244 excluding Native Americans. There has been a dramatic increase and fluctuation in the population's growth. The last several censuses have shown an increase in inhabitants with the 2002 population at 8,325 representing a 43% increase from the last census in 1990.

Crook County and Prineville have been growing at a rate that is more than twice the state average for the last 5 years. It has ranked in the top 10 (of 36 counties) for growth in number of residents for the past three years. In 1990, the town's population was 5,410, which has grown to 8,500 in 2003.

Recent Development

The community has been making significant public investments in expanding hospital facilities, a new high school, a new public library, a new public park and extensive playground, and fully serviced industrial park.

Prineville is also home to Oregon's third largest privately held company and third largest overall Central Oregon employer - Les Schwab Tire Centers. Schwab employs over 1,000 people in Crook County. The company has been in a steady growth pattern for quite some time, building two new warehouse/distribution centers in years 2002-2003 for a combined area of 1,089,000 square feet. These recent additions give Les Schwab over 2,000,000 square feet of warehousing to support the firm's 313+ retail tire stores throughout the West.

Other large manufacturers have made Prineville their home including Clear Pine Molding (Contact) and Woodgrain Millwork each with nearly 500 employees and Pioneer Cut Stock Inc.

Prineville also has a high concentration of trucking/ground transport companies. With seven regional firms based in the town, businesses in the region have excellent service and rates for transport to and from major markets. Outside the manufacturing and distribution sectors, agriculture still plays an important economic and cultural role for residents of the town and Crook County. Annually, the industry contributes more that $40 million to the local economy in commodities sold.

Livability

Prineville is a community with a strong identity. Community leaders must have the town's interests at heart and with the residents engaged in many civic activities. A good example is the connection between residents, businesses and the school system. Remarkably, Prineville has approximately 600 students involved in its School-to-Work program – an effort to provide students in the area with practical work experience in area businesses. The high level of community-wide participation contributes to the town's low dropout rate which is less than half that of the state average.

Prineville's low cost of housing is an asset to the community, with the one of the lowest median home prices in the region, and nearly the least costly average home price as compared to other communities in Central Oregon.

Climate

With a strong heritage in agriculture - rodeos, county fair, and outdoor recreation are very popular in the community. The town is also the gateway to the Ochoco National Forest, Painted Hills National Monument, and a host of lakes and reservoirs popular with boaters and fishermen. Near-year round golfing is a popular attraction for visitors and residents alike given that Spring comes earlier and Fall stays later in Prineville. The climate of the Prineville area is characterized by many sunny days with an average of 11 inches of rainfall and 14 inches of snow each year. The average temperature can fluctuate in summer and winter rising or falling 40 to 50 degrees in a single day. Prineville summer temperatures range from an average high of 85 degrees Fahrenheit with low humidity to a low of 44 degrees Fahrenheit. Winters average highs are in the 40's to lows in the 20's.

Fast Facts

- Prineville has Oregon's highest per capita of manufacturing jobs
- Oregon's largest School-to-Work program operated in Prineville through a partnership with the Chamber of Commerce
- The City of Prineville operates the last municipally owned freight railroad in the United States, a 17 mile stretch between the town and the shared mainline
- Prineville is its only incorporated city within Crook County's sizeable 2,982 square miles of area.

Environment and Geology

Prineville is located at the base of high plateaus and traversed by many natural drainage ways. Ochoco Creek and the Crooked River run through the center of the community. Various greenbelts and wildlife-rich riparian areas exist within the community. This situation offers opportunities to develop additional preservation greenbelts and multipurpose areas that can buffer these sensitive lands from the negative impacts of urban development.

The 100-year floodplains near the rivers are potential hazard areas for development. The land area within the Prineville UGB includes over 320 acres within the floodplain.

Many small drainage tributaries of the major streams have high flood hazard and erosion potential within localized areas. However, these localized flash flood conditions do not contribute significantly to flood conditions when channeled into the larger drainages. Many hazard areas can or have been partially, or totally, reclaimed through adequate engineering, especially where drainage can be provided within areas of high water tables. Seasonally high water table problems are caused by spring runoff of snow melt, by flood and sprinkler irrigation, and by soils with high enough clay content to make them impervious to ground water flow. The general soil boundaries indicating ground water problems have been further modified by engineering practices such as diversion canals, drainage ditches, and interceptor drain tiles.

The areas indicated as having extreme or moderate high water table's present problems for foundations, underground utilities, septic tanks, wells and adequate drainage. Engineering techniques may solve these problems. Consequently, increased development costs can be expected. There are approximately 760 acres of soils poorly suited for foundations in the Prineville Urban Area. These soils, also located within areas of high water tables, create additional limitations for sewers, water systems, and other underground utilities. Severe limitations also exist for roadways because of the soils' high shrink-swell characteristics. Problems associated with these soils include foundation cracking, settling and water damage to structures, and underground utility systems that may result in pollution of groundwater.

The general geology of Crook County is almost entirely volcanic in origin. The Clarno and John Day Formations are the most extensive with Columbia River Basalts, Dansforth Mascall Rim Basalts, Deschutes Formations and unconsolidated materials (i.e. alluvial valleys and terraces, etc.) following in decreasing order. The steepest slopes (in excess of 30%) generally pose higher development and maintenance costs for structures and utilities, although modern engineering technology and design may alleviate some or all of these limitations. Shallow rocky soils, high erosion potential, mass movement, septic tank limitations and low agricultural potential commonly characterize steep slopes.

Issues, Goals, Policies, and Programs

Prineville is a small rural community. It provides both shopping and employment for City and Crook County residents. The City was built along the rivers and railroad tracks, using the rail to ship the lumber and agricultural products that came into the town from the nearby farms. As the rest of Central Oregon grew, so did Prineville, but at a much-reduced rate given its distance from regional centers like Bend. State highways improved vehicular access to Prineville from points west, and the residential population found that the multiple access routes allowed for improved transportation to needed goods and services not readily available in Prineville. Today, new residents come to Prineville because of its small-town character and current low housing prices, locating their families in this community though their jobs; service and shopping needs may be elsewhere.

Prineville's street patterns and subdivisions testify to a value of open spaces and easy vehicular and large transport access. As time passed, there was a transition from the older streets lying parallel to the old railroad line to the newer ones paralleling section lines. Over time, orientation to the railroad gradually became less important. Subdivisions rotated to match section lines, accommodating rural land ownership patterns as surrounding farmland converted to residential and urban uses.

Prineville has historically attracted people for two primary reasons: one for its natural resource and recreation based heritage and another for its emergence as a small town within Central Oregon. Although previous traditional industries are rapidly diminishing, as illustrated by the reduction in the lumber and agricultural industries, new community construction is taking place on lands that were formerly farmed for many years or had a history of underdevelopment. Historic buildings do remain evident in the central business district and nearby neighborhoods. Longstanding businesses, with original facades and signage, are adjacent to newer establishments. Industrial areas are continuing to develop with needed businesses and manufacturing offering much needed jobs for the community.

A variety of shopping districts extend along the street systems. These separate the typical residential subdivision pattern that represents the style of single-family land development over the past century or more. Large numbers of established trees and open spaces still exist along the Ochoco and Crooked River within the urban areas.

Desired Community Development Characteristics

Prineville's residents agree the community's appearance is very important. Additionally, they are concerned about the transitions between different types of land uses and the influx of new development that is urban in nature. Citizens want to have a more stable economic environment that allows workers to avoid daily trips to other cities. They also want to have the shopping and service opportunities that larger cities provide without losing small town feel and becoming saturated with prototypical franchise and big-box architecture. The community's entries on the highway corridors need to be improved to define the character of the growing community for visitors and residents alike. Citizens want to recognize and utilize the surrounding agricultural, recreation, and natural areas while preserving views and maintaining a supply of open space around the community. Overall, citizens desire a quality living experience that allows them to raise their children in a safe and nurturing environment; an environment where children can grow up, get the education and jobs they need.

As the community grows, the public must determine what land use planning techniques are necessary for guiding and shaping new developments and how to revitalize re-developing areas of the City and urban area. The community must be able to guide and shape growth in order to achieve thoughtful and quality development. The concepts contained in this chapter are intended to ensure community growth and redevelopment enhances the local quality of life by:

- *Emphasizing and enhancing the community's small-town character*
- *Emphasizing the importance of providing a quality environment to raise children*
- *Providing for compatibility in land uses*
- *Promoting "complete neighborhoods" so residents are not inconvenienced by the lack of nearby essential goods and services, employment and recreation*
- *Emphasizing that the Downtown areas must be strong enough to compete with other nearby communities and strip commercial.*
- *Promoting quality of life for citizens by improving residential areas*
- *Encouraging strong activity in commercial and industrial areas*
- *Recognizing that the natural environment is an integral part of the community*

The implementation of the above concepts should result in a more interconnected community that meets the needs of Prineville's families, residents, visitors, businesses, and the environment.

"Complete Neighborhoods" are key to the success of Prineville

How we design and build our neighborhoods is of extreme importance to the community. The expected growth and expansion of the community will occur in and around the natural topographic features. This will create development patterns that result in large neighborhoods that cannot link up to one another. Because of this, newer neighborhoods must be as self-supporting as possible, meaning they should contain nearly all of the amenities and services (or easy access to those that are not in the immediate area) needed for daily living.

The overall goal for Prineville is to provide various neighborhood types ranging from small hobby farms, single-family and multi-family neighborhoods, to commercial and industrial use areas linked together by common features such as open space, trails, transportation networks, etc. Regardless of the type of neighborhood, all neighborhoods should contain specific types of convenience features and amenities, easily identified as essential to providing the lifestyle that Prineville seeks to maintain and build upon.

Neighborhoods should be designed to be self-supporting and contain mixed-uses, pedestrian amenities, open spaces, employment/shopping/service opportunities, and consideration of lands needed for public uses. The land uses may include elements necessary to complement and improve the adjacent or abutting existing urban form by utilizing planning techniques to reduce: traffic congestion and trip lengths, poor neighborhood design leading to urban and suburban sprawl, infrastructure costs, environmental degradation, and piecemeal development patterns that lead to additional community expense and subsidy.

The purpose of this section is to require the development of master plans for new or enhanced neighborhoods. The goals, policies, and programs in this chapter are designed to protect and enhance the community's neighborhoods. They address the interrelationships of spaces and systems incorporating the entirety of the community's physical environment in a manner that cannot be achieved in this plan's other chapters. These relationships shape community identity, providing the context in which the community residents live, work, move, and play.

Goal # 1: Improve the function and appearance of the community's residential neighborhoods, commercial and industrial areas.

Residential Neighborhood Values and Policies

Residential neighborhoods shall include the following features:

Master plan required. Before any required land division approval or design review approval, a master plan shall be prepared for all parcels and sites over 5 acres in size as of the date of adoption of this plan. Other types of development proposals may require master plans and/or master planning techniques.

"Complete neighborhood" land use and design standards. Neighborhood Master Plans shall be evaluated based on the adopted land division and zoning ordinance criteria as applicable, and shall also contain the following neighborhood design elements:

- Development of residential neighborhood lots shall use planned unit development techniques or zoning overlays to permit and control mixing of uses.

- Neighborhood lots shall be designed to be within 1200 feet of open spaces, parks or other recreational areas. Trails and sidewalks are considered to be basic infrastructure and may not to be considered as open spaces for meeting this requirement unless they are located in special preservation areas such as riparian areas, etc. The 1200-foot distance shall be measured along the proposed or existing walking surfaces such as ADA accessible sidewalks, trails, and streets.

- Neighborhoods shall include a mix of housing types to achieve at least 60% of the maximum density designated for the underlying zones, including non-residential lands. The mix of housing types shall not exceed the density for the underlying zone unless a public park greater than 3 acres in size is proposed to be within the neighborhood. In no case, shall the density exceed 10 % of the maximum density for the underlying zone and in no case shall the higher density dwellings be located next to existing lower density dwellings unless separated by a setback twice the requirement established for the residential dwellings.

- Neighborhoods shall include designation of public use lands necessary for schools, trails, emergency services, infrastructure support systems, transit amenities, and natural resource protection in accordance with this Plan and State law.

- Neighborhoods shall contain small blocks not exceeding 660 feet in length; with a maximum perimeter of 1,600 feet unless separated by open spaces and other recreational uses or when the City has approved an exception to block length.

- Neighborhoods shall contain open spaces, typical municipally-sized parks, in addition to trails, pocket parks, pavilions, squares, plazas, greenbelts, natural resource protection areas, structured and unstructured open space, etc as appropriate to the setting and density of the area.

- Neighborhoods shall contain employment/shopping/service opportunities located in areas that can be served by transit and easily accessed by residents in the neighborhood. Residentially oriented services (i.e. convenience stores, laundromats, cafés, etc.) shall not exceed a distance greater than 2640 feet (1/2 mile) from one another unless as approved by exception.

- The required neighborhood design elements shall be included in all master planned neighborhoods ***unless*** it can be proven that the abutting and/or adjacent developed lands include the elements necessary to meet the intent of this section. Adequate proof shall include studies, demographic data, and other suitable information to provide the City with factual data to support findings for approval. The expense for supplying the proof shall be borne solely by the property owner or applicant. The proof shall provide reliable evidence that the adjacent and/or abutting properties contain the elements necessary to create or complement the proposed neighborhood.

Programs:

The City shall draft and adopt design guidelines and other planning tools that educate, encourage and regulate the development of neighborhoods. Such planning tools include, but are not limited to the following:

1. Draft and adopt updated local zoning ordinance provisions to reflect the desired design element necessary to regulate growth.

2. Draft and adopt updated local land division ordinance provisions to reflect the desired design element necessary to regulate growth.

3. Draft and adopt a consolidated neighborhood overlay map showing potential new neighborhood areas.

4. Provide incentive programs when at all possible to encourage affordable housing in new neighborhood development.

5. Create a model urban living environment guideline

6. Draft and adopt neighborhood design guidelines

Commercial and Industrial Area Values and Policies

New commercial and industrial areas shall include the following features:

Commercial and industrial area development plan required. Before any required land division or design review approval, a development plan shall be prepared for all parcels and sites contemplated for development. The intent of these policies is to create "complete commercial and industrial areas" and avoid piecemeal development practices that can lead to unnecessary community subsidy and sprawl.

Land use and design standards. Commercial and Industrial development plans shall be evaluated based on the adopted land division and zoning ordinance criteria and shall also contain the following design elements:

- Planned unit development techniques or zoning overlays to permit and control mixing of uses. This may include access to sidewalks, trails, transit, open space, parks or other recreational areas.

- Architectural features that articulate the exteriors of large buildings to reduce the visual mass and enhance the architecture of the community.

- Outdoor amenities in the form of pocket parks, plazas, exercise facilities, on site cafes, day care facilities or other features that enhance the working experience for employees and reduce vehicle trips.

- Techniques to provide and implement design features that minimize the negative effects of infill development by improving compatibility with existing structures and land uses.

- Orienting the building primary access point to a public sidewalk or street.

- Planting and maintenance of suitable street trees.

- New parking areas shall, to the greatest extent practical, be placed around new buildings in order to avoid concentrations of parking and excessive walking distances from the street to the primary access point.

- Adequate off-street parking for bicycles.

- Adequate buffers from incompatible uses. *i.e. If new commercial and industrial uses are proposed to be located next to existing residential dwellings they must be separated by a side or rear yard setback twice the requirement established for the use.*

- Designation of public use lands necessary for schools, trails, emergency services, infrastructure support systems, transit amenities, and natural resource protection in accordance with this Plan.

- New development of commercial lots shall contain, at a minimum, 51% commercial use to minimize the exclusive use of a commercial lot as primarily residential

- Area studies containing analysis of the land uses contained within the perimeter of the development site. This may include demographic data necessary to show the quality and quantity of the existing commercial and industrial types, mixed-uses, open space and recreation areas, public use lands, trails and sidewalks, and utility needs. The City staff, in collaboration with the applicant proposing the development, shall jointly evaluate the commercial/industrial area study and determine what land uses are necessary to promote and implement the "complete industrial and commercial area" concept. The City may require certain missing commercial/industrial to be developed on or adjacent to the redevelopment property or require a pro rata cash contribution to the future development of such elements. The required "complete" design elements shall be included in all (re)development proposals unless it can be proven that the abutting and/or adjacent developed lands include the elements necessary to meet the intent of this section.

Programs:

The City shall draft and adopt design guidelines and other planning tools that educate, encourage, and regulate the development in commercial and industrial areas. Such planning tools include, but are not limited to the following:

1. Draft and adopt updated local zoning ordinance provisions
2. Draft and adopt updated local land division ordinance provisions
3. Provide incentive programs to encourage quality commercial development and infill projects.
4. Draft and adopt a consolidated neighborhood overlay map showing potential neighborhood redevelopment areas and needed commercial and industrial services and employment centers

5. Draft and adopt new commercial and industrial design guidelines
6. Draft and adopt design guidelines for single-family housing in commercial and industrial areas.
7. Develop incentives that encourage high quality building design in all new construction, renovations and rehabilitation
8. Require a high level of property maintenance throughout the commercial and industrial community
9. Review code enforcement role and procedures for effectiveness in abating zoning violations
10. Identify community entry locations to be revitalized and sponsor a competition for entry statement designs in cooperation with other civic groups, schools and volunteer organizations. Create welcoming and visually important entry statements along highway entries.
11. Develop parking standards that incorporate on street parking.
12. Reduce the distance pedestrians must travel when crossing streets, using sidewalk "bulb-outs" and pedestrian "islands" at key intersections.
13. Work with ODOT to make highway environments more walkable, particularly through the commercial core areas.
14. Install lighting that is more pedestrian in scale along popular walking corridors.
15. Orient and screen truck loading docks and service areas to minimize impacts on adjoining residential areas and to decrease or eliminate in street parking loading and unloading.
16. Locate parking lots to encourage pedestrian access to commercial uses from adjoining neighborhoods.
17. Locate and screen solid waste bins and recyclable materials to minimize impacts on adjoining residential areas.

Goal # 2: Improve and strengthen the function and appearance of the community's downtown central business district.

Local Business Incentives, Values and Policies

- Any project in the downtown central business district area may receive expedited City review and processing for any required land use procedure

- A downtown revitalization program shall be researched and developed to include incentives and other features desired by the community. These may include the following:
    1. Placement of buildings close to the sidewalk areas.
    2. Orientation of building entrances to streets and sidewalks.
    3. Reduced side and rear yard setbacks.
    4. Use of urban building materials that are compatible with historic structures and reduce energy consumption.
    5. Use of multiple-story building architecture for maximum utilization of land. Coordinate with the Crook County Fire and Rescue Department on building heights.
    6. Improved signage techniques.
    7. Street tree programs.
    8. Reduce the need for tractor-trailers to access the downtown area for supplies and services.
    9. Develop delivery systems that do not negatively affect pedestrians, shoppers, and traffic flows.
    10. Pedestrian amenities and improved crossing corners.
    11. Pocket parks and pedestrian rest areas.
    12. Improved lighting systems to improve nighttime commerce, (pedestrian scaled lighting), safety, and reduced impact on abutting neighborhoods.
    13. Reserved on street parking spaces for disabled, public transportation, maintenance and emergency services.
    14. Opportunities for public art and expression
    15. Parking district programs and other techniques to improve parking supplies for patrons.
    16. Placing overhead utilities underground shall be a priority.
    17. Improve outdoor trash storage and removal systems.
    18. Identify links to nearby neighborhoods and make sidewalk improvements.
    19. Establish consistent design standards for downtown streets, sidewalks, and pedestrian amenities.
    20. Encouraging a full spectrum of local businesses – i.e. hardware stores, theater, etc.

- Support the formation and continued operation of a business association and designate a staff liaison to attend Chamber of Commerce meetings

Programs:

The City shall:

1. Draft and adopt exemptions and special procedures for expedited processing of any development application in the downtown central business district.

2. Update and implement the Downtown revitalization program. This may include purchase, consolidation and assembly of property for sale or lease to key businesses.

3. Appoint a staff member to be a liaison for local businesses on downtown issues.

4. Review water/sewer services and projects to ensure adequate service delivery to the downtown area.

5. Update the existing Downtown Enhancement Plan and expand the borders of the "downtown core" as currently designated in the plan.

6. Revise the land division and zoning ordinance to allow mixed-use development.

7. Draft and adopt a design assistance program to help business owners, builders and contractors create new construction and renovation plans that enhance the central business district's character.

8. Explore the feasibility of urban renewal and other business improvement districts.

9. Coordinate with the downtown business owners for the creation and adoption of a sustainability plan for publicly owned projects and other developments within the downtown business district.

10. Coordinate signal timing with ODOT for maximum benefit to the urban area.

11. Take appropriate steps to encourage the development of truck stop facilities.

12. Provide information to builders on meeting or being exempted from universal access requirements in historic structure renovations.

13. Take appropriate steps to encourage the development of a multi-use path that connects downtown businesses with outlying residential neighborhoods.

Tourism and Visitor Values and Policies

Downtown central business district areas and the community in general can benefit from strong tourism and other visitor attraction strategies. These strategies include, but are not limited to the following:

- Improve coordination between City, local tourism agencies and Chamber of Commerce.

- Improved website and other web-based tourism enhancement techniques.
- Improved access to the historical assets of the community by developing heritage markers and/or interpretive signs for visitors and local residents alike.
- Improve and enhanced community entry areas.
- Maximize local railroad assets for tourism opportunities.
- Study seasonal differences in traveling public and target business and recreational advertising strategies to match needs.
- Sponsor children's activities and other venues to attract families and other visitors to the community.
- Examine strategies for improving choices in restaurants and entertainment options.
- Encourage key anchor stores in the downtown core, including businesses that encourage nighttime activities (i.e. movie theaters, quality sit-down restaurants, etc.)

Programs:

The City shall:

1. Inventory, document and photograph all historical assets within the community.
2. Work with local citizens to coordinate opportunities for accessing local historical assets and design a historic walking tour.
3. Coordinate and sponsor a competition for entry statement enhancements and designs in cooperation with other civic groups.
4. Acquire necessary property and obtain necessary approvals from ODOT for enhancing ROW areas for tourists and visitors.
5. Improve visual connections to the central business district by installing effective directional signs at logical street access points.
6. Study shuttle service from Redmond airport to Prineville's central business district and other commercial activity areas.
7. Coordinate with other local groups to develop a central business district hospitality study that includes activities for local youth.
8. Encourage travelers to spend the night and enjoy Prineville.
9. Work with local business groups to maximize coordination efforts and effectiveness of such programs.

2

Urban Land Use and Zoning Designations

Prineville's Comprehensive Plan

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Urban Land Use and Zoning Designations

April 2006

Chapter 2 Urban Land Uses and Zoning Designations

Purpose and Intent

The Prineville urban area contains land use descriptions and zoning for residential, commercial, and industrial areas. This chapter examines the different zone and land use designations and implementation strategies. The primary designations implement the strategies that regulate the use of land and its ability to support the community's long-term development objectives. The goals, policies and programs contained in this chapter will help the City manage its land uses to meet the growth needs of the Prineville community. It should be noted that the existing Comprehensive Plan Map, also known as the "Prineville Area Physical Development Plan", will need to be updated and various changes made given the age and poor drafting quality. Commensurate with revisions and improvements to the Comprehensive Plan Map, various errors were discovered on the 2006 Zoning Map. These errors and other needed revisions will be needed to improve consistency and compatibility with the revised Comprehensive Map.

Issues, Goals, Policies, and Programs

The anticipated growth of the community will create a variety of pressures upon local citizens, the environment, and infrastructure of Prineville. A variety of land uses and commensurate development regulations will help keep community values intact.

The intent of this chapter focuses on specific land use practices that provide the guidance necessary for accommodating growth while continuing to preserve, maintain, and enhance Prineville's community values.

Definitions

Marijuana Grow Site (MG) - means a location that grows and/or processes marijuana that exceeds the amounts allowed by State law for an individual or household.

Marijuana Facility (MF) - means a location where Marijuana is grown, processed, sold or dispensed or any combination of these activities which is registered by the State of Oregon.

Goal # 1: Create land use zones and land use regulations that enhance Prineville without sacrificing community values

Residential Zone Values and Policies

- Residential zones should be places where citizens can raise their families in a safe and nurturing environment.

- Residential zones that include amenities promoting family living environments and safe places for children to play walk to school, and experience natural resources are highly desired.

- Residential zones that include compatibility standards to facilitate transitions between new and established uses will help to alleviate the pressures of growth upon existing community residents.

- Residential zones that provide for a broad range of densities and housing choices avoid creating imbalances that require remedies using community subsidy or tax dollars.

- Residential zones must include outright permitted and conditional uses adequate to develop "complete" neighborhoods and suitable living environments.

- New residential developments shall analyze the impact of the new development upon community infrastructure, natural resources, and local cultural attributes before development can proceed. Any necessary mitigation plan shall be examined for feasibility and effectiveness in remedying the impacts. No new development shall be permitted which creates the need for subsidy by community members, in other words, "new development shall pay its' own way."

- Prineville has many natural features worthy of preservation and enhancement. New residential developments shall incorporate where practical, existing natural features into new projects as a way to protect the natural beauty of Prineville.

- Residential zones shall promote walk ability and connectivity to adjacent neighborhoods, open spaces, parks, and commercial nodes.

- Residential zones shall incorporate affordable housing concepts.

Programs:

The City shall:

1. Develop an overlay zone that identifies logical neighborhood boundaries that contain or could contain elements that support the development of "complete neighborhoods."

2. Examine the existing neighborhoods and determine what amenities are lacking in each area such as open space, trails, service centers, infrastructure, pedestrian amenities, etc.

3. Update local land use regulations to facilitate quality development allowing for the efficient development of complete neighborhoods.

4. Update local land use regulations to include compatibility standards that will accommodate new development while minimizing the disruption to the existing community.

5. Regularly monitor the housing supply and support land use changes that encourage more housing choices and proper supply levels.

6. Update local land use codes to ensure the community that new development pays its' own way and does not require community subsidy.

7. Inventory all natural features and cultural attributes that require special protection or special consideration prior to new development.
8. Promote the appearance of open space through clustering of building groups.

9. Create flexible zoning standards to allow for affordable and smaller lot sizes where appropriate and ensure compatibility with adjacent development.

10. Assess the connectivity of new residential neighborhoods with commercial nodes and schools, and assure that walkable distances are in place.

Commercial Zone Values and Policies

- Commercial zones shall be places that provide a wide range of services and goods to citizens in a convenient manner and without creating unnecessary subsidies.

- Commercial areas, nodes, and zones should be located throughout the community to provide convenient shopping, employment, and services to citizens in an efficient manner.

- Commercial zones must include outright permitted and conditional uses adequate to fully support the needs of the Prineville community.

- Commercial zone regulations should be flexible and include incentives to attract businesses to create a self-supporting community and competitive business environment.

- Commercial zones should provide adequate opportunities to locate and operate businesses so Prineville can be as self-sufficient as possible without requiring citizens to make excessive vehicle trips to other communities.

- Commercial zones should receive high priority for improved infrastructure and other government capital improvement programs.

- The downtown business commercial core area is a key feature of Prineville and should be enhanced to provide a draw for all citizens and visitors alike. Convenient and plentiful transportation and parking opportunities are necessary for the success of the downtown area.

- Commercial areas should provide not only service and shopping opportunities but adequate supplies of employment opportunities.

- Commercial projects that contain quality architecture, reflective of the locale and environment, mixed-uses, open spaces, pedestrian amenities, and adequate parking areas shall be required and promoted throughout the community as the city grows.

- Commercial projects that are aesthetically designed to blend in with the environment and are compatible with mixed-uses and residential areas will be encouraged over commercial developments that require large acreages and private parking fields.

- Commercial projects that maximize land spaces and are multi-storied with opportunities for upper-floor and/or offices and housing should be encouraged as a way to utilize valuable lands efficiently.

- Existing strip commercial areas can be unsightly, unsafe, and create excessive vehicle trips. Successful development strategies should include methods for redeveloping and improving the curbside appearance and function of existing strip areas.

- New extensions of commercial strip areas shall be developed only when it can be proven that needed services could not be provided to the community without developing lands at the ends of the exiting strips. Such new extensions shall be designed as centers with shopping streets or lanes instead of direct highway access. Building setbacks in commercial strip areas shall be such as to minimize distances onto sidewalks and streets, thus encouraging safe and easy pedestrian and bicycle access.

- New commercial areas, not at the ends of existing strips shall be designed as commercial nodes or centers to avoid creating new strip areas.

- Commercial areas should allow for service, repair and small manufacturing as a way to preserve industrial parcels in large acreages. Special incentives may be needed to control land prices for these uses.

- New commercial zones should be in areas where commercial and support services are needed and will thrive.

- Marijuana Facilities (MF) may be allowed in Commercial Zones through the application of Marijuana Overlay and process found in the City of Prineville Land Use Code Chapters 153, 153A and 153B.

- Marijuana Grow Sites (MG) may be allowed in Commercial Zones through the application of the Marijuana Overlay and permit process found in the City of Prineville Land Use Code Chapters 153, 153A and 153B.

Programs:

The City shall:

1. Develop an overlay zone or framework plan locating anticipated new commercial areas throughout the community.

2. Evaluate existing commercial zones and determine where and what business services are lacking within the community.

3. Update the local land use regulations in order to improve, enhance, and encourage quality commercial development, including modifying commercial zone setback requirements, parking standards, and bicycle parking requirements.

4. Evaluate and coordinate business incentive programs with other entities and economic development agencies.

5. Prioritize business area needs when developing infrastructure programs and capital improvement planning within the community.

6. Monitor and report on the quality, function, and improvement required of downtown area parking. A parking district program should be explored as a way to maximize parking opportunities.

7. Explore and develop incentives for locating more employment and upper story housing opportunities in the downtown area.

8. Develop a development guideline and site plan template for the downtown area.

9. Update local land use regulations to facilitate quality commercial development promoting efficient development of land and successful commerce.

Industrial Zone Values and Policies

- Industrial areas that are served by adequate community transportation, convenient connections to highway access, workforce housing, water, and sewer, communication, power and gas systems will have a competitive advantage in the Central Oregon Region.

- Industrial zones should provide the greatest density of manufacturing jobs per acre, exclusive of workforce housing, and be located in places that do not disrupt the function of other land uses.

- Industrial zones should provide places for manufacturing, repair, with potential for high concentrations of jobs, products, and services in areas that can be conveniently served by transportation and easily accessed by high numbers of employees.

- Industrial activities should include buffers to protect any nearby neighborhoods and/or workforce housing from the negative effects of industrial activities. Heavy industrial uses should be located away from residential neighborhoods.

- New Industrial zones should be located close to other industrial zones as a way to maximize available infrastructure.

- It is necessary to prioritize capital improvements in industrial areas to attract and retain industrial and manufacturing uses.

- Clean industries are preferred. Industries that produce excessive noxious airborne particulates and non-disposable hazardous waste may not be allowed.

- Industrial zones shall have vegetative buffers to reduce the negative impacts of large, plain buildings, outdoor storage, mechanical equipment, and large parking areas on adjacent less intensive zones or uses.

- Industrial areas that provide a wide choice of parcel sizes including workforce housing options and are highly desirable.

- Large industrial lots of more than 20 acres in size should be reserved as an enticement for attracting new industry.

- Small service, repair, and manufacturing industries should be encouraged to locate in commercial areas, if appropriate, as a way to retain large industrial acreages. Special incentives may be needed to offset the difference in land costs.

- Industrial areas that provide mixed-use opportunities and service uses for employees can reduce excess vehicle trips and community subsidy. They should be encouraged in industrial zones subject to proper siting and regulations that limit standard or non-workforce housing.

- Larger width streets are appropriate in industrial areas as are employee amenities including public, parks, day care, respite areas, trail connections, and other outdoor recreation opportunities.

- Incentives that retain and attract industries to Prineville will benefit the community as a whole by improving the employment and population balance and promote overall economic growth.

- Industrial areas near local airports can enhance commerce and attract compatible aviation activities and industries.

- Industrial areas near the City Railroad facilities can enhance commerce and attract supportive activities and industries. Industrial uses should be encouraged to use railroad facilities for transportation of heavy freight, thus reducing vehicular traffic on roadways.

- There are several older industrial zone designations within Prineville that are no longer appropriate due to: abutting development patterns; redevelopment and site changes that have occurred as a result of a declining timber industry; specific locational characteristics that are better suited to mixed-use urban development patterns; and, brownfield redevelopment opportunities. These unique areas should be converted to other uses subject to proper analysis, zone changes, and plan amendments as needed.

- Conversions of industrial lands to other uses shall only be allowed for development of mixed-use projects. These conversions will only be allowed when the zone change and plan amendment process includes studies, as appropriate, showing that the conversion does not negatively affect the 20 year supply of industrial lands.

- Marijuana Facilities (MF) may be allowed in Industrial Zones through the application of the Marijuana Overlay and permit process found in the City of Prineville Land Use Code Chapters 153, 153A and 153B.

- Marijuana Grow Sites (MG) may be allowed in Industrial Zones through the application of the Marijuana Overlay and permit process found in the City of Prineville Land Use Code Chapters 153, 153A and 153B.

Programs:

The City shall:

1. Maintain an inventory of industrial uses; analyze and determine desired uses.
2. Develop an overlay zone locating new industrial areas throughout the community.
3. Evaluate how to best improve the west entrances to the community adjacent to industrial areas.
4. Update the zoning ordinance to improve development patterns.
5. Develop incentive programs for locating new industry including workforce housing.
6. Modify the Transportation System Plan to include special street standards for industrial areas.
7. Work with local and regional economic development agencies to highlight Prineville as a dynamic place to locate and operate industrial businesses.
8. Coordinate industrial development with railroad facilities and encourage railroad use to the greatest extent possible. Special incentives may be applicable.
9. Monitor and evaluate the Prineville Layout Master Plan in order to provide coordinated land use and activity planning that enhances the nearby industrial areas.
10. Encourage nonpolluting industry.

Goal # 2: Update the UGB boundary when necessary.

Urban Growth Boundary and Policies

- The UGB must include all of the land needed for residential, industrial, and commercial development for ~~at least~~ a 20-year period.
- UGB reserve planning is a valuable tool for predicting future growth areas over a 50 to 100 year period. The appendix contains the map of the UGB expansion areas developed in discussion with property owners and as reviewed at various public meetings. See appendix for the UGB Reserve map.

Programs:

The City shall:

1. Periodically evaluate land capacities and land supplies for each zone and element of the General Plan every 2 years as appropriate.

2. Maintain adequate levels of residential, commercial, industrial, and recreation lands for a 20-year period.

3. Use a variety of methods to predict land needed for a 20-year period.

4. Prepare, adopt, and update infrastructure master plans to properly accommodate growth without excessive public subsidy.

5. Actively seek and acquire land needed for future infrastructure to avoid excessive land prices for property necessary for: transportation, water, and sewer improvements; telecommunication needs; energy needs; emergency service substations; gas; electricity; protection of natural resources; and, other needed facilities.

6. Regularly update and map population projections to support changes to urban growth boundaries and other land use planning tools.

7. Build community consensus and utilize a pragmatic approach when developing annexation programs.

8. Recognize the importance of the agricultural and urban interface areas and reduce conflicts between both uses as growth occurs.

9. The City shall initiate urban area reserve planning in the year 2007 and complete the study for presentation to the Planning Commission for review and recommendation to the City Council. The urban reserve planning study shall utilize a variety of predictive techniques; not limiting the study to just absorption rates, but taking into consideration selective industry incubation, local cultural desires, workforce housing and mixed use development techniques, infrastructure capacity, industry and commercial trending, economic and market studies, incentive programs, labor pool analysis, etc.

10. The City shall coordinate population studies and statistical review with Crook County.

11. The City shall develop an annexation program that evaluates and describes the ways and means of adding land to the City limits. The study shall include a variety of annexation techniques appropriate for a dynamic community and seek to minimize community anxiety about inclusion to the incorporated area. The study shall include a financial analysis describing the advantages and disadvantages of annexation with regard to tax revenues, expense of service delivery, and citizen expectations with a high emphasis on producing satisfaction rather than discord.

12. Prineville shall require open space buffers and/or other development techniques to reduce conflict between urban and agricultural areas.

Goal # 3: Broaden the availability of alternate mode transportation options by organizing land uses in an efficient manner

Alternate Mode Transportation Values and Policies

- Alternate mode transportation opportunities should be expanded as part of new development and redevelopment proposals.

- The topography of the Prineville community is mixed. The outlying areas contain various landforms that necessitate the creation of separate residential areas in-between the rimrock/plateau features. These areas will need to be developed as "complete neighborhoods" to provide proper service levels, infrastructure systems, reduced vehicle miles traveled, and other designs/devices that support alternate mode use.

- The Prineville community desires to move towards creating land use patterns that support a multi-modal transportation system. This technique will seek to connect all areas of the community resulting in greater sustainability of all resources in spite of the challenges created by the varied topography.

- Land use patterns can be improved by the use of master plans for certain developments. Master plans which emphasize aesthetics and community compatibility, circulation, landscaping, open space, storm drainage, utilities, building location and design, and access to commercial and community facilities will provide the most efficient use of land and encourage the use of alternate modes for transportation.

- Higher density residential areas that are within walking distance of shopping, jobs, open space, recreation, and transit services will use land efficiently without sacrificing the existing low density residential character.

- The existing street grid system, with modifications to enhance views and respond to natural topography, is a good way to provide connectivity between all uses and encourage alternate mode use.

- New developments and redevelopment projects that place housing within walking distance of shopping, services, employment, parks, recreation, and schools will be the easiest to serve with transit and other alternate modes of travel.

Programs:

The City shall:

1. Revise the land use regulations to recognize outlying areas will require special design considerations to avoid community subsidy and excessive vehicle miles traveled.

2. Consider efficient land use techniques as a way to use land efficiently and create better sustainability of resources.

3. Revise the land use regulations to include a requirement for master planning, as appropriate.

4. Revise the development regulations to encourage higher density residential development near shopping, jobs, recreation, open space, services, higher order street classifications, and future transit corridors.

5. Develop street standards that regulate the spacing, classification, and placement of needed street types. Higher order streets shall include elements beyond sidewalks to support alternate mode use, including but not limited to the establishment of bicycle lanes.

6. Update the City Code of Ordinances to require adequate bicycle parking facilities when deemed appropriate.

7. Create incentives and other land use regulations that support mixed-use development techniques. The regulations must include effective standards for mixed-use developments adjoining less intensive uses to reduce conflict between such uses.

Goal # 4: Establish appropriate land use regulations to support a sustainable community

Sustainable Community Values and Policies

- Sustainable development techniques and other sustainable community options should be part of many community functions and services.

- Sustainability concepts allow communities to use land wisely and sustain inventories of limited resources for a longer amount of time.

- The community will benefit from incorporating sustainability concepts throughout the governmental structure and the local planning program.

- The community should look to City government as a model for sustainability. Local businesses and industries could benefit from following the demonstrated success of the governmental sustainability programs.

- The community will be able to regulate growth and encourage compact development at the core of the city by providing incentives for infill and redevelopment projects.

Programs:

The City shall:

1. Examine and implement a sustainability program for all City resources.

2. Develop energy efficiency targets and guidelines for the construction, renovation or operation of municipal facilities, incorporating new technologies for passive solar lighting and heating, appliances, HVAC, insulation, high-efficiency fleet vehicles, cooperative purchasing strategies and other applications.

3. Coordinate and develop an informational flyer and website data to help local businesses create healthy and sustainable working environments.

4. Review regulatory, pricing, taxing, and capital improvement practices to encourage urban development within city limits and develop strategies for encouraging compact development of vacant or under-utilized land to limit pressure for expanding the city's boundaries.

5. Promote land use regulations that encourage energy conservation and reduce air pollution.

6. Monitor the sustainability plan for effectiveness and modify the plan where necessary to meet community expectations.

Goal # 5: Establish growth management tools and other strategies to pace land development with the ability to provide the required services within the community

Growth Management Community Values and Policies

- Prineville will need to utilize various planning strategies to accommodate growth and have a higher success rate for developing as intended and with minimum conflict.

- Properly accommodating future growth assures the community that new development and redevelopment are supported by adequate infrastructure.

- Infrastructure expansions and improvements at the core of the community tend to regulate growth at a pace that the community can accept without reducing service levels for existing residents.

- Capital Improvement Plans that support existing industry, commerce and residential areas before serving new urban lands typically utilize limited public funds in an efficient and practical manner without subsidizing growth.

- Growth models can help predict the intended pattern of growth and provide realistic development guidelines for developers.

- Development must "pay its own way" to reduce community subsidy and minimize the negative effects of growth.

- Limitations on development outside of the City limits will reduce unnecessary "leap frog development" and unanticipated City subsidy.

- Developers must be required to analyze the full impact of proposed development upon infrastructure, schools, parks, natural resources, cultural resources and emergency services before development.

- Marijuana Facilities (MF) and Marijuana Grow Sites (MG) may be allowed in Industrial or Commercial Zones through the application of the Marijuana Overlays and permit process found in the City of Prineville Land Use Code Chapter 153, 153A and 153B. Approval of the Marijuana Overlays found in the City of Prineville Land Use Code shall be required to:
    - be consistent with the Comprehensive Plan;
    - be suitable for the MF and MG in accordance with the Prineville Land Use Code;
    - be considerate of the public health, safety, and welfare;
    - be licensed by the State of Oregon.

- This policy establishes guidance for the siting of Measure 91 (aka Recreational Marijuana) marijuana grow sites and facilities in the City of Prineville as authorized by State Law and Federal Law. The City of Prineville has developed Comprehensive Plan Policies and Land Use Codes which establish how Oregon's Measure 91 is addressed by the City of Prineville. The City of Prineville is positioned to allow recreational marijuana grow sites, processing and facilities consistent with the Oregon Measure 91 in the event that circumstances change pertaining to Marijuana, including but not limited to changes of status at the Federal law level.

Programs:

The City shall:

1. Create a priority system for the planning and funding of local infrastructure improvements. Prioritize capital expenditures by a) mandated by legislative authority of State or City, b) maintaining the City's commitment to public health, safety, and welfare, c) maintaining the viability of existing facilities and services, d) increasing the efficiency of existing facilities and services, and e) expansion of the existing system for new services.

2. Utilize transportation system improvements as a growth control measure with highest priority given to projects within the City limits, and maintenance of existing facilities shall receive priority before outer area improvements.

3. Develop an overlay model of desired growth patterns and land uses.

4. Reject public development projects that are beyond the city's financial and physical capabilities to maintain and protect.

5. Analyze fiscal impacts of an annexation concurrent with analysis of potential revenues.

6. Abstain from annexing land without a concurrent waiver of M37 and other necessary requirements such as non-remonstrance agreements and support for future transit.

7. Consolidate the General Plan Map and the Zoning Map into one document.

8. Regularly examine impact fees and other implemented exactions for legal appropriateness and consistency in application.

9. Examine and update all processing fees to make sure that the cost of service is borne by those receiving it.

10. Encourage, monitor, and provide incentives for infill development over new projects at the fringe of the urban growth boundary.

11. Enter into discussions with Crook County to improve the current intergovernmental agreement.

3

Natural Environment

Prineville's Comprehensive Plan

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Natural Environment

April 2006

Chapter 3 Natural Environment

Purpose and Intent

The future of Prineville will be shaped by how the community decides to accommodate growth and balance that against preservation of various elements of the natural environment. The State of Oregon Goal 5 Guidelines establish that the following resources shall be inventoried: a. Riparian corridors, including water and riparian areas and fish habitat; b. Wetlands; c. Wildlife Habitat; d. Federal Wild and Scenic Rivers; e. State Scenic Waterways; f. Groundwater Resources; g. Approved Oregon Recreation Trails; h. Natural Areas; i. Wilderness Areas; j. Mineral and Aggregate Resources; k. Energy sources; l. Cultural areas. Local governments and state agencies are encouraged to maintain current inventories of the following resources: a. Historic Resources; b. Open Space; c. Scenic Views and Sites. Following procedures, standards, and definitions contained in commission rules, local governments shall determine significant sites for inventoried resources and develop programs to achieve the goal.

Prineville's topography and small town charm are inseparably linked with natural floodplains and drainage ways, air quality issues, sensitive riparian areas, steep slopes, varied topography, historic flooding potential, urban flora and fauna, and high water tables. Thus, Prineville will need to adopt development regulations to protect critical areas (sensitive fish and wildlife habitat, frequently flooded areas, steep slopes, wetlands) and preserve air quality. Regulations should be balanced with other local values and in conformance with state law. Efforts to protect the natural environment should focus on maintaining a balance between the economy and ecology of the area while enhancing the aesthetic and livability ideals of the community.

In 2006-07, the City contracted with Winterbrook Planning to prepare site-specific inventories of the location, quantity and quality of Goal 5 resources within and immediately outside the Urban Growth Boundary. Winterbrook worked with Crook County GIS staff to prepare detailed maps and spatial analysis of significant riparian corridors, wetlands, wildlife habitat and scenic areas.

The Goal 5 inventory "clusters" significant natural resource into the following contiguous natural resource sites:

1. **Barnes Butte Scenic Area and Hudspeth Drainage**
2. **Upper Ochoco Creek Riparian Corridor and Scenic Rimrock**
3. **Lower Ochoco Creek Riparian Corridor**
4. **Upper Crooked River Riparian Corridor and Scenic Rimrock**
5. **Lower Crooked River Riparian Corridor and Scenic Rimrock**
6. **Ryegrass Drainage Riparian Corridor**

Winterbrook also worked with Crook County staff to map significant groundwater resources and Goal 7 natural hazards, including steep slopes, slide hazards, floodplains and dry wash areas. There is considerable overlap between Goal 5 natural resources and Goal 7 natural hazards within the Prineville UGB: approximately two-thirds of Prineville's Goal 5 natural resource area is affected by one or more natural hazards.

Next, Winterbrook prepared a draft limited protection program for all significant natural resources. The limited protection program balances urban development needs with conservation of the Goal 5 resource site. Generally, this program begins with existing Crook County and Prineville regulations, and combines Goal 5 (natural resource) and Goal 7 (natural hazard) protection programs where appropriate.

Next, Winterbrook evaluated the economic, social, environmental and energy consequences of three alternatives:

1. full local protection of each resource site (allow no conflicting urban development);
2. no local protection (allow conflicting urban development without mitigation); and
3. limited protection of each resource site based on the draft Goal 5 protection program.

After considering the draft limited protection program and its ESEE consequences, the City adopted a final Goal 5 protection program that implements the following natural resource and hazard policies.

Issues, Goals, Policies, and Programs

The City of Prineville and the surrounding area lie in a spectacular basin framed by dramatic geological forms and resource lands. Area residents have quick and convenient vehicle access to a variety of rural areas, forests, reservoirs, recreational areas, rivers, creeks, and other open spaces. Some of these areas, such as the Crooked River and Ochoco Creek riparian systems, public lands, open spaces, parklands, and plateaus are within the city limits. Preservation and enhancement of surrounding natural environmental system is a vital aspect of the community. Providing trails and alternate mode access to these special areas is necessary to avoid capacity issues, encourage healthy lifestyles, and to encourage safe access by children and adults. Protection of these special areas offers more than just aesthetic benefits; they can preserve the community's natural beauty without sacrificing economic development.

Local area livability can be enhanced and growth can occur in and around special areas if development regulations take the following issues into consideration:

- Opportunities for trail connections to existing and planned public parks and other recreational activities
- Updating the Code of Ordinances to improve regulations related to natural hazards such as flooding, wildfire, etc.
- Special setbacks from cliff edges and architectural design requirements for hillside areas.
- Inventory and analysis of important wildlife habitat
- Enhancement of the urban forest
- Increased air and water quality
- Preservation of key open spaces
- Protection of local values regarding the social and ecological benefits of maintaining the natural environment

Goal # 1: Protect and enhance identified Goal 5 resources and other features of the natural environment using a variety of methods and strategies

Natural Environment Values and Policies

- Local citizens desire to be good stewards of their community's natural resources, including significant natural resource sites and natural hazards shown on the Prineville Goal 5 and 7 inventory.

- The local economy can benefit from efforts to protect the natural environment. Prineville considered the economic consequences of resource and hazard protection in its analysis of economic, social, environmental and energy (ESEE) consequences of alternative resource protection programs.

- Programs are needed to address the protection of the natural environment in a balanced and fair fashion given the urban development goals of the City. Prineville's limited protection program achieves an appropriate balance between urban development needs (employment, housing, schools, parks and institutions), conservation of significant natural resources, and protection of life and property from natural hazards.

- Riparian and wetland areas support important wildlife and ecology and should be retained and enhanced to the greatest extend possible. Wildlife habitat associated with rivers, creeks and wetlands will be protected by maintaining and enhancing riparian vegetation within significant riparian corridors.

- The creeks and rivers that traverse the community need special setback protection and corridor enhancement. Prineville has applied a three-tiered protection program that recognizes different levels of development that have occurred near Ochoco Creek, Crooked River, and the Hudspeth and Ryegrass Drainages.

- The cliffs and rimrock areas should be preserved and local regulations should be crafted to limit development intrusion into these areas. Prineville will continue to apply Crook County scenic setbacks along rimrock canyons as land is annexed to the City, and new local regulations will protect the rimrock face and talus slopes below.

- Barnes Butte provides the scenic backdrop and identity to Prineville, and is recognized as the community's defining scenic resource site. Prineville will allow for an appropriate residential development, while protecting Barnes Buttes and associated steep slopes, dry washes and raptor habitat through a three-tiered protection program.

- The Prineville community has long experience with damaging floods. Prineville will amend the floodplain ordinance to incorporate a "no net loss of flood storage capacity" standard. Significant riparian corridors and wetlands within the 100-year floodplain will have a high level of protection.

- Air inversion policy …[no change, or we could add language noting that tree conservation in riparian/wetland/habitat areas will have positive benefits for local air quality]

- The local water table is high in many areas of the community. To avoid further contamination of local aquifers, Prineville shall protect inventoried groundwater resources through adoption of a well-head protection ordinance as recommended by the Oregon Department of Environmental Quality.

- The open spaces and natural areas within the community need to be inventoried and networks of open space within the community shall be maintained and enhanced, including wildlife habitat corridors, storm water management areas, trails and other sensitive areas. Prineville will maintain updated inventories of Goal 5 natural resource and Goal 7 hazard areas.

- The local urban forest helps to create shade, improve respite areas, enhance drainage ways, and beautiful the community.

- Citizens should have convenient access to natural areas when practical and as long as sensitive areas are not diminished by such access.

- Children and other citizens will benefit from learning about and understanding the special characteristics of urban wildlife and natural habitats.

Programs:

The City shall:

1. Create an inventory of Goal 5 resources and natural areas that require special protection and new regulations.

2. Coordinate with the Crook County Parks and Recreation Department to develop an inventory of open spaces that can complement the system of parks and other recreational spaces.

3. Develop a system of linking open spaces, cultural/historic areas, natural areas, recreational areas, and public parks in coordination with the Parks District and other affected agencies.

4. Create a program that better informs the community about the importance of natural systems, cultural/historic areas, and open spaces.

5. Support and collaborate with the Parks District to keep the community Parks and Recreation Plan comprehensive and updated, outlining current and future requirements for open space and related Goal 5 resources.

6. Work with surrounding jurisdictions, including Crook County and BLM, to develop and implement a regional system of Goal 5 and open space corridors.

7. Evaluate and update all ordinances regarding riparian setbacks, flood plain protection, enhancement and development mitigation.

8. Encourage corridor development for riparian protection, pedestrian use, and wildlife routes.

9. Re-evaluate street design guidelines to include provisions for street trees, paths as alternatives to sidewalks, and plantings that provide shade and a variety of drainage controls.

10. Update and modify development regulations to provide protection of Goal 5 and other natural resources, reduce potential for flooding, and encourage private and/or public-private partnerships to protect and enhance sensitive natural areas.

11. Encourage revenue-producing activities in sensitive areas, resource land, and park and recreation development opportunities if they help protect natural features.

12. Leverage funding for habitat improvements by applying for grants to develop and protect natural areas, build trails, and sustain wildlife as appropriate.

13. Develop focused donation programs to help manage identified sensitive areas, naming of open spaces, riparian corridors, respite areas, waysides, trail segments, and other programs that can count toward grant match programs.

14. Encourage provision of open space with new development by providing developer incentives in addition to minimum standards in regulations.

15. Restore the functions of damaged wetlands and floodplains within the community by identifying a feasible variety of strategies and implementation techniques.

16. Create design guidelines to include provisions for critical areas and natural resource lands that minimize fragmentation of species and habitat due to development.

17. Limit development that diminishes desired or indicator species in or adjacent to fish and wildlife habitat areas.

4

Parks, Recreation and Open Space

Prineville's Comprehensive Plan

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Goal #1: In collaboration with the Crook County Parks and Recreation District and other partners, provide public parks, recreational facilities, trails, programs and events that meet the diverse needs of users, and that enhance the health, livability, and quality of life of the community.

- Policy 1. Promote a collaborative system to maximize the benefits of parks and recreation. Ensure a consistent and seamless arrangement for system operations.
- Policy 2. Activate parks, and facilitate the coordinated provision of recreation programs and events.
- Policy 3. Enhance existing parks and facilities and develop new opportunities to provide engaging community recreation and social spaces that meet the needs of residents, workers, and visitors now and into the future.
- Policy 4. Protect natural resources and provide trails to connect people to parks, open space and community destinations.
- Policy 5. Maintain and replace assets in a sustainable manner and preserve and showcase the area's historical and cultural heritage for future generations.

Chapter 4 Parks, Recreation and Open Space

Purpose and Intent

The State of Oregon requires that cities manage and operate adequate facilities for recreation and open space. Key elements of the parks plan required by the state include a map to indicate the location and boundaries of the park system, and appropriate zoning and map designations including objective land use and siting review criteria. Open space responsibilities also overlap with Goal 5 issues but the emphasis for utilization and preservation remains the same.

This chapter discusses how the City of Prineville intends to provide public parks and recreation areas and strives to strengthen the City's parks and recreation opportunities through land use strategies and inter-agency cooperation. Based on the Unified Parks and Recreation System Plan developed in collaboration with the Crook County Parks and Recreation District (CCPRD), this chapter describes existing conditions, community needs, goals, and policies related to the park system. The Unified Parks and Recreation System Plan is herein adopted by reference and provides a more comprehensive description of the park and recreation system and the long-term plan for the future.

The City and CCPRD have been successful working together to leverage resources for the parks and recreation system. With over 19 sites that represent approximately 915 acres of public parks and recreation facilities, and dozens of programs and community events, parks and recreation are a major part of community identity and livability and central to the area's long-term future.

Background

In 1983, voters formed the Crook County Parks and Recreation District with boundaries based on the City's urban growth boundary. The City owned and managed parks prior to transferring these sites to CCPRD. In 1990, CCPRD expanded its boundary through annexation and the current boundaries match the Fire and Rescue District, Fire Zone #2.

In 2004, CCPRD completed a Comprehensive Plan for parks and the improvement and development of District operations and administration, parks and facilities, and recreation programs. In 2021, the City completed its first comprehensive plan (the Unified Parks and Recreation System Plan) for parks and recreation in partnership with CCPRD and with support from Crook County. The Plan outlines priorities for the future guided by the community's vision, a technical analysis of needs, and a strategic approach to implementation.

Issues, Goals & Policies

Prineville's unique setting, climate and culture all influence park and recreation opportunities. Located in Central Oregon's high desert, Prineville is surrounded by agricultural lands and publicly managed open spaces including the Crooked River and Crooked River National Grasslands, and Ochoco National Forest. Many local schools also provide opportunities for public recreation and use during non-school hours. The area's many park and recreation opportunities are central to the area's high quality of life, but steady growth and continued demands on park services resources are important considerations for the future.

Park Land

Together, the City, County and CCPRD own or maintain 19 parks and facilities, totaling approximately 915 acres. Only two sites are outside of the city, but within the CCPRD boundary (Crooked River Wetlands and Ochoco Lake Campground). CCPRD serves a population of approximately 14,269 residents (2017 Crook County estimates) and covers approximately 60.8 square miles. Just outside the city, there are approximately 467 acres of state land, as well as thousands of acres of national forest east of the CCPRD boundary. The Crooked River Canyon (a designated Wild and Scenic River), Prineville Reservoir, and Ochoco Lake are also popular destinations nearby.

Park Inventory Summary

Park Type	Total Acreage	Total Sites
Neighborhood Parks	22.2	9
Community Parks	55.4	3
Natural Areas	120	1
Special Use Sites	239*	4
Undeveloped Parks	480	3

Source: Crook County GIS, City of Prineville. *Includes acreage for golf course, fairgrounds, Crook County RV Park, and Ochoco Lake Campground.

There are many different types of recreation facilities that offer places to play, relax, or gather. Ochoco Creek Park serves as the city's central park and offers the largest range of experiences, from community gatherings and play to off-street biking and basketball. Most parks provide restrooms, picnic facilities, and an open lawn area. Fewer sites offer places to play or dedicated natural areas as part of the park design. There are also several specialized facilities such as camping areas, off-leash dog areas, and public art/memorials.

In 2017, the City completed the Crooked River Wetlands to improve municipal wastewater treatment. The wetlands now provide a range of benefits from cost savings and recreational opportunities to educational and environmental benefits. The City also conducted major changes to

the water distribution system to improve water conservation efforts and protect the city's water supply. During this same time the City acquired the Barnes Butte Recreation Area, a 460-acre parcel located at the east end of the city limits.

Camping

CCPRD provides camping areas at three sites. Located close-in to Prineville, the RV Park borders the fairgrounds and offers a range of amenities for RVs, as well as camping and reservable cabins. In addition to campgrounds, Ochoco Lake and Haystack Reservoir provide access to water recreation, and also offer day use. A large percentage of CCPRD's budget stems from camping fees.

CCPRD Camping Areas

Site	Owner	Spaces	Amenities
Crook County RV Park	Crook County	• 81 RV sites • 9 tent sites • 2 cabins	RV hookups, laundromat, community room, WiFi, dump station, pavilion
Ochoco Lake	Oregon State Parks	• 22 tent sites • 4 hike/bike sites	Potable water, picnic tables, fire pits, restrooms, boat launch, trails, swimming
Haystack Reservoir	BOR	• 16 RV/tent sites • 3 reservable sites	Picnic tables, restroom, trails, boat launch, swimming

Trails

There are a variety of paved and unpaved trails in Prineville. The City's Transportation System Plan (TSP) lists a total of four off-street paved trails totaling approximately 3.2 miles competed as of 2013. In addition, many of the proposed bicycle plan elements of the Crook County TSP provide direct connections to the City of Prineville. Since this time, the City has been active in adding additional trails and connections to this network. As part of the Ochoco Mill Site redevelopment, the multi-use path on the east side of Combs Flat road has been constructed from 3rd Street south to the hospital.

The 66 Trail System provides the primary nearby single track trail access for all ability levels. The existing 2.3 miles of Lower 66 trails are contained within Oregon State Park property. Managed by the Central Oregon Trail Alliance (COTA), volunteers are actively expanding this trail system on both sides of Highway 126. Along with city trails, the Crooked River Scenic Bikeway extends 25 miles south from the City of Prineville, along Highway 27 to a point just below Prineville Reservoir's Bowman Dam.

Existing Off-Street Paved Trails

Trail	Approximate Length (miles)
Ochoco Creek Shared-Use Trail	1.7
Highway 26 Trail	1.0
O'Neil Highway Trail	0.2
Iron Horse Trail	0.3
Total	3.2

Recreation Programs and Events

CCPRD partners with other providers and volunteers to offer over 30 different programs, classes, events, and camps. For overall enrollment, fitness/health-related classes such as gymnastics and karate, and educational/technical classes such as dog obedience and hunter safety have experienced the largest recent enrollment. There is limited capacity for indoor spaces and facilities such as Ochoco gym and the Juniper Art Guild are at capacity for scheduling additional activities. CCPRD programs draw participants from within the CCPRD boundary and beyond. Based on enrollment data, there are a considerable number of participants that live outside the boundary.

Management and Operations

Prineville's major public agencies share responsibilities in providing parks and recreation services, including the City and School District. The City is responsible for management and operations of the golf course, Barnes Butte Recreation Area and the Crooked River Wetlands complex, while the School District provides public access to several indoor facilities and fields. To promote coordination, the Local Intergovernmental Committee involves members from each of the major governmental agencies at the local level, including the City, School District, and CCPRD.

Community Needs

Throughout development of the Unified Parks and Recreation System Plan process, the City and CCPRD relied on a range of events and activities to hear from the public and identify the types of ideas and improvements that will be needed to build a stronger system of public parks and recreation opportunities. The following are needs identified for parks and recreation areas within the City of Prineville and CCPRD boundary.

- Diversified, multi-generational experiences: In general, a focus on offering age-appropriate activities emerged as a key opportunity, as well as supporting activities that people of different ages could enjoy together. Many parks lack play areas or have play areas that are aging or limited in interest for different age groups. Providing more opportunities for teens

was among the top three areas participants would like to see expanded, followed closely by opportunities for older adults/seniors, and then kids (6-12). Another widespread recommendation involved providing more ADA accessible recreation opportunities.

- Opportunities for year-round enjoyment: Numerous responses captured a desire for Prineville residents to enjoy places to play or recreate year-round, particularly during winter months. In general, a common sentiment emerged, describing a lack of places to play and socialize indoors throughout the year. Questionnaire respondents identified covered and indoor spaces as the second greatest need for Prineville's parks and facilities.

- Repairing/replacing the community pool: Prineville's only community pool (the public pool at Ochoco Creek Park) was built in 1950 and CCPRD and pool supporters have been looking into options for its future. According to the questionnaire, building a new pool as part of a community recreation center was the top need by a significant margin (67%) and updating/rebuilding the existing pool also received strong support (27%). Further supporting this desire, questionnaire results showed swimming as one of the most popular activities.

- Integrating nature: A connection to nature stands out as a distinguishing aspect of Prineville's system. Prineville and the surrounding area offer a wealth of experiences from backcountry adventure and exploration to scenic routes and vistas. Community members and visitors enjoy spending time in nature and value large natural areas and undeveloped sites. Some of questionnaire respondents' most popular destinations are the trails looping around the Barnes Butte Recreation Area, the green space within Ochoco Creek Park, and the open space in the Crooked River Wetlands Complex. Residents appreciate these wild, undeveloped spaces, particularly for walking, exercising, dog walking, and observing wildlife. Connections to nature inspired a range of ideas for exploration.

- Expanded trail network: Prineville has good connectivity and an emerging trail system, with an even greater potential to expand the network. Similar to state and regional trends, walking and trail-based activities are of the top activities in Prineville. Building on the need for safe, walkable access to parks and the popularity of cycling, an interconnected multi-modal trail network linking Prineville parks is a major opportunity.

- Safe, family-friendly places: Questionnaire respondents who don't use parks in Prineville cited feeling unsafe/unwelcome as the primary reason (along with being too busy) keeping them from using parks. Prominent issues involve the perception of homelessness, antisocial behavior, drug/illegal activity and trash. Overall, community members are seeking improvements to make all of Prineville's public spaces feel comfortable, welcoming, and safe.

- Fiscal sustainability: Participants expressed concern about sufficient budget to maintain existing parks and facilities, renovate or add new facilities, and keep recreation costs affordable for community members. Parks management and quality may be compromised due to high demand and resource shortages.

Goal #1: In collaboration with the Crook County Parks and Recreation District and other partners, provide public parks, recreational facilities, trails, programs and events that meet the diverse needs of users and that enhance the health, livability, and quality of life of the community.

Policy 1. Promote a collaborative system to maximize the benefits of parks and recreation. Ensure a consistent and seamless arrangement for system operations.

The City shall:

- Follow a formalized collaborative approach to providing parks and recreation services. Work closely with CCPRD, the County, School District and other partners to ensure a collaborative approach to the provisions of park and recreation services. CCPRD will serve as the primary lead in providing these services.
- Coordinate the land use and development process. In the City of Prineville, the City will lead the land use development process using this Plan as a guide and coordinating with CCPRD and the County as applicable.
- Work with CCPRD and the Chamber of Commerce to explore opportunities for private recreational enterprises or public/private partnerships, and to promote tourism within the city and greater region.

Policy 2. Activate parks and facilitate the coordinated provision of recreation programs and events.

The City shall:

- Integrate the area's unique history and cultural heritage in the parks and recreation system.
- Provide signage and facilities to support environmental education and interpretation, including information on wildlife in developed parks and natural areas, particularly at points of interest such as trailheads, viewpoints and sensitive areas.
- Designate the Crooked River Corridor as a hub for recreation. The cluster of parks, natural areas, historic sites, and recreation areas along the Crooked River should be leveraged for natural resource protection, economic development, and community identity.
- Evaluate and improve park accessibility. Working with the CCPRD, complete an ADA assessment and/or transition plan to identify required upgrades in accordance with the Americans with Disabilities Act.
- Work with local partners to increase localized events and keep them relevant/stimulating.
- Collaborate with local and regional partners to build necessary infrastructure for bicycle tourism.

Policy 3. Enhance existing parks and facilities and develop new opportunities to provide engaging community recreation and social spaces that meet the needs of residents, workers, and visitors now and into the future.

The City shall:

- Continue leveraging park land level of service standards. Any decision to add new park land should consider a range of factors including park access, needed maintenance and ongoing operating expenses and additional factors as part of the land review process.

Existing and Future Park Land Levels of Service

Park/Facility	Total Existing Acres	Adopted Park Land Level of Service Standard (acres/1,000)	Existing Park Land Level of Service (acres/1,000)	2040 Future Level of Service (acres/1,000)
Neighborhood Parks	22.2	1.5 to 2	1.6	1.21
Community Parks[1]	73.4	5 to 7	5.1	4. 0
Total Developed Parks [1]	95.6	N/A	6.7	N/A
Natural Areas[2]	580	20+	40.6	31.6
Special Use Sites	239.3	N/A	N/A	N/A

Notes: [1] Includes Seehale Property (18 acres); [2] Includes Barnes Butte (460 acres).
Source: Portland State University Population Research Center, "2019 Annual Oregon Population Report Tables," Table 4 (population of Prineville and Crook County). Population of Crook County Parks & Recreation District was estimated by FCS GROUP; Existing population (2019) = 14,269; Future population (2040) = 18,348.

- Coordinate with CCPRD to implement adopted park dedication standards. CCPRD should continue to identify potential future neighborhood parks in future growth areas using approved park dedication standards, as well as other design and acquisition guidelines.
- Develop a land dedication policy based on the recommended classification standards and the anticipated cost of developable park land.
- Coordinate new park design and development with surrounding land uses. Design and develop parks that consider nearby neighbors and land uses.
- Design parks with consideration for sustainability, water quality, water conservation, and flood impact mitigation. All new recreation facilities should be designed and constructed using green design and development practices.
- Embrace park connections to water with waterfront paths, overlooks, and access. Collaborate with CCPRD to acquire strategic areas along rivers and canals to protect and conserve scenic, recreational and natural areas that are accessible to the community.
- Design all facilities for operational efficiency and safety, and for barrier free access as required by the Americans with Disabilities Act (ADA).
- Focus on place making to create parks as memorable and engaging places. Emphasize park design, site character, identity, and sense of place through the use of art, colors, plantings,

natural elements and topography. Incorporate natural, cultural and historical elements and interpretive/educational features.

Policy 4. Protect natural resources and provide trails to connect people to parks, open space and community destinations.

The City shall:

- Continue to build on the river corridor vision by focusing on continuous and connected greenways along the Ochoco and McKay Creeks, and the Crooked River for safe and efficient multi-modal connectivity and healthy wildlife habitat.
- Continue to develop a comprehensive and inter-connected off-street trail system that provides connectivity to destinations throughout Prineville and to surrounding destinations for bicyclists and pedestrians.
- Collaborate with State Parks to identify a solution for safer access to the 66 Trails.
- Create opportunities for residents and visitors to connect with nature, both physically and visually, including new or improved pollinator patches, protection or integration of native plants, introduction of urban wildlife corridors, and protection and access to natural areas.
- Integrate flood mitigation into site design. Parks in flood zones should be designed to control floodwater during rainy seasons, while also designed for passive recreation and non-motorized connections.
- Pursue master planning and phased improvements at the Barnes Butte Recreation Area. As part of ongoing planning, the City should work with CCPRD to examine potential for BLM lands near Barnes Butte.
- Acquire open space lands, when appropriate, as a means of protecting unique environments and providing passive recreation opportunities.
- Improve the urban tree canopy in parks and along street frontages.

Policy 5. Maintain and replace assets in a sustainable manner and preserve and showcase the area's historical and cultural heritage for future generations.

The City shall:

- Coordinate with CCPRD in maintaining park and recreation facilities based on the needs and characteristics of specific parks.
- In collaboration with the County and CCPRD, develop a reporting program for all park concerns or maintenance needs. Use the program to track the types of maintenance needs and park or facility "hot spots" to inform future workload planning and annual budgets.
- Working with CCPRD, ensure adequate staffing levels to deliver safe, high quality, and needed park and recreation services.
- Use sustainable, easy-to-maintain landscaping materials and practices in all parks.
- Develop and implement edge treatments to improve the management of the areas where traditional park features intersect with natural areas.

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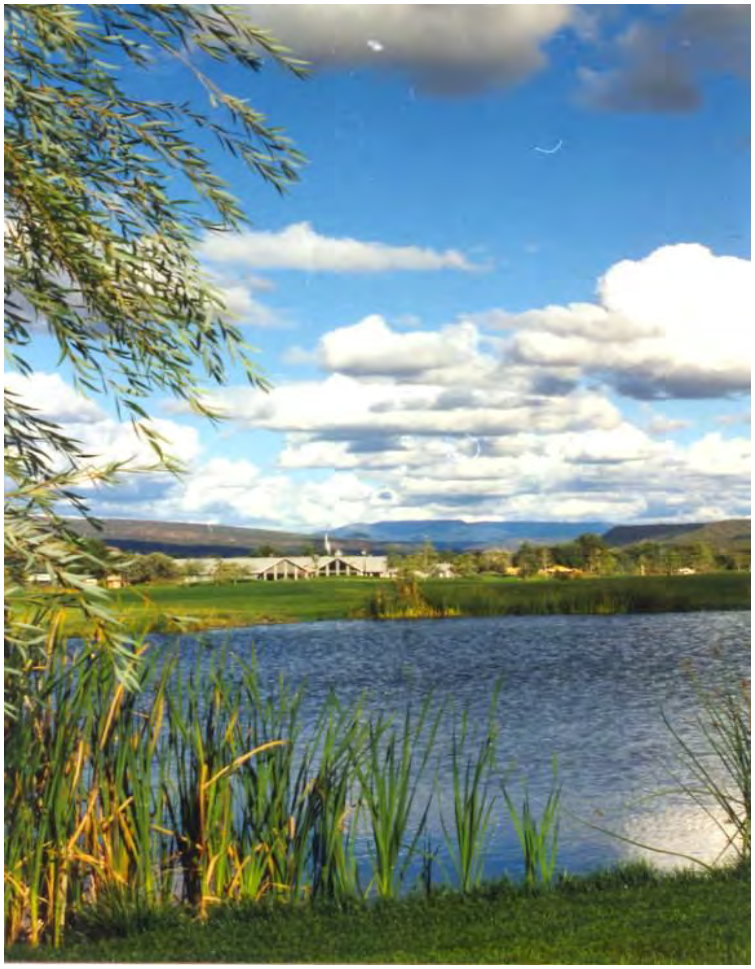

Economy

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Chapter 5 Economy

Purpose and Intent

Goal 9 of Oregon's Statewide Planning Goals and Guidelines pertains to economic development. This goal calls for diversification and improvement of the economy. It requires communities to inventory commercial and industrial lands, project future needs for such lands, and plan and zone enough land to meet those needs. Thus, the City of Prineville is required, by law, to provide at least a 20-year supply of commercial and industrial land and commensurate infrastructure. The goal also requires that comprehensive plans shall "*include an analysis of the community's economic patterns, potentialities, strengths, and deficiencies as they relate to state and national trends*."

There is no dispute that successful commercial and industrial activity requires sufficient and suitable land inventories. Careful attention to the necessary space requirements and locational considerations of potential commercial and industrial uses is necessary to promote, maintain, and encourage a variety of local economic activities on lands that are competitively priced. It is generally understood that when the supply of economic lands are constrained, land prices unnecessarily increase and this could reduce Prineville's chances at attracting business.

In conformance with Goal 9, the City conducted and updated a Buildable Lands Analysis[1] in order to evaluate land availability and examined market trends. Other studies were also used to determine land supply and long-term land needs and together with the updated buildable lands inventory, are good data sets from which to derive assumptions about economic land needs. Local and regional experts have also supplied the city with information about other economic factors that affect Prineville. The findings derived from the Buildable Lands Analysis and other studies were used to address the key factors of Goal 9 identified above. The bulk of these data sets are located in the appendix.

Understanding the City's economic assets will also be a key task in analyzing the existing and future economy. Land use planning, permitting processes, infrastructure development and related efforts of the City will influence future business development. Coordination with local business groups such as the Chamber of Commerce and Economic development For Central Oregon will be essential to identifying what type of development enhancement and infrastructure is necessary to support desired industries. The City and private groups will need to work together and implement programs as necessary to help companies and new businesses easily locate in Prineville, expand, and stay competitive in the local and regional markets.

Issues, Goals, Policies, and Programs

Assumptions and Trends

The City of Prineville can play an active role in helping to support the local economy by continuing to enhance existing businesses and generate new activity. The local economy of Prineville is directly tied to land zoning and available supply, historical land uses, local and regional

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[1] *The analysis has been updated as needed to reflect actual land absorption, City Council policy, and other relevant inventory monitoring factors.*

demographics, labor pool, suitable housing, public services and transportation facilities. City regulations have a direct impact on the ability of existing business to expand and attraction of new business.

Private and public economic development efforts should focus on strategies that increase the opportunities for existing businesses. Likewise, efforts should also focus on expanding the possibilities for future workers and entrepreneurs by offering opportunities for local citizens to stay in the community and obtain nationally competitive jobs.

The national economy, society, and environment are key factors that will influence the local economic climate of Prineville. This chapter illustrates Prineville's existing economic patterns and potential economic opportunities. The analysis begins with a review of the current economic state of economic development in Prineville and Crook County. It also is necessary to identify any obstacles to future enterprise. This type of analysis approach can strengthen the community's position as a unique, established, and attractive place to work, live, shop, and recreate.

Access and Location

The City of Prineville is a small community approximately 17 miles outside of the Highway 97 corridor, which is a vital link to the Willamette Valley and other metropolitan areas. The location of the community and proximity/distance from Highway 97 will continue to be somewhat of an obstacle for new businesses and industries that rely on speedy shipping and proximity to support services in Bend, Redmond, Portland-Metro and the I-5 Corridor. However, the charm of the area, quality of life, good development climate, Enterprise Zone, City-owned railway, volume of available land and lower land costs will continue to be elements that can help overcome the distance to regional highway issues. The recent development of the Millican Highway connection from Highway 20 (Burns) to Highway 126 at the industrial park will be an advantage for trucks looking to avoid the congestion in Bend and Redmond. Even though the community is removed for the Highway 97 corridor, the time savings gained from the Millican Highway connection will help to compensate for the loss in direct or origination trips. The addition of truck stop services near the intersection of the Millican Highway and Highway 126 will help to serve the industry while reducing the negative impact of the truck traffic upon the rest of the community at the City center.

Alternatives to Access Difficulties – A Focus on Technology

Difficulty in reaching convenient access to regional transportation corridors can be partially overcome by transitioning to a technology and knowledge-based economy. Jobs that rely upon the development of technology and the transfer of knowledge products do not necessarily rely upon large amounts of truck shipping necessitating regional highway access. Information and technology markets influence and support all types of industries from retail to wholesale to manufacturing and service firms. Such industry is changing the speed and efficiency of business operations, the skills of workers, and the expectations of consumers. As a result, business owners and employees in the technology industries do not need to solely rely on ground shipping to deliver products to customers. Linking economic development strategies to a technological based economy is a trend that will be critical to enhancing the local job market.

Downtown Prineville - The "Core" Commercial Area

Prineville has a viable downtown area, which serves as a central feature in the community. Various studies have shown that this is where the maximum effort should be expended to improve the retail business climate. The downtown area could benefit from the addition of commercially zoned lands as necessary to deepen lots and broaden redevelopment opportunities.

Other Commercial Areas

The existing development patterns and commercial zoning designations have given rise to commercial development adjacent to the primary roadways in a "strip" configuration. The negative effects of such strip development include:

- poor access control, conflict with ODOT, and undesirable access for commercial developments;
- shallow lot depth limiting future business or center–type development;
- poor sign control and limited aesthetic options;
- longer vehicle trips to reach needed shopping services; and,
- reduced opportunities for buffering between land uses.

Strip commercial areas on the edges of the community force shoppers to travel by cars along the primary access ways. Pedestrian and alternate mode opportunities are lost when commercial zones are located great distances from population centers and neighborhoods. In addition, sole reliance upon vehicle travel to reach strip shopping areas can lead to unnecessary vehicle travel and expensive widening improvements along major roads. The synergy of commercial activities is lessened when commercial uses are not located in centers or downtown. Mixed-use zoning and rezoning of certain parcels to provide enough land in sizes necessary to accommodate commercial centers rather than a continuation of additional shallow-depth strip commercial will be necessary to provide a better balance of commercial development and reduce unnecessary vehicle trips.

Industrial Areas

The community also has a major industrial area near the Prineville Airport and a railroad dependant industrial area in the NW quadrant. These industrial areas are top priorities for local decision makers concerning infrastructure planning and economic expansion incentives.

There are various older, industrial areas scattered around the city, but these tend to create incompatibility issues with adjacent residential and mixed-use areas as well as disrupt natural drainage ways and riparian areas. Some of these older industrial areas have been developed with residential uses and suffer from incompatible Plan designations. The City intends to rezone the undeveloped portions of these industrial areas to mixed-use areas and residential zones without negatively affecting the industrial land inventory. The trend to incorporate mixed-uses on lands that are incompatible with established residential uses will enhance the ability of the community to add more mixed-use zones throughout the urban growth boundary. The properties slated for proposed rezoning are shown on Map No. 3 in the appendix.

Critical Drivers of Prineville's Economy

Many factors drive an economy. Some are influenced by the global economy, others by federal and state policies, and still others by regional elements. Some factors are in the control of the community and others are not, yet they all interrelate. One of the first steps in developing sound

economic development plans is to understand what drives the local economy. The factors identified as those most directly affecting Prineville's economy included:

Types of Businesses:

- Traditional manufacturing businesses: products, components, machines, farm and construction equipment, woods, metals, glass, stone, fertilizer and chemicals, and composite materials.
- Emerging businesses: high tech, Internet, e-commerce, creative services, and, mixed-use developments providing jobs and workforce housing to reduce employee commute time/highway congestion.
- Support businesses: Suppliers, retail, services and repair, personal and business services. A variety of company sizes: from small to large - commensurate with growth trends.

Business Operations:

- Skilled workers
- Workforce housing
- Telecommunications capacity
- Access to support services
- Access to capital

Regional Development Factors:

- Infrastructure & transportation
- Land availability and cost factors
- Affordable housing
- Access to post-secondary education system

Business Climate Factors:

- Public policies, fees, land use restrictions
- Tax structure and Strong stable government
- Transportation options

Livability & Image:

- Small town charm, arts & culture, access to services
- Growth management
- Overall quality of life
- K-12 education system
- Access to health care
- Access to quality shopping and recreation

It is essential that Prineville's community leaders examine how these drivers, whether they are strengths or weaknesses, affect economic development planning. Businesses, industry groups, the Chamber of Commerce, city staff, community development representatives and others involved in the adoption of the Plan identified the following as *key issues* that will likely influence the future economy.

1. The ability to capture the growth in emerging industries such as high tech, software, bioscience, and e-commerce.
2. The ability to redevelop areas to meet density and employment goals while keeping a sense of place.
3. The need to consider small business and local services as part of the overall economic picture.
4. How to develop an image for Prineville that will support and retain existing businesses and attract new ones.
5. The link between Prineville's economy and that of the broader Central Oregon region.
6. How to identify, improve, and pay for the basic transportation and infrastructure needs necessary to facilitate business development.
7. How to develop and retain quality workforce housing.

Existing Economic Conditions – *National, State, and Local Trends*

The community will need to monitor and consider the importance of local and national trends and related economic activities as part of local growth management. For example, the *2000 Census, Economic Development for Central Oregon (EDCO)* and other local experts have provided data used to forecast certain features of the local economy. This data is utilized in the subsequent economic evaluation detailed below.

Labor Statistics and Trends

The unemployment rate in Crook County was at 4.4% in 2000, which was slightly lower than Central Oregon (Crook, Deschutes, & Jefferson County) at 4.9% but higher than the nation at 4.0% for the same year. The primary means of transportation for the local workforce was private vehicles where 69.3% of the workers drove alone while commuting to their jobs. Interestingly, 23.6% of Prineville's commuters carpooled to places of employment and only 3.3% walked to work.

Local Unemployment Rates as Compared to State and Nation

	Central Oregon	Oregon	U.S.
1996	8.7%	5.9%	5.4%
1997	8.1%	5.8%	4.7%
1998	7.2%	5.6%	4.5%
1999	6.7%	5.7%	4.2%
2000	6.5%	4.9%	4.0%
2001	6.9%	5.9%	4.8%
2002	8.0%	7.5%	5.8%
2003	8.0%	8.2%	6.0%
2004	7.0%	8.5%	5.5%
2005	6.1%	6.9%	5.1%
2006	5.4%	6.0%	4.6%

Crook, Deschutes and Jefferson Counties vs. Oregon and U.S.
Sources: U.S. data from January 2007 Employment and Earnings (BLS), Oregon and regional data from Oregon Employment Department.

Car commuting in Crook County is higher than other places in Central Oregon. This is expected because of the rural setting and distance from other employment areas in Bend and Redmond contributing to a higher commute rate. This situation will not change until the local population can support more industry, service and retail choices in the Prineville community.

	Central Oregon**	Oregon*	WA*	CA*
TRADE				
Plumber	$23.52	$24.40	$23.58	$20.36
Receptionist	$10.82	$10.50	$10.93	$11.20
Secretary	$12.65	$12.64	$14.06	$14.25
Truck Driver, Heavy	$16.34	$15.83	$17.03	$16.75
PROFESSIONAL				
Industrial Production Manager	$34.54	$33.63	$35.66	$36.07
Marketing Manager	$37.21	$38.03	$41.30	$42.47
Electrical Engineer	$32.49	$33.12	$33.96	$36.01

Average Wages Offered for Selected Occupations

*Bureau of Labor Statistics (2001 most recent stats) **Oregon Employment Department (2002 stats)

Income Level Comparisons

Income Levels										
	Median Income (family of 4)*					Per Capita**				
	2004	2003	2002	2001	2000	2002	2001	2000	1999	1998
Crook	$47,900	$45,100	$35,300	$34,700	$34,400	$21,859	$21,070	$20,225	$21,168	$19,905
Deschutes	$57,800	$54,200	$45,000	$44,200	$41,600	$28,193	$27,585	$26,469	$26,077	$24,784
Jefferson	$45,200	$43,800	$36,700	$36,500	$35,900	$20,510	$17,867	$17,746	$18,806	$18,328
Oregon	$58,600	$56,300	$48,900	$47,800	$46,000	$28,792	$28,222	$27,660	$26,261	$25,446

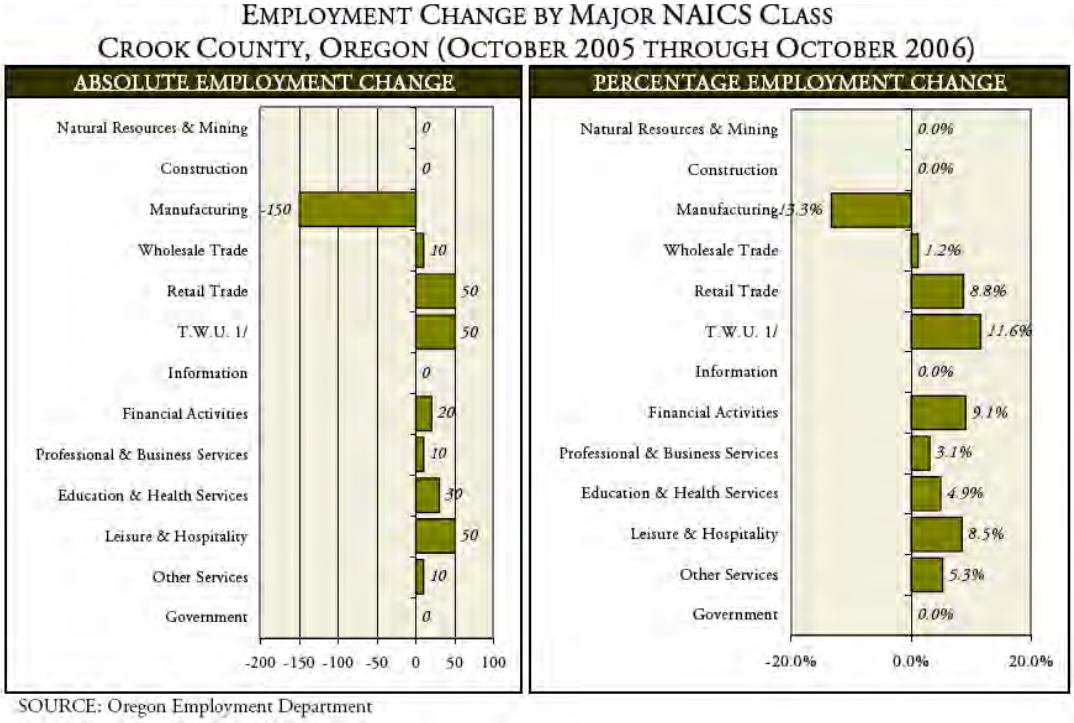
*U.S. Department of Housing and Urban Development

**U.S. Bureau of Economic Analysis

Sources: U.S. data from January 2001 Employment and Earnings (BLS), Oregon and regional data from Oregon Employment Department.

Availability of Products and Services

Competition for products and services currently provided by Bend and Redmond will typically continue until there is an adequate demographic base in Prineville to support additional shopping, employment and service needs of the community. The large commute has certain disadvantages in that it tends to over-utilize existing road capacities at peak hours and this creates a high subsidy for City and State transportation projects, etc. However, the ability for business owners to draw from a wide labor pool is an advantage and helps to broaden job choices for residents. As the community diversifies and moves further away from a farm and forest based economy the opportunities for more variety in employment *and* shopping choices is expected to increase.



SOURCE: Oregon Employment Department

Employment Changes

Industry growth was led by Transportation and Warehouse (11.6%), Financial Activities (9.1%), Retail Trade (8.8%), and Leisure and Hospitality (8.5%). Manufacturing was the only industry that had a net loss of jobs between October 2005 and 2006. The manufacturing industry lost 150 jobs for a decrease of 13.3%. This decrease is attributable to a decrease in wood product manufacturing. The Oregon Employment Department releases updated ten year employment forecasts every two years at the regional level. The most recent forecast (2004-2014) indicates an anticipated 17,520 job increase for Region 10. Future employment gains are expected to be realized largely through service sector growth. Roughly 50.3% of anticipated employment growth is projected to originate from Professional & Business Services, Education & Health Services, Leisure & Hospitality Services, and Other Services. Prineville and Crook County lie within State of Oregon Assessment Region 10. The Region 10 data indicate that non-farm income is dramatically increasing. These regional reports show that manufacturing, lumber remanufacturing production and service sectors are expanding as population growth occurs.

Primary Industries and Employers

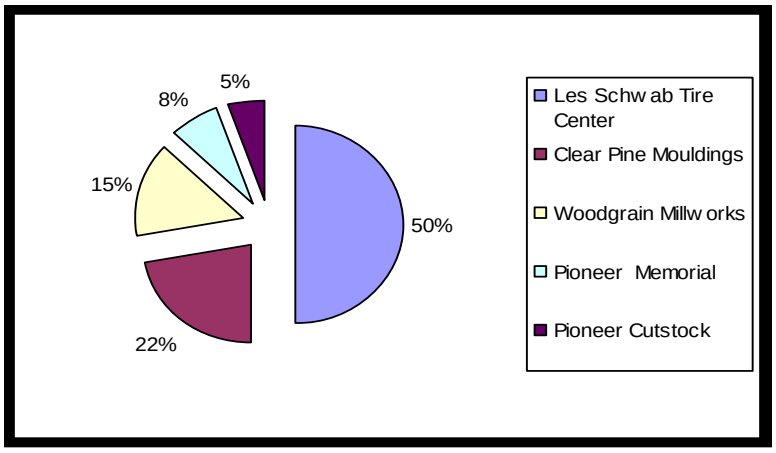
The primary industries in Crook County and Central Oregon are listed in the table below.

PRIMARY INDUSTRIES IN CENTRAL OREGON

County	Industry	Total Employment
Crook	Agriculture	400
	Distribution & Warehousing	1,402
	Education & Health Services	559
	Tourism	425
	Wood Product Manufacturing	1,084
Deschutes	Computer & Electronic Manufacturing	362
	Distribution & Warehousing	862
	Health & Social Assistance	5,908
	Professional, Scientific & Technical Services	1,889
	Recreational & Transportation Equipment	1,110
	Tourism	7,652
	Wood Product Manufacturing	1,920
Jefferson	Agriculture	630
	Health & Social Assistance	198
	Manufacturing & Fabrication (includes Wood Product Manuf.)	1,264
	Recreational Equipment Manufacturing	250
	Tourism	556

Local occupations are distributed among several areas and are consistent with the recent Census data. Management, professional, and related occupations cover about 21% of the employed individuals in Prineville; 26.7% in production, transportation, and material moving; while another 37% work in the sales, service and offices occupations. Farming accounts for only 2.5% of city occupations and less than 1% of total revenue generated in Crook County.

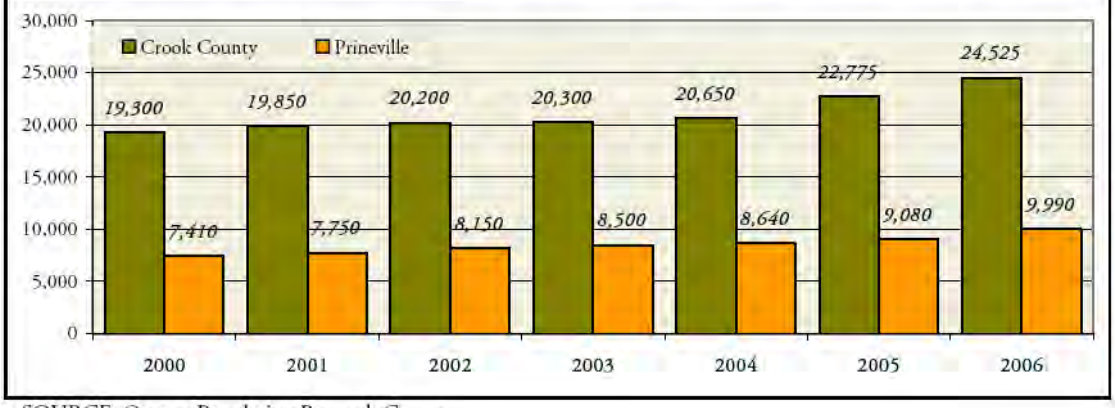
Top *Private* Largest Employers in Prineville



Prineville has the highest per capita of manufacturing jobs in the state. The demand for remanufactured wood and secondary wood products, high number of ground transportation companies (7), and the Les Schwab distribution plant are the primary reasons for this situation.

Annual Population Estimates
State, Regional, & Local Trends (2000-2006)

Region/ Location	Year (July 1st Estimates) 2000	2001	2002	2003	2004	2005	2006	00' - 06' Growth	05' - 06' Growth
Oregon	3,436,750	3,471,700	3,504,700	3,541,500	3,582,600	3,631,440	3,690,160	1.2%	1.6%
Region 10	155,050	161,300	166,550	170,700	176,350	186,865	198,205	4.2%	6.1%
Crook County	19,300	19,850	20,200	20,300	20,650	22,775	24,525	4.1%	7.7%
Prineville	7,410	7,750	8,150	8,500	8,640	9,080	9,990	5.1%	10.0%



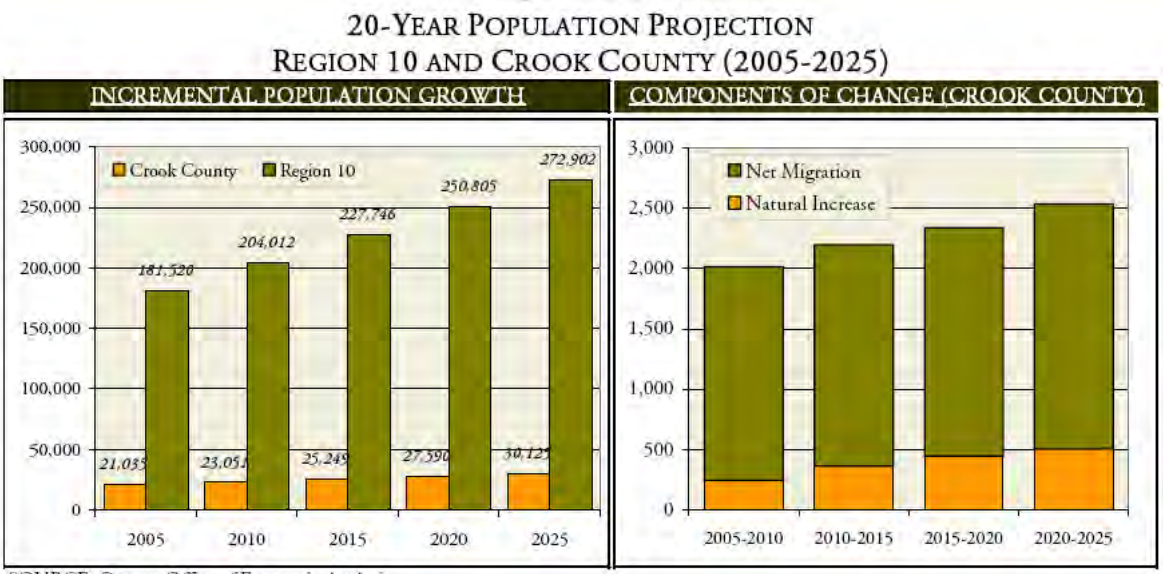
SOURCE: Oregon Population Research Center

Despite healthy population increase over each of the last six years, a significant population influx occurred in 2005 which displayed 10.3% growth in a single year. It is predicted that inflation in housing prices in competing markets, namely Bend and Redmond, is largely responsible for Crook County's recent popularity. Over the next twenty years, the Oregon Office of Economic Analysis fully expects regional and County-level population to continue a healthy growth pattern. Through 2025, State forecasts estimate an additional 91,382 individuals are expected to permanently reside within Region 10, 9,090 of which to be captured by Crook County, a capture of roughly 9.94%. Additionally, roughly 82.3% of anticipated Crook County population growth will be realized through net immigration.

Over time, and as the population increases, the trend will be for more diversification in job choices. According to the Oregon Employment Department report, Employment Projections by Occupation 2002-2012[2] the community can expect to see the greatest job growth in the following occupational areas:

- Health Care
- Professional and Technical
- Service and Retail including hospitality services

The increase in health care jobs is much different from the current local situation and is primarily due to an expected increase in young families with children, and an older population made up of retirees and baby-boomers. As the older population and general population increases so does the need for more choices in medical services. Health care professionals are in current demand and this is expected to continue as the largest growth area. The City will need to provide the proper amount of developable and adequately zoned lands to accommodate the expected increase in healthcare businesses and medical services. Prineville's small town charm and high level of livability will continue to attract young professionals and entrepreneurs. The retail and service markets will need to respond to this influx in order to meet demands of the growing population, particularly as housing choices increase. The City will need to provide the proper amount of developable and adequately zoned lands to accommodate the expected increase in professional, technical, service, and retail professions.



SOURCE: Oregon Office of Economic Analysis

Specific Employment and Industry Projections

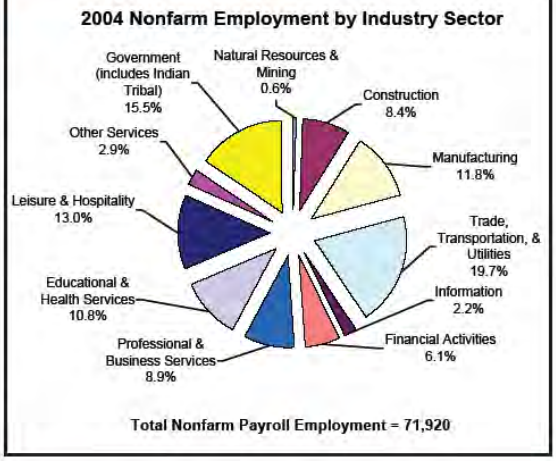
The 'snapshot" of data tables below provide a more precise projection detail for a period of 10 years beginning in 2004. This data is derived from the 2000 Census and information prepared by the Oregon Employment Department (OED). This type of projection is useful for analyzing the current land use ordinances to make sure the community can adapt to the projected needs.

Generally, the current ordinances are adequate, although a few modifications are needed to better support desired outcomes.

Region 10 Industries At A Glance . . .

Employment Projections by Industry, 2004-2014

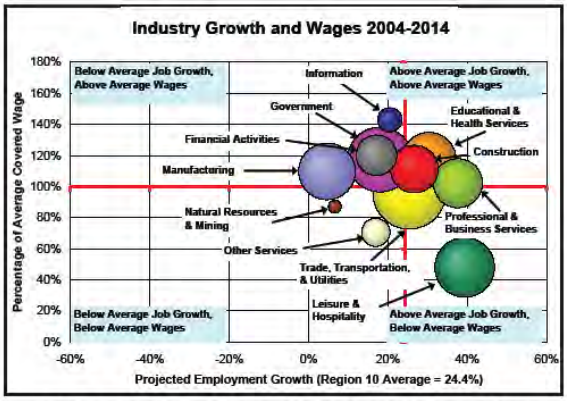
Industry	2004	2014	Change	Percent Change
Total Nonfarm Payroll Employment	*71,920*	*89,440*	*17,520*	*24.4%*
Natural Resources & Mining	450	480	30	6.7%
Construction	6,030	7,640	1,610	26.7%
Manufacturing	8,510	8,910	400	4.7%
Trade, Transportation, & Utilities	14,150	17,750	3,600	25.4%
Information	1,560	1,880	320	20.5%
Financial Activities	4,370	5,120	750	17.2%
Professional & Business Services	6,400	8,810	2,410	37.7%
Educational & Health Services	7,800	10,170	2,370	30.4%
Leisure & Hospitality	9,370	13,060	3,690	39.4%
Other Services	2,120	2,480	360	17.0%
Government (Includes Indian Tribal)	11,150	13,160	2,010	18.0%

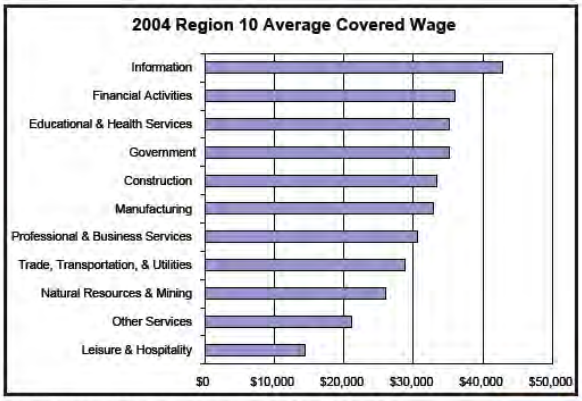


Top Performing Private Industries

Industries With the Most Jobs	2004 Employment	2014 Employment	Projected Change	Percent Change
Food Services & Drinking Places	**5,507**	7,325	1,818	33.0%
Wood Product Manufacturing	**4,020**	3,898	-122	-3.0%
Specialty Trade Contractors	**3,812**	4,840	1,028	27.0%
Administrative & Support Services	**3,504**	5,126	1,622	46.3%
Ambulatory Health Care Services	**2,772**	3,638	866	31.2%
Industries Adding the Most Jobs, 2004-2014				
Food Services & Drinking Places	5,507	7,325	**1,818**	33.0%
Administrative & Support Services	3,504	5,126	**1,622**	46.3%
Accommodation	2,340	3,703	**1,363**	58.2%
Specialty Trade Contractors	3,812	4,840	**1,028**	27.0%
General Merchandise Stores	2,167	3,134	**967**	44.6%
Industries Growing the Fastest*, 2004-2014				
Electronics & Appliance Stores	169	301	132	**78.1%**
Accommodation	2,340	3,703	1,363	**58.2%**
Museums; Parks & Historical Sites	71	111	40	**56.3%**
Motion Picture & Sound Recording Ind	89	134	45	**50.6%**
Administrative & Support Services	3,504	5,126	1,622	**46.3%**

*Limited to industries with a minimum 2004 employment of 40 and that satisfy Employment Department confidentiality criteria.





For additional information, contact Steve Williams at Stephen.C.Williams@state.or.us or (541) 388-6442

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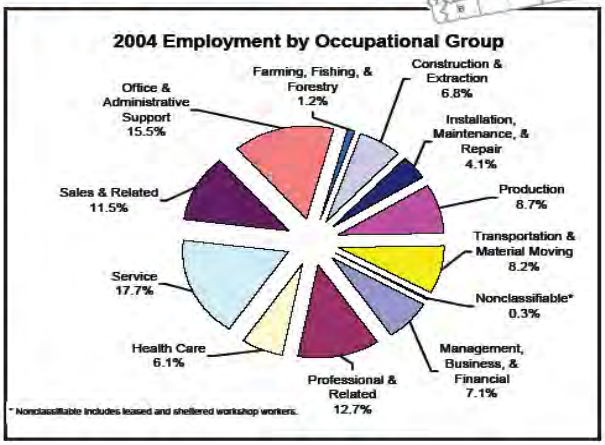
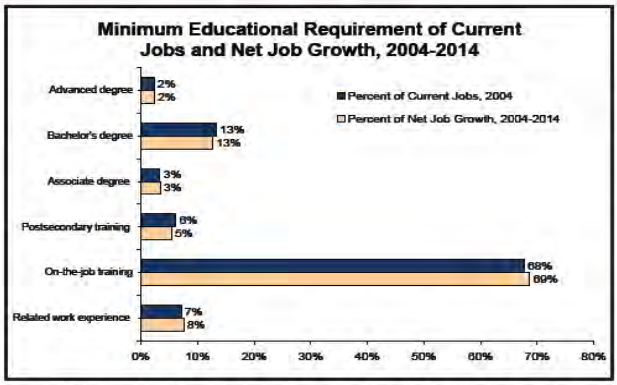
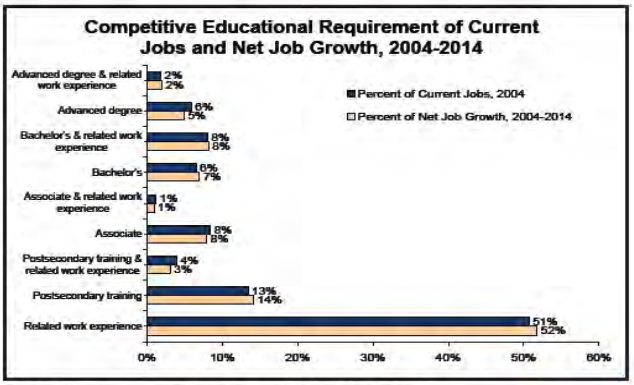
Region 10 Occupations At A Glance . . .

2004 Employment by Occupational Group			
Occupational Group	2004 Employment	Percent Of Total	Statewide % of Total
Total Payroll Employment	*72,598*	*100%*	*100%*
Management, Business, & Financial	5,182	7.1%	8.7%
Professional & Related	9,219	12.7%	15.5%
Health Care	4,458	6.1%	6.4%
Service	12,874	17.7%	15.2%
Sales & Related	8,340	11.5%	10.6%
Office & Administrative Support	11,254	15.5%	16.6%
Farming, Fishing, & Forestry	895	1.2%	2.4%
Construction & Extraction	4,930	6.8%	4.3%
Installation, Maintenance, & Repair	3,001	4.1%	4.0%
Production	6,292	8.7%	7.9%
Transportation & Material Moving	5,927	8.2%	7.6%
Nonclassifiable*	226	0.3%	0.7%
*Nonclassifiable includes leased and sheltered workshop workers.			



Top Performing Occupations					
Occupations With the Most Jobs	2004 Employment	2014 Employment	2004-2014 Percent Growth	2004-2014 Growth Openings	2004-2014 Total Openings*
Retail Salespersons	**2,756**	3,721	35.0%	965	2,091
Waiters & Waitresses	**1,571**	2,236	42.3%	665	1,591
Cashiers	**1,448**	1,874	29.4%	426	1,128
Office Clerks, General	**1,414**	1,751	23.8%	337	687
Laborers & Freight, Stock, & Material Movers, Hand	**1,372**	1,551	13.0%	179	628
Occupations Adding the Most Jobs, 2004-2014					
Retail Salespersons	2,756	3,721	35.0%	**965**	2,091
Waiters & Waitresses	1,571	2,236	42.3%	**665**	1,591
Customer Service Representatives	911	1,366	49.9%	**455**	626
Cashiers	1,448	1,874	29.4%	**426**	1,128
Registered Nurses	1,247	1,616	29.6%	**369**	682
Occupations Growing the Fastest, 2004-2014**					
Correctional Officers	62	328	**429.0%**	266	307
Aircraft Structure, Surfaces, Rigging, & Systems Assemblers	42	92	**119.0%**	50	69
Amusement & Recreation Attendants	239	423	**77.0%**	184	269
Hotel, Motel, & Resort Desk Clerks	129	203	**57.4%**	74	145
Entertainment Attendants & Related Workers, All Other	52	80	**53.8%**	28	45
*Total Openings include openings resulting from growth and from workers leaving the occupation. ** Limited to occupations with a minimum 2004 employment of 40.					





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The predictions for commerce and industry growth do not show a large increase in the type of high employment, large industrial development that Prineville and EDCO hope to attract to the community and region. However, the current economic incentives, limited land supply in other nearby communities, and the level of commitment shown by local leaders may dispel the predicted trend and lure additional large manufacturing, industrial, and technologically-based businesses to the community.

The OED predictions do not take into account the current lack of desirable industrial land in Bend and Redmond. This factor alone has proven to be valid with the recent development of several new industrial parks near the Prineville Airport and brisk 2004-2006 land sales in adjacent industrial areas. Developers are keen to focus on Prineville now that there is a better selection of industrial parcels to choose from in the UGB. The selection has been enhanced by the recent UGB expansion, which added over 540 acres of industrial land to the UGB.

Existing Economic Conditions Conclusion

Prineville's local leaders encourage quality development and job creation. While retail, service, and the health care industry will continue to grow and expand, community leaders have aggressively focused efforts on attracting large industrial development. It is anticipated that these efforts will bring forth industries that rely on a large number of employees and create additional family-wage jobs in the community. Community leaders have made it clear that large industrial development is needed in addition to the sectors identified in the predicted trend data. Likewise, there is a companion goal to reduce the daily commute for local residents by the creation of additional family wage jobs within the community.

According to Economic Development for Central Oregon -EDCO staff –

> ***"Central Oregon has steadily diversified its employment and economic base. For the past decade, Deschutes County has lead Oregon in high technology growth (over 270%). Numerous companies from the Silicon Valley, Portland-Vancouver Metro, and Puget Sound have relocated or expanded here - escaping skyrocketing costs, electricity shortages and tight labor markets. Many of these firms are small but extremely innovative, producing niche-market products from semiconductors to software, medical instruments to recreational equipment."***

Competitive wages relatively lower housing costs, and high quality of life features will continue to attract businesses and companies to the region. Prineville will need to supply adequate levels of skilled labor force, developable lands and increased housing choices to continue to be attractive to new business development as a way to compensate for less-than-perfect access to key highways.

Overall, Central Oregon is a desirable place to locate businesses and while the region is not on the I-5 corridor there are certain advantages to the area given the labor rate comparisons and other positive demographic features. Oregon's largest School-to-Work program operates in Prineville, through a partnership with the Chamber of Commerce.

Existing and Proposed Industrial Opportunities - Industrial Land Site Requirements

Prineville has a variety of industrial areas spread throughout the community. A few industrially zoned lands suffer from a lack of performance standards, which can lead to compatibility issues with adjacent residential neighborhoods. The transition from a lumber based economy to tourism and locational factors have rendered some industrial parcels ripe for redevelopment into other less intensive or mixed uses. As older industrial areas transition to mixed-uses and new industrial areas are created, the City will need to explore alternatives to incompatibility issues including but not limited to rezoning, mixed-use development techniques and additional setback and compatibility standards.

THE OCHOCO LUMBER MILL PROPERTY - A REDEVELOPMENT SITE

A few industrial areas such as the former Ochoco Lumber Mill site lie adjacent to the UGB and along Highway 126. The redevelopment of these types of sites will require careful planning and use of mixed-use development techniques as a way to avoid the negative effects of additional strip commercial development patterns. The Ochoco Lumber Mill site is too close to residential uses to continue as heavy manufacturing. Thus, a new type of zone, one that is compatible with adjacent development patterns, is more appropriate.

Numerous discussions with the owner of the Ochoco Lumber Mill property have revealed that they wish to potentially develop a mixed-use project on the site. This would include commercial, industrial, open space and housing activities. The owners have stated that they also intend to enhance the alignment of Ochoco Creek and its floodplain where it crosses the site and develop suitable buffers and separation from the nearby existing neighborhoods. This type of redevelopment is consistent with Plan objectives and helps to diversify the economy as it further transitions from lumber to other needed business types.

The recommended "complete neighborhood and commercial/industrial area standards" contain good compatibility requirements and will help to buffer industrial uses from other activities. The industrial areas that are close in and near the higher population areas contain the largest variety of industrial uses. It is expected that as land prices and population increase the existing heavier industrial uses will transfer to other less populated outlying areas. Traditionally, the smaller industrial uses such as service and repair or contractor services have located close to the urban core. The heaviest concentrations of industrial lots are in industrial parks as described below.

Murphy Industrial Park

Located in Prineville, the Murphy Industrial Park consists of 14.7 acres of light industrial zoned property with 10 lots ranging from 1 to 3.39 acres. The property is located 1/4 mile east of Hwy 26 and Hwy 126 and within Prineville's new enterprise zone. The Murphy Industrial Park is located in Prineville's designated Oregon Enterprise Zone, which offers qualifying businesses 100%, 3-5 year property tax exemptions on new, qualified investment in plant and equipment. The site is served with all utilities and is very nearly flat, ensuring ease of development.

Baldwin Industrial Park

The Baldwin Industrial Park offers exceptional values on land and structures, as well as easy access to Hwy 126. The Park is part of the City of Prineville's newly developed industrial area and within the city's enterprise zone. The Park is only 17 minutes from the regional airport in Redmond and less than a half hour to Bend. The site is served with all utilities and is very nearly flat, ensuring ease of development. Forty (40) total acres are available with lots ranging from ¾ of an acre to over 5 acres. The Baldwin Industrial Park is located in Prineville's designated Oregon Enterprise Zone, which offers qualifying businesses 100%, 3-5 year property tax exemptions on new, qualified investment in plant and equipment.

Tom McCall Industrial Park

Crook County and other private developers own over 100 acres known as Tom McCall Industrial Park near the Prineville Airport[3]. The site is served with all utilities and is very nearly flat, ensuring ease of development. Certain development regulations imposed by the County control the purchase price and business plan of prospective developers. The intent is to preserve large parcels for industrial campus uses needing large site requirements.

Tom McCall Expansion - Prineville Industrial Park

[3] Crook County also owns over 1000 acres in the vicinity, which could be converted to future industrial uses.

The Tom McCall Expansion, known as the Prineville Industrial Park is 118 acres in size and privately owned. The property abuts the County industrial lands and wraps around the Oregon Youth Association - OYA facility. This facility will be converted to Oregon National Guard uses. A variety of lot sizes are available ranging from .5 to 50 acres in size. Airport access to taxi ways may be available at the southern end of the property. There is an increasing need for additional access to the airport form adjacent lands. The FAA has traditionally discouraged such access but the viability of the airport depends upon such services.

Prineville Airport Business/Industrial Park

The Prineville/Crook County Airport includes two runways with the largest offering a 5,000-foot runway capable of handling jet traffic at an elevation of 3,246 feet above sea level. Pilot activated runway lighting and fixed base operator (FBO) services are available. The airport has several sites available for industrial and commercial development but is for lease only.

Local Efforts to Target Desired Industries

Economic Development for Central Oregon (EDCO) has focused their efforts in attracting new business and industry by targeting specific types of development. These include:

General Industry Cluster Targets

- Aerospace and Aviation
- High Technology (includes software, hardware and biotechnology)
- Light Industrial and Manufacturing (Plastics, assembly, printing, misc.)
- Recreational Equipment Manufacturing
- Research and Development Firms
- Secondary Wood Products
- Headquarter Firms

Within these broad categories, 21 of the nearly 1,000 SIC (Standard Industry Classification) Codes have been chosen by EDCO as specific targets for growth and recruitment. They include:

Specific Targets

2396 Automotive Trimmings, Apparel Findings & Related Products
2542 Store and Office Fixtures (except wood)
2732 Book Printing
3751 Motorcycles, Bicycles & Parts
3792 Travel Trailers and Campers
3799 Transportation Equipment, NEC
3845 Electro medical & Electrotherapeutic Apparatus
3721 Aircraft
3728 Aircraft Parts & Engine Parts
7371 Software Development, Custom
7372 Software Development, Prepackaged

3082 Plastics Profile Shapes, Unsupported
3089 Plastic Products, NEC
3672 Printed Circuit Boards
5099 Durable Goods, Wholesale, NEC
2541 Store and Office Fixtures, Wood
2674 Bags, Uncoated Paper & Multiwall
3086 Plastics Foam Products
3087 Plastics Resins, Custom Compounding
3674 Semiconductors & Related Devices
3949 Sporting & Athletic Goods, NEC

All of the above targets are suitable uses in the Prineville community. However, the City wants to attract clean industries and avoid those that can cause harm to the environment or create potential City subsidy. This goal may mean that some industries may need to be carefully examined for potential community pollution. The City will need to make sure that the industrial and commercial zoning regulations can accommodate the future development industries identified above.
As mentioned above, the identified target industries do not necessarily match the forecasted local trends. However, this does not mean the desired industries are unsuitable for Prineville. On the contrary, the local desires, and State/National trends are **all** to be considered when developing the assumptions used to support this economic opportunities analysis.

Industrial Land Inventory Needs Analysis

Prineville is the only incorporated city within Crook County's sizeable 2,291 square acres. Prineville would like to provide jobs in the community for all of it's' citizens and not suffer the negative impacts of the daily commute to other cities. The City of Prineville cannot meet this goal at present. Efforts to induce additional job creation are underway and were given a boost by the 2004 UGB expansion that took in an additional 540 acres of land for industrial purposes. The responsibility to maintain a supply of adequate industrial lands, and provide a sound industrial climate to support additional job creation is a continuing responsibility of the City as part of the Goal 9 requirements and City Council policy.

The development trend in Prineville is primarily a product of reaction to a changing lumber and agricultural base. Lands that were devoted to primary lumber manufacturing have either ceased operation or transformed to respond to market needs and available lumber supply.

From the mid-1980's until 2003, some industrial lands were permitted to allow development of non-industrial and/or commercial uses. These decisions were part of an effort to retain business and help provide jobs in the community. Higher land prices and limited supply of commercial land exacerbated this situation. However, this technique created problems with compatibility to primary industrial uses and tended to underutilize valuable industrial land resources. Better efforts at coordinated economic development strategies, appropriate mixed-use land development, and incentives to encourage commercial development in appropriate locations will reverse this negative trend.

The City intends to preserve industrial areas for predominantly industrial uses. This may be difficult in light of M37[4], but development of incentive programs such as the Enterprise Zone and the City's required M37 waiver as a condition of annexation will be helpful to preserving industrial lands for future economic development.

Numerous parcels of land in the UGB are inappropriately designated industrial. The zoning of these parcels will need to be corrected and appropriately zoned. The largest of these parcels are known as the Ochoco, Smith, Carpenter, and Rhoden sites. These were not considered prime industrial lands in the Benkendorf report and/or in related City studies. Other parcels of land containing residential homes have an inappropriate designation as "industrial" and need to be rezoned. See attached map showing proposed rezone areas. The 2004 UGB expansion industrial lands need analysis was based on a combination of factors. These factors continue to be useful for future land need forecasts.

11 Industrial Land Forecasting Factors

Historical development trends

Availability of infrastructure and transportation access

Physical features that enable easy development; including infrastructure supply

Features that restrict or limit development – open space, natural resource protection

Location and proximity to labor force

Growth management goals and compliance with State law

Community employment needs, niche development, emerging markets

Complete neighborhood development techniques

Private or public ownership

Proximity to airport and glide path restrictions

The recent Benkendorf Report, as modified, other studies, and the recent UGB Expansion Report are the source of the current industrial inventory data. Modifications were completed using local and regional data and development trends combined with regional and statewide efforts to attract commerce and industry to the region. Thus, the forecasted land needs are a product of various technical sources in addition to the data listed above.

The appendix of this Plan shows that the bulk of serviceable and available industrial lands were essentially depleted as of 2004. The industrial inventory was replenished with the addition of 540 acres of industrial land in the UGB expansion approved by the State of Oregon in late 2004. This amount of land was thought to be more than adequate for at least the planning period, or 20 years. However, no amount of data or model can accurately predict the future economic land needs of a community or the exact amount of land needed in each category. Therefore, a variety of factors must be used to estimate the amount of developable land needed. Moreover, because it is not prudent to use absorption rates alone, the City has chosen to use the 11 forecasting factors described above. The result is an "estimate" of needed lands for the future beyond the recent UGB

[4] M37 is a measure approved by Oregon voters to protect property rights for those who have owned property prior to restrictive land use regulations that limit allowed uses of property. M37 is being re-examined and it is unknown whether the measure will be sustained over the years

expansion. These estimates are used as a basis for making land use decisions and as new data or new predictive models become available, the estimates will be revised.

Revisions to the Plan can occur at any time, once supporting evidence shows a need for a change or update. Thus, the community can be assured that careful monitoring of all predictive data will be the best method for addressing the economic land needs of the community.

The 11 forecasting factors can be used to formulate assumptions about economic trends and determine industrial land needs. These factors form assumptions and when combined with local planning and economic development goals, are intended to provide a foundation for assessing any changes in the Plan. As of the date of approval of this plan, the basic assumptions are as follows:

- The National, State and Local trend shows that the highest economic growth will be in Health, Retail, Service and Professional fields.

- The goals of the community and those of local economic development experts focus on high technology, manufacturing, and production as desired industries. These goals may conflict with the predicted trends.

- Public facilities that serve industrial lands must be complete and adequate to support community economic development goal. The most recent geological data shows the Deschutes Aquifer serves the industrial lands near the airport. This is in contrast to existing industrial sites (and other zones for that matter) located at lower elevations. Water supplies near the airport are more readily available and reliable than water sources at the center of the City.

- Lands that have appropriate infrastructure in place and are competitively priced will be easier to market to prospective developers. Lease-only lands are more difficult to market because of bank financing conditions.

- Industrial lands must be attractive and include support services and workforce housing for employees.

- The 2004 UGB expansion included lands specifically reserved for:
    1. Railroad, and/or railroad supportive uses
    2. Sewer Treatment Plant Expansion
    3. Large acreages for campus-like manufacturing or technical companies – publicly and privately owned

- Industrial lands that have historically supported lumber mills may need to redevelop in response to the economic changes and lack of raw timber supplies.

- Industrially designated lands near the core of the community will need to be reclassified to other zones to improve compatibility with abutting uses, encourage more mixed-use zoning, and to encourage innovative land use techniques that improve and broaden the labor pool. This conversion in combination with a need for additional industrial lands that are situated at the near the airport will require a future UGB expansion.

- Airport lands are a valuable industrial resource requiring special management, planning, and development techniques. The Airport Master Plan deals with the specifics of airport development.

- The 2003 revised Benkendorf Report provides valuable data that must be combined with other studies/data and the above 11 factors to accurately represent the land needs of the community.

- Industrial lands that contain natural resource areas and other areas that require special protection will reduce the overall inventory of developable industrial land.

The above assumptions can be combined to make certain quantitative determinations about needed industrial land supplies over the 20-year period. As previously mentioned above, the City had added 540 acres of industrial land to its inventories in 2004 as shown on Exhibit I-1. Each portion of added industrial land area was given a label and a 25-30% non-buildable factor was applied to the various acreages in each area. In addition, some of the lands were slated for specific development purposes, which were not speculative. The sewer treatment plant and the lands reserved for railroad uses are examples of non-speculative development proposals. The charts shown below give the acreage details for vacant and developable industrial lands.

Before UGB Expansion

Industrial Lands Available prior to UGB Expansion	Airport-publicly owned – lease only	Other- private and publicly owned
	305.0 acres	5.0 acres

After UGB Expansion

Industrial Lands Available after UGB Expansion	Airport-publicly owned – lease only	Other- private and publicly owned
	305.0 acres	824.0 acres

The Prineville community had very little privately owned, developable, industrial land available before the 2004 UGB expansion. After expansion, development activity/absorption, development restrictions, and reservation for special uses reduced the number of developable acres to the amounts shown below.

Reductions to Industrial Land Acreages after 2004 UGB Expansion

Area or Area Number	Total Acres Without Reduction	Developable Acres With Reduction
Airport	305.0	210.0
UGB Area 6	160.0	120.0
UGB Area 6a	80.0	36.0
UGB Area 6b	160.0	150.0
UGB Area 7	313.0	219.0±
UGB Area 8	77.0	0.0 – sewer treatment plant only
UGB Area 9	34.0	14.7 – reserved for railroad uses
Totals	824.0	750.0

Some of the above acreage reductions are estimates based upon average percentage of developable lands that contain constrained areas such as rock outcrops, steep slope, future ROW areas, buffer areas, public facility needs, airport glide paths, and other obstructions to development. Modern engineering techniques and other development strategies may be able to increase the actual and final amount of developable land.

Original Industrial Land Need Forecast

The Benkendorf Report utilized a combination of forecasting techniques based upon future population estimates and employees per acre data. The 2003 revisions to this report show that additional amounts of non-lease industrial land are required for the needs planning period in addition to other industrial land types. The City originally thought it took in more land than it needed for industrial purposes because of the assumptions made in 2003. The amount of 824.0 acres reduced to 750.0 acres was a result of incorporating the variety of City-preferred techniques and assumptions described above. For example: it was assumed that the railroad uses anticipated in UGB Expansion Area 9 will not develop as quickly as other industrial uses given historical demand. In addition, the development restrictions (lease only, etc,) for lands at the airport create an obstacle for certain types of desired development. Because the airport and railroad are long-term community features that will take many years (more than 20) to fully develop, these areas should be reserved and not included in the total net need for the purposes of this planning period.

Existing Industrial Lands Located Near Incompatible Uses

The City has also continued analysis of the potential negative impacts of retaining heavy manufacturing and other industrial land designations currently located near the older parts of the city. In-depth review of these areas indicates the industrial areas are located in areas with limited water supply, adjacent to sensitive wetlands, steep slopes, and long established low-density residential development.

Existing Residential Development on Industrial Lands

The City has numerous residential homes built on industrially zoned lands. This situation needs to be corrected. The City has proposed a legislative fix to this situation and in combination with UGB expansion will serve to correct long standing zoning errors. A demonstrated need for additional developable residential lands (as described in following chapters) and to develop within the guidelines of a "framework plan" supports the rezoning of poorly located industrial areas to other uses. Map # 3 shows these areas.

Additional Reductions to Industrial Land Acreages after 2004 UGB Expansion Due to Needed Rezonings*

Land Area By Historic Ownership Name, etc.	Total Current Industrial Acres Requiring Rezoning to Other Uses
Carpenter	100.0
Rhoden	120.0
Ochoco	120.0
Smith	60.0
Northridge	115.0
Other Areas	20.0
UGB Area 9	34.0
Totals	569.0[5]

**See Error and Potential Rezoning Map at Appendix.*

Properly Located Industrial Land

A future UGB expansion will add additional areas for industrial development near the airport and will help Prineville address the current jobs/housing imbalance. Redmond and Bend currently have a greater number of employment opportunities, which results in a significant number of Prineville's residents commuting to other cities on a daily basis. Such commutes have the effect of over utilizing limited energy and natural resources, creating unnecessary business expenses, and increased infrastructure costs for community.

Commuting has been found to reduce effectiveness of business operations due to increased employee travel time and increased absences related to weather and road conditions. Likewise, Prineville has lower housing prices, which attract employees who cannot afford to live in Bend or Redmond[6]. Additional supplies of appropriately located industrial land will help to provide quality jobs in the Prineville community thus, reducing the need for citizens to seek employment in other cities.

[5] *Acreages estimate until verified with GIS and survey data*

[6] *This is discussed further in the Housing section of the Plan.*

Current Industrial Land Prices – *Supply and Demand*

The price of industrial land near the airport has increased from $1.25 per square foot in 2004/05 to over $4.50 a square foot in 2006. The increase is a direct result of limited supply of available industrial land and the effect of land prices in Redmond and Bend which are over $9.00 per square foot. See attached Exhibit I-2.

Adding more industrial land to the UGB, in appropriate locations, will help to stabilize land costs and keep Prineville in top position with lower priced and larger sized lands ready for development.

The Baldwin Industrial Park and other newly developed industrial areas near the airport have experienced brisk development since the 2004 UGB expansion. This trend will continue and the proposed expansion of the UGB to add additional industrial lands near the airport, especially in an area with reliable water supply, will help broaden Prineville's ability to attract and maintain business.

Restricting the ability to expand the UGB to include more industrial land will have a harmful effect on Prineville's economy. The community needs to expand the UGB to remedy the loss of industrial land that should be rezoned to more appropriate uses. Thus, once the total amount of industrial land to be rezoned to other uses is removed from inventory and added to the previously identified need for a long-term supply of industrial lands the long term need now totals 1393 acres. This need in comparison to industrial land inventory shows that the UGB should be expanded to supply needed new industrial lands.

Industrial Land Need Post-2004 UGB Expansion

Industrial Acres Added to UGB In 2004 And As Reduced By Constraints	Identified Industrial Acres That Should be Rezoned to Other Uses	New Total Industrial Acreage Need
824.0 acres reduced to 750.0 acres	569.0	824.0 +569.0 = 1393.0 acres

Large Acreages Needed

The community supports targeting of specific industrial uses that can provide many jobs at one location. These industries tend to require large acreages from 50 to 120 acres to support large buildings in a "campus" arrangement. Good examples of such developments are Les Schwab, Lancair, call centers, truck stops, workforce housing/industrial developments, and airports. The

community intends to provide for and reserve large tracts for these types of development. The existing Enterprise Zone was created to entice large industrial developments to Prineville.

It is anticipated that there should be an inventory of large "for purchase" industrial lots appropriately located in industrial areas near the airport area. The City has determined that approximately 250 acres above the Benkendorf Report recommendation is appropriate. This allows for a variety of industrial development on the lands required for industrial development per the Benkendorf Report and related studies to provide for up to 5, 50-acre parcels, or combinations thereof, for large industrial development over the 20-year planning period. This is assumption is based upon local data and the demonstrated goal of targeting specific industries beyond the current trends. It is important to do this since the trend information does not necessarily reflect the needs of a growing community like Prineville, where supporting a broader range of employment and industrial choices to reduce historical jobs/housing imbalances is a community goal.

Estimated 20-year Industrial Land Absorption Over the Planning Period 2005-2025

Type of Industrial Lands	Years 2005-2010	Years 2010-2015	Years 2015-2020	Years 2020-2025	Total Acres*
Airport – Leased Only	Varies	Varies	Varies	Varies	210.0
Typical Industrial Lands	75 acres dev./year	50 acres dev./year	50 acres dev./year	50 acres dev./year	1125.0
Large Industrial Parcels	50 acres	50 acres	100 acres	50 acres	250.0
Railroad Lands	Varies	Varies	Varies	Varies	15.0
					1600

Industrial service, contractor operations, assembly, and repair businesses look to Prineville's available industrial lands for development opportunities. This trend has resulted in a vast amount of industrial development activity in Prineville over the past 5 years, which has continued through 2006.

This trend is expected to continue as commercial lands increase in cost and pressure to accommodate growth continues. It is appropriate to assume that industrial uses requiring less than 15 acres of land each will develop the quickest during the planning period. The evidence to support this conclusion includes the past historical data showing that industrial development has been occurring on parcels less than 15 acres in size. Development in Baldwin and Murphy Industrial Parks specifically focus their marketing efforts on attracting smaller industrial developments.

Existing/Proposed Industrial Opportunities- Industrial Land Site Requirements

The lack of easy to develop industrial lands in both Bend and Redmond will attract industrial uses to Prineville where land is plentiful and available at a competitive cost. Likewise, the demand for low cost developable residential land in Bend and Redmond will attract more people to Prineville where such lands are available and UGB expansion potentially supportable.

Both Bend and Redmond have had delays in getting their UGB expansion plans completed. This situation will encourage more people to locate homes and support businesses near or in Prineville. This eventuality is reflected in the table above where the first 5-year projection of typical industrial land absorption is estimated at 75 acres per year and then tapers off as Bend and Redmond resolve their inventory and UGB expansion issues.

The Prineville community needs additional industrial lands for the 20-year planning period as described above. The amount of land necessary to sustain the needs of planning period includes the acreages of those inappropriately located industrial lands that will be rezoned to mixed-uses as part of the Plan update mapping process. The programs listed below require regular review of the industrial lands inventory and recommend when and how future changes to industrial land inventories should be made.

Existing and Proposed Commercial Opportunities – Commercial Lands Site Requirements

The City of Prineville contains five commercial zones located throughout the community. The 2004 UGB expansion plan did not include additional commercial lands even though there is a demonstrated need for an additional 100 acres of commercial land within the UGB. This is because the opportunity to rezone and revitalize various areas with mixed-use development techniques will satisfy the need. Therefore, no additional commercial land is needed at the periphery of the community. New commercial lands will occur as a result of the following actions:

- Addition of new commercial lands abutting the Downtown Core Area
- Addition of commercial land to serve neighborhoods and employment areas
- Addition of commercial and rezoned industrial land along the existing strip to deepen existing commercial lots for redevelopment to support commercial "centers."

The City will need to encourage the additional of new commercial centers to areas near expanding residential areas and avoid lengthening the existing 3rd Street strip. This is sound land use planning and allows for flexibility to respond to market forces while recognizing that mixed-use planning and the "complete neighborhood" concept can meet the future economic development demand for any needed commercial development in the urban area.

The downtown core of the community is desired to be the focus of continued revitalization efforts. Several studies have been completed to provide guidelines for improved aesthetics and other development strategies intended to attract and retain businesses to the downtown area. However, this has been made difficult by the commercial "strip" that runs east-west along 3rd Street, also known as Highway 126 and Highway 26. Newer commercial stores have located along the strip and this has caused congestion by allowing direct access to the highway. The strip can also detract shoppers from the downtown area, which can create excess vehicle trips for citizens and reduce viability of the downtown core. Nonetheless, the newer franchises on the strip are desired commercial uses and help to address citizen needs for goods and services.

The opportunity for "center-type" rather than "strip" development is possible if the anticipated commercial rezonings occur over time. A new technique that builds on an old concept -"Main Street" type development, is a successful land use technique that can correct and improve commercial vitality by encouraging pedestrian access. "Main Street" development techniques provide for a more walkable shopping experience without excessive vehicle trips. The storefronts face a local access street that is perpendicular to the primary access street Revisions to the development codes may be required to enable this development technique.

The 2004 UGB expansion took in additional new residential and industrial lands. The local topography necessitates that these new areas project "out" from the urban core to avoid steep rimrock and other topographical obstacles. The result is that the City, as a whole, is forced to grow in a less-than-compact form. However, the development pattern *within* the new areas can be compact and designed to serve as many citizen needs as possible. This means that mixed-uses, including convenience commercial service centers, open space, and some employment areas will be required to develop in new neighborhoods so as to reduce vehicle miles traveled and improve efficiency for all residents. The community will benefit from adding small commercial areas to new and revitalized neighborhoods as the community grows. Citizens have expressed a need for additional neighborhood and local shopping opportunities that do not require excessive vehicle trips or vehicle trips to other communities.

Commercial Land Inventory Needs Analysis

The City conducted various inventory and land need analyses. The Benkendorf Report as revised states that approximately 100 acres of additional commercial land should be added to the existing commercial inventory. The original Benkendorf study advised that only 80 acres would be needed and this should be allocated to supply only two, 40-acre parcels for large "big-box" development.

There is a significant obstacle with the original Benkendorf recommendation. Big-box stores typify strip development unless they are located in centers or mixed-use areas. In addition, the community would not benefit from applying new commercial designations to only two areas of the community. This is because the community has diverse commercial needs and supports new commercial lands to be strategically placed throughout the community. Efforts to deepen the commercial designations in the downtown core and rezone redevelopment lands in other areas are a higher priority than only focusing on big-box development in a few areas.

Moreover, it is necessary to recognize that the Prineville community is made up of various neighborhoods separated by topography or other barriers. Some of these neighborhoods are located in areas that are not served with adequate commercial services. The broadly applied mixed-use and/ or improved land use development practices advocated in other parts of this Plan could not be achieved if the new commercial lands were limited to just two areas.

It could be detrimental to the community to limit new commercial areas to just two large businesses and not allow other areas to redevelop or respond to certain market forces in combination with mixed-use development techniques. Thus, Prineville's economy will be benefited by being flexible with the placement of new commercial land needs over the 20-year period rather than restrict itself to 2 parcels limited to big-box developers.

The commercial inventory data below is derived from the Benkendorf Report, as revised.

Existing Developed Commercial Lands in the Prineville Urban Area

Zone	Code	Parcels within the UGB					
		Vacant Acreage	# of Parcels	Non-Vacant (Developed) Acreage	# of Parcels	Total Acreage	# of Parcels
Central Commercial	C-1	5.10	29	53.10	258	58.20	287
General Commercial	C-2	13.05	10	121.15	198	134.20	208
Professional Commercial	C-3	0.0	0	5.70	30	5.70	30
Neighborhood Commercial	C-4	-	-	-	-	-	-
Recreation Commercial	C-5	0.0	0	2.70	3	2.70	3
Total Commercial - City		**18.15**	**39**	**182.65**	**489**	**200.80**	**528**

Commercial Land Need by Development Type, Prineville Urban Area

	Unadjusted Net Buildable Acreage Needed	Unadjusted Gross Buildable Acreage Needed	Additional Gross Acreage Needed	Total Adjusted Gross Buildable Acreage Needed	Net Buildable Acreage Available	Gross Buildable Acreage Available	2023 Net Need (or Surplus) - Gross Acreage
Commercial - non-lease only	112.8	141.0	**100.0**	221.0	33.57	41.9	199.1
Commercial - lease-only - Airport	12.5	15.6	0.0	15.6	18.8	23.5	(7.9)

The above tables include land within the airport facility that permits commercial uses. This public land is lease-only and not as desirable as private land that can be purchased. This is due to the financing difficulties presented by lease-only land and the development restrictions in place at the Prineville Airport.

It should be noted that the primary growth industry and target areas described earlier in this chapter also apply to the commercial analysis. Again, as the trend information suggests, the primary growth sectors will be health care and commercial activities, particularly service, and retail. The EDCO target areas are mostly industrial but could have a retail/commercial component that would be a secondary use to the primary industrial development.

Existing and Proposed Commercial Opportunities – Commercial Lands Site Requirements Conclusion

The community is poised to respond to the need for additional commercial designations. The current UGB contains adequate lands upon which to develop needed commercial uses as long as the needed rezonings are timely and planned to respond to mixed-use and other development techniques that can enhance the urban community. Performance standards and the planned unit development (PUD) section of the implementing land use ordinances can help provide for a more integrated and balanced development pattern, particularly with new commercial areas. For now, the 100 acre commercial land need should be a starting point and not a limiting factor, especially if there is a demonstrated public need and benefit for additional commercial lands beyond the City recommendation. Thus, the City has developed a firm position that UGB expansion is not needed for adding lands solely for commercial development. Rather, new commercial areas should be the product of rezoning existing lands with in the current UGB and/or when necessary to support mixed-use development strategies.

Goal # 1: Provide adequate industrial and commercial land inventories to satisfy the urban development needs of Prineville for at least the 20 year planning horizon.

Economic Values and Policies

- Updates to inventories and analysis of needed industrial and commercial land types, existing land supplies, and economic development strategies for meeting the requirements of the community are essential. It is necessary to provide adequate buildable industrial and commercial land for at least 20 years.

- Updates to the inventories may be required in response to redevelopment, proposed zone changes, mixed-use development techniques and planned unit developments that enable "complete neighborhood" concepts and economic development opportunities.

- State, local, and nationwide trends are not adequate to properly estimate needed industrial and commercial lands. Other local information and economic development targeting goals must be used to properly evaluate future land needs.

- Adequate public facilities must be planned, funded, and installed to serve industrial sites and commercial areas.

- Preservation of large industrial parcels over 20 acres in size will attract target industries and new manufacturing businesses.

- Preservation of lands for workforce housing will also attract target industries.

- Urban reserve planning will be needed to project growth beyond the 20-year period imposed by the State of Oregon.

- Additional land is needed to support commercial and industrial uses. Where there are particular locational requirements for certain activities, amendments to the Comprehensive Plan may be necessary. Amendments should be evaluated in relation to all applicable policies of the Comprehensive Plan.

Programs:

The City shall:

1. Regularly monitor and analyze commercial and industrial land inventories. When new lands are needed, the City Council shall authorize expansion of the UGB or other methods to ensure that at least a 20-year inventory of land for each category is available within the urban area.

2. Update and manage all public facilities planning to meet community and economic development goals while encouraging additional public and private investment in the community.

3. Explore and initiate methods for preserving large industrial parcels to meet projected demand.

4. Complete urban reserve planning consistent with the other provisions previously listed in this Plan. See attached Urban Reserve Area Map No. 4

5. Any correction amendments and needed legislative changes for rezoning shall be processed immediately upon City Council directive.

6. Develop a community entrance plan that fosters improved aesthetic treatments and buffering along the western entrances to the community.

Goal # 2: Develop an "Economic Development Strategic Plan" and other mechanisms necessary for supporting and enhancing the local economy.

Economic Values and Policies

- Successful economic development strategies require cooperation with a variety of agencies and other groups to develop a plan that best meets the requirements of a growing community.

- Successful economic opportunities rely upon the communities' ability to support and connect various elements of the economic development into an integrated framework.

- Promoting an entrepreneurial climate for existing and new businesses is a key factor in strategic planning.

- Providing a strong public partnership with local businesses is key to successful economic development.

- Ensuring a high quality of life and the small town atmosphere is essential to addressing citizen concerns about growth and economic development.

- SDC charges must be carefully monitored and evaluated to ensure that development pays its own way while not creating obstacles to desired development.

- The adoption and implementation of a Downtown Enhancement Plan will help to ensure the long-term success of the urban core area.

- The State of Oregon transportation system (ODOT) has a significant effect upon the local community. Local groups and City decisions makers will need to establish good working relationships with ODOT to ensure coordination and quality development.

Programs:

The City shall:

1. Organize and staff an economic development committee whose purpose is to monitor and recommend needed changes to the City economic opportunities analysis and develop an "Economic Development Strategic Plan." The committee shall include three members of the City Council, 2 members of the Planning Commission, and two ad hoc members of the community experienced in economic development and any staff members deemed appropriate by the City Manager.

2. Continue to refine which commercial and industrial activities are lacking in the community. The City shall identify needed commercial and industrial areas on an overlay map. The overlay map is a general framework plan that represents where certain areas of the community could benefit from additional commercial or industrial designations.

3. Develop strategies to capture the opportunities of a technology and knowledge-based economy.

4. Modify the land use development codes to better address economic development objectives and encourage appropriate mixed-uses in commercial and industrial zones.

5. Update and monitor the SDC methodology to assure appropriate charges to new development.

6. Adopt a Downtown Plan that includes a long-term strategy for enhancing development opportunities in the urban core and creates a "sense of place" for local residents and visitors alike.

6

Transportation (2025)

Chapter 6 Transportation

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Purpose and Intent

Transportation System Plans (TSP) are developed per Oregon Transportation Planning Rule (TPR) (OAR 660-012) and must be consistent with existing regional, state, county, and local plans, policies, and documents including the Oregon Highway Plan, the ODOT 2020 Transportation System Plan Guidelines, and the Prineville Comprehensive Plan (adopted in 2007 and amended as recently as 2024). The TPR implements Statewide Planning Goal 12. Transportation, that promotes the development of safe, convenient, and economic transportation systems designed to maximize the benefit of investment and reduce reliance on automobiles.

Statewide Planning Goal 12, Transportation provides a framework for local jurisdictions to create a transportation system plan that considers all modes of transportation, including transit, automobiles, air, rail, bicycles and pedestrians.

The 2025 City of Prineville Transportation System Plan (TSP), adopted here by reference; establishes the city's projects, policies, and objectives designed to fulfill Prineville's transportation needs. The development and prioritization of these projects was driven by development, review of prior planning efforts and analyzing existing needs and future conditions. Public involvement from Prineville residents also played a key role in shaping projects and determining what priorities to take when addressing the multitude of needs in the city.

The Prineville TSP considers all the land within the city limits and the Prineville urban growth boundary (UGB). The TSP serves as a 20-year plan to guide transportation improvements and enhance overall mobility for vehicles, pedestrians, and bicyclists throughout the city. This Chapter list the goals found in the TSP and identifies specific City policies. The implementation measures for these goals and policies is found within the City's Land Development Code, and the City's Specifications & Standards Manual.

Goals

The 2025 TSP includes updated goals, objectives, and evaluation criteria that reflect local transportation needs that have emerged since the last TSP update in 2013. The 2025 TSP update includes fewer goals and objectives to streamline implementation and better identify the critical priorities for the transportation system.

Goal #1: Ensure a safe, efficient, and accessible transportation system for all users.

Goal #2: Build a complete system of walking and cycling routes that connect neighborhoods to schools, parks, jobs, and other key places.

Goal #3: Build and maintain the transportation system to support economic development in the region.

Goal #4: Improve system performance by balancing mobility and access along main travel routes, including on state highways.

Goal #5: Minimize the impacts of the transportation system on the natural and built environments.

Policies

Street Network

The foundation of the Prineville transportation system is a product of the existing roads and highways that cross the community. The City has a hierarchical roadway system as follows:

Roadways are classified using arterial, collector, and local designations depending on the intended function and the adjacent land use needs. Figure 15 in the TSP shows the functional classification of each roadway in Prineville. Figure 16 in the TSP shows the functional classification of existing and future. The map also includes "vision" projects that are not part of the TSP but are acknowledged for future consideration.

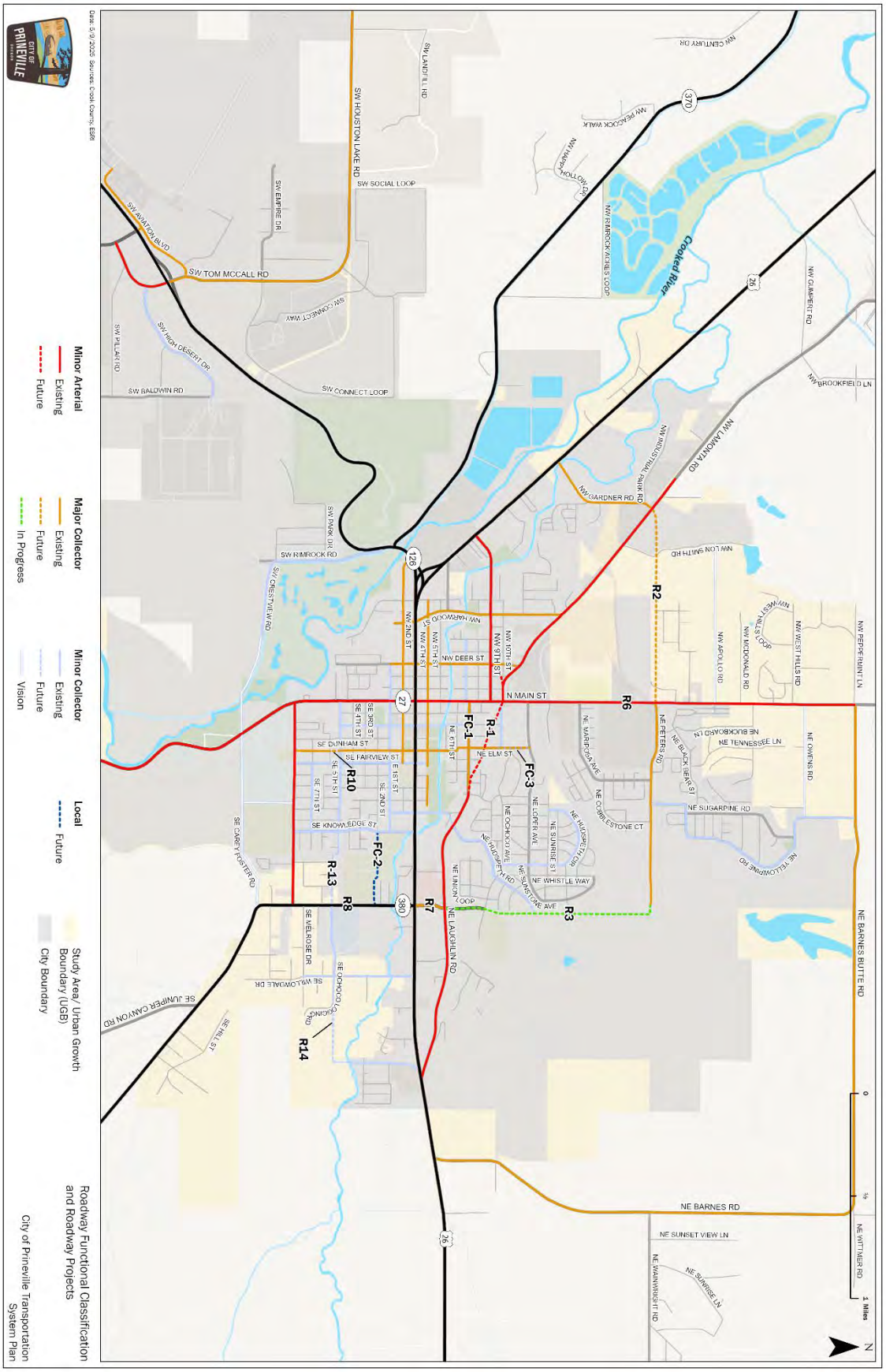
Major Arterials primarily provide mobility particularly between large population centers or activity generators. Mobility is emphasized over local access connections. Within Prineville, all major arterials are ODOT facilities. U.S. 26 and OR 126 are examples of major arterial facilities. Their main functions are to provide east-west connection through town as well as to connect Prineville with nearby communities.

Minor Arterials are also intended to serve mobility needs over access needs in town. However, minor arterials provide important connections through town rather than connecting Prineville to other communities. Main Street is an example of a minor arterial in Prineville. Its main purpose is to connect the north and south areas of Prineville.

Major Collectors provide connection between local streets and the arterial street system. Trip lengths are generally shorter on collectors. Collectors provide a link between local traffic generators and more regional facilities. An example of a major collector in Prineville is NE 2nd Street. NE 2nd Street's primary function is to connect residential and commercial areas with Main St. and U.S. 26.

Minor Collectors are similar to major collectors in their purpose of linking local and regional traffic facilities. However, minor collectors typically provide access to and circulation within neighborhoods, industrial areas and commercial areas. SE 5th Street is an example of a minor collector. It connects all residences in the area to other commercial, residential or public areas.

Local Streets provide direct access to land. Shorter trips are common, and through-trips are discouraged. Travel is generally at lower speeds than on other road classifications. Prineville's local streets generally connect to collectors. Roadways that are not labeled as collector or arterial streets on Figure 15 are designated as local streets.


Minor Arterial
Existing
Future
Major Collector
Existing
Future
In Progress
Minor Collector
Existing
Future
Vision
Local
Future
Study Area/ Urban Growth Boundary (UGB)
City Boundary
Roadway Functional Classification and Roadway Projects
City of Prineville Transportation System Plan
Cooked River
SW HOUSTON LAKE RD
SW SOCIAL LOOP
SW TOM MCCALL RD
SW CONNECT LOOP
SW BALDWIN RD
SW RIMROCK RD
NW LAMONTA RD
NW GARDNER RD
N MAIN ST
NW 2ND ST
NW 4TH ST
NW 9TH ST
NW 10TH ST
NW DEER ST
SE 3RD ST
SE 4TH ST
SE 5TH ST
SE 7TH ST
SE 1ST ST
SE 2ND ST
SE DUNHAM ST
SE FAIRVIEW ST
SE KNOWLEDGE ST
NE 6TH ST
NE ELM ST
NE UNION LOOP
NE LAUGHLIN RD
NE BARNES BUTTE RD
NE BARNES RD
NE SUNSET VIEW LN
NE SUNRISE LN
NE WHISTLE WAY
NE SUNSET AVE
NE SUGARPINE RD
NE TENNESSEE LN
NE BLACKJERK ST
NE PETERS RD
NE MARIPOSA AVE
NE COBBLESTONE CT
NE COPPER AVE
NE OCHOCO AVE
NE AUSPEN PL
NE AUSPEN RD
NE YELLOWPINE RD
NE OWENS RD
NE WITTMER RD
NE WAINWRIGHT RD
NW PEPPERMINT LN
NW WEST HILLS RD
NW MCDONALD RD
NW APOLLO RD
NW WESTSIDE ST
NW LON SMITH RD
NW INDUSTRIAL PARK RD
NW CLIMPERT RD
NW BROOKFIELD LN
NW RIMROCK ACRES LOOP
NW PEACOCK WALK
NW CENTURY DR
SW LANDFILL RD
SW EMPIRE DR
SW AVIATION BLVD
SW CONNECT WAY
SW HIGH DESERT DR
SW PILLAR RD
SW PARK DR
SW PRESTWICK RD
SE CAREY FOSTER RD
SE JUNIPER CANYON RD
SE WELROSE DR
SE MILLCOMOALE DR
SE OCHOCO LOOP
SE HILL ST
R1
R2
R3
R6
R7
R8
R10
R13
R14
FC-1
FC-2
FC-3
126
27
380
370
26
0
½
1 Miles
N

General Transportation Street Network Policies	
1.	The City will improve the transportation system in accordance with the Standards and Specifications Manual for all people and all modes of travel, including those that do not rely on single occupant vehicles.
2.	Promote and enhance the livability of the community, preserve valuable resources, and provide more transportation choices.
3.	Ensure a well-connected and redundant transportation network to facilitate emergency services and evacuation during emergencies.
4.	Require new developments to include an analysis of transportation impacts, needs, and mitigation options. When warranted, Require that development projects provide a Transportation Impact Analysis or Transportation Impact Letter analyzing project conditions in order to minimize impacts and protect transportation facilities.
5.	Ensure the transportation system supports economic development and facilitates deliveries of goods and services. This includes considerations for overnight truck parking in appropriate locations in or outside the City.
6.	Collaborate with people living and working in Prineville, state agencies, Crook County, transit service providers, local business interests, special interest groups, and tourism professionals on transportation system decision making.
7.	Promote traffic calming measures in core commercial areas and residential neighborhoods to reduce vehicular speeds on roadways and create a safe pedestrian/bicycle environment.
8.	Provide sidewalks, trails, open spaces, connections between open space, bike lanes, transit amenities, and pedestrian amenities to encourage transportation choices and promote a high level of livability.
9.	Implement planned new roadways, connections, and other TSP improvements as part of new development.
10.	Develop an approach to funding necessary transportation improvements over the life of the TSP.
11.	Allow for the development of private streets systems, where appropriate and where they are guaranteed to be maintained by parties other than the City, to reduce the overall funding need for street maintenance and the need to seek additional tax revenues.
12.	Promote transportation demand management (TDM) strategies to reduce vehicle miles traveled (VMT) on the transportation system.
13.	A safe transportation system, particularly for pedestrians, shall be reviewed as part of any development or transportation infrastructure project. This includes impacts to low-income residents, minority populations, elderly populations, youth, and people living with disabilities when implementing transportation infrastructure projects.
14.	Provide opportunities for street trees, pedestrian amenities, separated sidewalks, curb extensions, traffic calming, and other related devices.
15.	Consider Innovative intersection designs such as roundabouts to reduce costs, traffic congestion, and concerns related to safety and accessibility.
16.	Monitor and update street functional classifications as necessary to sustain the expected growth of the community and meet applicable Transportation Planning Rule (TPR) objectives.
17.	The City and State should consider interim solutions for large long-term projects that take multiple years to fund and implement.

Active Transportation System

A well-connected and -maintained active transportation system enables safe and convenient travel by foot, bicycle, or other active mode of transportation between neighborhoods, retail centers, employment areas and transit stops. The active transportation network is composed of sidewalks, roadway crossings, bicycle lanes, multiuse trails, and neighborhood greenways. Existing active transportation conditions are described in section 2.4 of the TSP, with locations shown in Figure 9 of the TSP.

Active Transportation Policies
1. Encourage pedestrian and bicycle travel with separated facilities as a safe, feasible alternative to the automobile
2. Require that all proposed subdivisions include bicycle and pedestrian paths and encourage paths accessing open space and parks.
3. Ensure that bicycle and pedestrian paths are well lit and provide visual surveillance from the street.
4. Prioritize paths along existing and proposed major and minor arterials as the preferred approach to accommodate bicycle and pedestrian paths.
5. Require all commercial, office, and multifamily development to provide safe and convenient off-street bicycle parking space and routes in their design.
6. Provide curb ramps at all corners, intersections, or locations where bicycle and pedestrian routes and paths intersect with streets.
7. Promote pedestrian and bicycle connections along existing waterways, utility rights-of-way, and properties that wish to be annexed to the city.
8. Improve signs, markings, wayfinding, and safety features on existing bicycle and pedestrian paths.

Public Transportation System

Transit within Prineville includes fixed-route and Dial-A-Ride service provided by Cascades East Transit (CET) and shuttle service provided by Grant County People Mover.

For fixed route transit, Cascades East Transit operates Community Connector fixed routes that connect to communities within Crook County, Deschutes County, and Jefferson County. CET operates Route 26 service between Redmond and Prineville. This service is open to the public and operates Monday through Friday. Weekend service is not currently provided. The annual ridership from Route 26 in 2017 was 16,067. Route 26 has a moderately strong ridership and productivity compared to other CET routes. CET has suspended fare collection until further notice on all CET services except recreation services.

Cascades East Transit offers a Rural Dial-A-Ride within Prineville. This service is open to the public and does not have eligibility requirements. Riders must call the day before service is needed to reserve a ride. Ride times are scheduled based on availability. The travel patterns from 2018 in Prineville include the Stryker Park bus stop as a key location since passengers can transfer to CET Route 26 and the Prineville Senior Center.

There are other public transportation services offered within the CET service area that are provided by other operators independent of CET services. The other transit provider that connects with the CET network is People Mover in Grant County, a shuttle service that provides connections to several Central Oregon communities. There are two Catch-A-Ride services offered: Monument to Bend and Prairie City to Bend. The transit services allow for statewide travel and are located within 0.25 to 0.5 miles of one or more CET bus stops.

Public Transportation Policies
1. Assess the possibility of a local circulator bus serving Prineville's major employers and destinations.
2. Encourage private inter- and intra-city transit to supplement existing Transit service
3. Develop accessible transit stops to facilitate to enable better mobility and access for people with disabilities and seniors.
4. Ensure the road network can sufficiently accommodate buses and other transit vehicles.

Freight & Rail

To serve industrial properties and support future economic development efforts, the City of Prineville has designated several roadways as local Truck Routes, including NW 3rd Street/U.S. 26, S Main Street, NW Lamonta Road, NW 9th Street, NW 10th Street, NW Gardner Road, NE Laughlin Road, SE Combs Flat Road, SW George Millican Road, and all highways entering town. Peter Road extension West is in question based on existing industrial zoning patterns that may change. The designation of these facilities as Truck Routes does not prohibit local delivery trucks from using other roadways, but is intended to encourage the use of these routes for regional freight needs through design and signage. Currently, most trucks travel on U.S. 26 and OR 126. Truck volumes comprise between 11% and 26% of the overall traffic volumes on Prineville's truck routes.

Formed in 1918, COPR directly serves industries in Crook County. The 18-mile City of Prineville Railway (COPR) short line service provides a primary freight connection between Prineville and the Burlington Northern Santa Fe and the Union Pacific Railroads at Prineville Junction three miles north of Redmond along the U.S. 97 corridor. The city's freight depot, constructed in 2010, lies in between U.S. 26 and NW Lamonta Road and provides multiple services, including intermodal transfers between trucks and the short line service, fostering freight rail links to destinations within the state and across the country.

The City increased its investment in the COPR short line service to Prineville Junction in 2010 and built a freight depot with assistance from Connect Oregon grants. The freight depot provides warehousing space, equipment ramps, freight-to-rail intermodal service, and bulk product storage. The freight depot's goal is to provide the Central Oregon region with these services and provide a regional multimodal transportation hub with links to destinations within the state and across the country. It is a more than 30-acre site along Bus Evans Road between Lamonta Road and U.S. 26, 3 miles west of the city and adjacent to the COPR mainline.

The location of this site and its intermodal infrastructure further justifies the City freight route designation of Lamonta Road. Coordination with Crook County should be pursued to similarly classify the portion of Lamonta Road located outside the city limits.

Freight and Rail Policies	
1.	Ensure that transportation system improvements are compatible with the Prineville Railroad and its facilities, including road construction, crossings, and bicycle and pedestrian improvements.
2.	Promote the value of the railroad and its transport capabilities to industries seeking to locate in Prineville.
3.	Monitor demand for goods transport by rail and prepare to take advantage of new opportunities.
4.	When railroad rights-of-way are considered for abandonment or vacation, promote the preservation of these corridors for other transportation services.

Aviation

Prineville is home to Prineville Airport, owned and managed by Crook County. The airport has two runways and is used primarily for general aviation by private individuals, corporations, the U.S. Forest Service, and the Bureau of Land Management. A Master Plan update for the airport was completed in 2017 and calls for expansions to the runway and taxi areas, but the expansion is not expected to significantly impact surface traffic. The airport currently generates low vehicle traffic volumes, and these are anticipated to continue in the future. No aviation improvements are recommended for the 2025 TSP update beyond those described in the Airport Master Plan.

Aviation Policies

1. Continue to jointly monitor and manage the airport facility to ensure maximum service to users, safety, enhancements to economic development, and adherence to FAA requirements.
2. Continue to adhere to the Airport Master Plan as a planning tool. Any significant modifications of the plan must be publicly examined through the land use process and be approved by City and County.
3. Continue to examine and evaluate UGB expansion on the west side of the airport to facilitate airport expansion and/or new industrial zones as a compatible use and buffer to airport activities.

Street Capacity and Service Level

Prineville's transportation system serves people driving, biking and walking to destinations in Prineville and enables connectivity out of the city. As the city has steadily grown in population, the number of travelers has increased in kind, spurring a need for solutions to ensure the system can sustainably accommodate future traffic and meet goals for safety and access.

Street Capacity and Service Level Policies

1. Meet applicable City, County, and/or State operational performance measures or identify alternative measures as appropriate in balancing other City goals and needs. The City may accept higher levels of congestion in some locations or corridors where it is impractical or costly to improve capacity.
2. Ensure connectivity of streets and pedestrian and bicycle facilities between neighborhoods and key community destinations such as schools and high traffic areas. These connections help reduce unnecessary traffic on higher order streets and corresponding intersections.
3. Reduce crashes in Prineville, particularly higher severity injury and fatal crashes, and those involving more vulnerable roadway users such as pedestrians and bicyclists.
4. Increase service level and reduce maintenance cost by maintaining at least a "good" pavement condition index (PCI).

Land Use and Transportation Connections

Most residential zones, public services, and the main commercial corridor— 3rd Street/U.S. 26—are located in the Ochoco Valley, while the Tom McCall area is home to the Prineville airport and industrial uses. In the past decade, Prineville has seen substantial growth of data storage facilities and other industrial uses in the Tom McCall area that have been a major driver of economic growth. New residential and industrial growth in Prineville is expected to continue over the 20-year horizon of the city's Comprehensive Plan and will influence the city's transportation needs.

Land Use and Transportation Connection Policies

1. Choose transportation investments that avoid displacing homes and businesses and that maintain Prineville's small-town character.
2. Growth should pay its own way without community subsidy.
3. Evaluate new projects to determine the impact of development upon the transportation system using the most recent edition of the Institute of Traffic Engineers (ITE) manual or alternative source as necessary.
4. Transportation impact shall be studied by the developer through a traffic impact analysis (TIA). The City shall evaluate and determine acceptable mitigation prior to issuance of any development permit.
5. Transportation mitigation costs may be refunded for transportation improvements, cash contributions, right of way dedications, transfer of development credits and development rights, real property and other significant contributions as the City sees fit to accept.
6. Monitor and revise SDC methodology as necessary to establish fees and reimbursement programs for individuals and entities that construct TSP master planned transportation improvements.

Sustainable Funding

The Prineville TSP contains projects that may be implemented on a short-, medium-, or long-term basis. Project prioritization includes factors such as community desire, available funding, staff capacity, and City leadership support. As limited funding exists, some projects may take years, if not decades, to complete. Over time, projects not included in this TSP may be added to address new needs that arise as Prineville's population continues to change. Chapter 5 of the TSP reviews funding forecasts and options.

Sustainable Funding Policies
1. Identify transportation alternatives that meet economic development, safety, and capacity needs at the lowest cost and maximize facilities' lifespan.
2. Seek a variety of funding sources for transportation improvements, maintenance, and preservation, such as state and federal grants, levies, increased taxes, bonds, and other sources.
3. Promote transportation demand management strategies (carpooling, flexible work hours, telecommuting, etc.) to reduce VMT on the transportation system.
4. Review and evaluate TSP projects at least every five years to ensure planned improvements continue to be aligned with the City's priorities for the transportation system.
5. The City shall review SDC fees annually to assure revenue collected is adequate to pay for the identified improvements. Annual adjustments shall be made to SDC's to cover the costs associated with quantified inflation rate

7

Housing (2019)

Prineville's Comprehensive Plan

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October 2019

Chapter 7 Housing

Purpose and Intent

The purpose of this chapter is to ensure the provision of appropriate types and amounts of land within urban growth boundary supporting a range of housing types necessary to meet current and future needs. These lands should support suitable housing for all income levels. Likewise, the Plan must also ensure that the appropriate type, location and phasing of public facilities and services are sufficient to support housing development in areas presently developed or undergoing development, or redevelopment.

This Chapter includes three supporting documents: (1) A Buildable Lands Inventory produced by Angelo Planning Group dated May 2, 2019; (2) A Housing Need Analysis produced by Johnson Economics dated June, 2019; and (3) A Housing Strategies Report produced by Angelo Planning Group dated June 10, 2019. These documents are the sources of information found in this Chapter and provide additional information for reference.

Introduction

Having affordable, quality housing in safe neighborhoods with access to community services is essential for all Oregonians. Like other cities in Oregon, the City of Prineville is responsible for helping to ensure that its residents have access to a variety of housing types that meet the housing needs of households and residents of all incomes, ages and specific needs. The City does this primarily by regulating residential land uses within the City, and working with and supporting non-profit and market rate developers, and other housing agencies in developing needed housing.

In addition, the City has undertaken and will continue to implement and update a variety of activities to meet current and future housing needs:

- Conduct and periodically update an analysis of current and future housing conditions and needs. The City most recently conducted this analysis in 2019. The results are summarized in this element of the Comprehensive Plan and described in more detail in a supporting Housing and Residential Land Need Assessment Report.
- Conduct and periodically update an inventory of buildable residential land (BLI) to ensure that the City has an adequate supply of land zoned for residential use to meet projected future needs. The City most recently conducted this analysis in 2019. The results are summarized in this element of the Comprehensive Plan and described in more detail in a supporting Buildable Lands Inventory Report.
- Adopt and amend, as needed, a set of housing-related Comprehensive Plan policies to address future housing needs.
- Regularly update and apply regulations in the City's Zoning and Land Division Ordinances to meet a variety of housing needs identified in the Comprehensive Plan and supporting documents.
- Implement additional strategies to address housing needs in partnership with state and county agencies and other housing organizations. Potential strategies are described in more detail in section 4 of the Housing Strategies Report prepared as part of the Housing Needs Analysis in 2019.

Demographic Conditions and Trends

Unless otherwise noted, the flowing discussion refers to the Prineville Urban Growth Boundary (UGB) area, not the city limits.

- Prineville is a City of an estimated 10,000 people within its City limits, (11,910 people within the UGB), located in Crook County in Central Oregon. An estimated 19% of the population in the UGB lives outside the city limits.
- Prineville has experienced steady growth, growing over 36% in population since 2000. In contrast, Crook County and the state experienced population growth of 15% and 21% respectively. (US Census and PSU Population Research Center)
- The Prineville UGB was home to an estimated 5,218 households in 2018, an increase of roughly 1,850 households since 2000. The percentage of families fell between 2000 and 2018 from 67% to 53% of all households. The city has a smaller share of family households than Crook County (65%) and the state (63%).
- Prineville's estimated average household size is 2.26 persons, having also fallen since 2000. This is lower than the Crook County average of 2.31 and the statewide average of 2.47.

FIGURE 1.1: PRINEVILLE DEMOGRAPHIC PROFILE (UGB)

POPULATION, HOUSEHOLDS, FAMILIES, AND YEAR-ROUND HOUSING UNITS					
	2000 (Census)	2010 (Census)	Growth 00-10	2018 (PSU)	Growth 10-18
Population[1]	8,755	11,010	25.8%	11,910	8.2%
Households[2]	3,362	4,415	31.3%	5,218	18.2%
Families[3]	2,275	2,879	27%	2,755	-4%
Housing Units[4]	3,596	4,975	38%	5,307	7%
Group Quarters Population[5]	181	236	30%	118	-50%
Household Size (non-group)	*2.55*	*2.44*	-4%	*2.26*	-7%
Avg. Family Size	*3.09*	*2.98*	-4%	*2.96*	-1%
PER CAPITA AND MEDIAN HOUSEHOLD INCOME					
	2000 (Census)	2010 (Census)	Growth 00-10	2018 (Proj.)	Growth 10-18
Per Capita ($)	$14,163	$17,692	25%	$18,503	5%
Median HH ($)	$30,435	$30,628	1%	$33,195	8%

SOURCE: Census, PSU Population Research Center, and Johnson Economics

Census Tables: DP-1 (2000, 2010); DP-3 (2000); S1901; S19301

1 From PSU Population Research Center, Population Forecast Program, final forecast for Crook Co. (2017)

[2] 2018 Households = (2018 population - Group Quarters Population)/2018 HH Size

[3] Ratio of 2018 Families to total HH is based on 2016 ACS 5-year Estimates

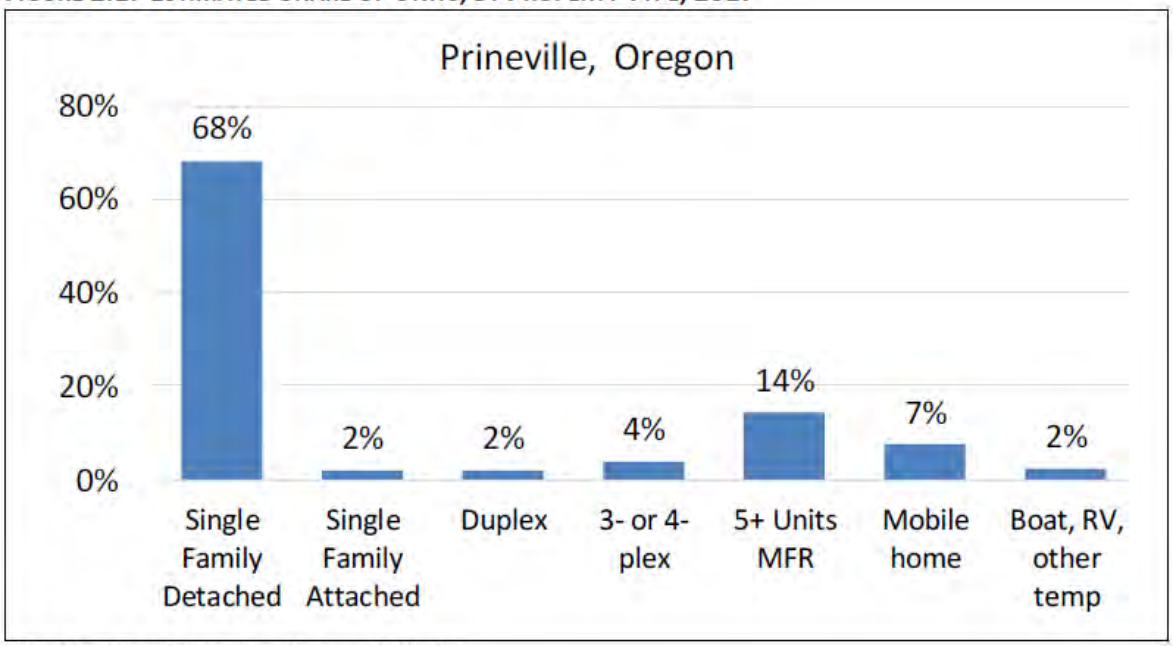
[4] 2018 housing units are the '10 Census total plus new units permitted from '10 through '18 (source: Census, Cities)

[5] Ratio of 2018 Group Quarters Population to Total Population is kept constant from 2010.

Housing Conditions and Trends

- **Housing Tenure.** Prineville has a greater share of owner households (55%) than renter households (45%) according to the Census. The ownership rate in Prineville has fallen significantly from 63% since 2000. During this period the statewide rate fell from 64% to 61%. Nationally, the homeownership rate has nearly reached the historical average of 65%, after the rate climbed from the late 1990's to 2004 (69%). The estimated ownership rate is higher in Crook County (67%) and statewide (61%).
- **Housing Stock.** The Prineville UGB had an estimated 5,300 housing units in 2018, with a very low estimated vacancy rate (includes ownership and rental units). Figure 2.1 shows the estimated number of units by type in 2017. Detached single-family homes represent an estimated 68% of housing units (includes manufactured homes on a single-family lot). Units in larger apartment complexes of 5 or more units represent 14% of units, and other types of attached homes represent an additional 8% of units. (Attached single family generally includes townhomes, some condo flats, and plexes which are separately metered.) Mobile homes (in parks) represent 7% of the inventory.

FIGURE 2.1: ESTIMATED SHARE OF UNITS, BY PROPERTY TYPE, 2017



SOURCE: City of Prineville, Census ACS 2017

Current and Projected Housing Needs

- The results show a need for 1,020 new housing units by 2039.
- Of the new units needed, roughly 57% are projected to be ownership units, while 43% are projected to be rental units. This is due to the forecast of a slightly higher homeownership rate in the future.
- The table shows no new need for ownership housing at the low-end of the pricing spectrum, but in the middle. This is because these are the value levels where a majority of the city's housing is currently found. Therefore, what Figure 4.3 represents is that there may be support for some units at higher price points.
- The greatest need for rental units is found at the lowest and middle price points. There is support for some units in the $900 to $1,100 rent levels, which is above most current market rents. This shows that there is some support for new, more expensive rental supply. There is also a need for some single-family homes for rent at higher price points.

FIGURE 3.4: PROFILE OF CURRENT HOUSING SUPPLY, ESTIMATED AFFORDABILITY (2018)

	Ownership Housing		Rental Housing		
Income Range	Affordable Price Level	Estimated Units	Affordable Rent Level	Estimated Units	Share of Total Units
Less than $15,000	$0k - $90k	687	$0 - $400	294	18%
$15,000 - $24,999	$90k - $130k	734	$400 - $600	672	26%
$25,000 - $34,999	$130k - $190k	883	$600 - $900	688	30%
$35,000 - $49,999	$190k - $210k	266	$900 - $1000	315	11%
$50,000 - $74,999	$210k - $340k	182	$1000 - $1600	403	11%
$75,000 - $99,999	$340k - $360k	15	$1600 - $1700	0	0%
$100,000 - $124,999	$360k - $450k	30	$1700 - $2100	0	1%
$125,000 - $149,999	$450k - $540k	20	$2100 - $2500	0	0%
$150,000 - $199,999	$540k - $710k	33	$2500 - $3300	0	1%
$200,000+	$710k +	69	$3300 +	15	2%
	55%	2,921	45%	2,386	0% 10% 20% 30%

Sources: US Census, PSU Population Research Center, JOHNSON ECONOMICS
Census Tables: B25004, B25032, B25063, B25075 (2017 ACS 5-yr Estimates)

FIGURE 4.3: PROJECTED FUTURE NEED FOR NEW HOUSING UNITS (2039), PRINEVILLE

OWNERSHIP HOUSING										
			Multi-Family							
Price Range	Single Family Detached	Single Family Attached	2-unit	3- or 4-plex	5+ Units MFR	Mobile home	Boat, RV, other temp	Total Units	% of Units	Cummulative %
$0k - $90k	0	0	0	0	0	0	0	0	0.0%	0.0%
$90k - $130k	0	0	0	0	0	0	0	0	0.0%	0.0%
$130k - $190k	0	0	0	0	0	0	0	0	0.0%	0.0%
$190k - $240k	17	21	0	7	0	59	0	104	17.8%	17.8%
$240k - $320k	121	0	0	0	0	0	0	121	20.7%	38.6%
$320k - $360k	181	0	0	0	0	0	0	181	31.1%	69.6%
$360k - $450k	108	0	0	0	0	0	0	108	18.6%	88.2%
$450k - $540k	49	0	0	0	0	0	0	49	8.5%	96.7%
$540k - $710k	19	0	0	0	0	0	0	19	3.3%	100.0%
$710k +	0	0	0	0	0	0	0	0	0.0%	100.0%
Totals:	495	21	0	7	0	59	0	582	% of All Units:	57.0%
Percentage:	85.0%	3.6%	0.0%	1.2%	0.0%	10.2%	0.0%	100.0%		

RENTAL HOUSING										
			Multi-Family							
Price Range	Single Family Detached	Single Family Attached	2-unit	3- or 4-plex	5+ Units MFR	Mobile home	Boat, RV, other temp	Total Units	% of Units	Cummulative %
$0 - $400	33	20	19	31	143	20	15	280	63.9%	63.9%
$400 - $600	0	0	0	0	0	0	0	0	0.0%	63.9%
$600 - $900	0	0	0	0	0	0	0	0	0.0%	63.9%
$900 - $1100	85	0	5	5	5	5	0	107	24.3%	88.2%
$1100 - $1500	0	0	0	0	0	0	0	0	0.0%	88.2%
$1500 - $1700	23	0	0	0	0	0	0	23	5.2%	93.4%
$1700 - $2100	5	0	0	0	0	0	0	5	1.1%	94.5%
$2100 - $2500	2	0	0	0	0	0	0	2	0.5%	95.1%
$2500 - $3300	22	0	0	0	0	0	0	22	4.9%	100.0%
$3300 +	0	0	0	0	0	0	0	0	0.0%	100.0%
Totals:	170	20	24	36	149	25	15	439	% of All Units:	43.0%
Percentage:	38.8%	4.5%	5.5%	8.2%	33.9%	5.7%	3.4%	100.0%		

TOTAL HOUSING UNITS									
			Multi-Family						
	Single Family Detached	Single Family Attached*	2-unit	3- or 4-plex	5+ Units MFR	Mobile home	Boat, RV, other temp	Total Units	% of Units
Totals:	665	40	24	43	149	84	15	1,021	100%
Percentage:	65.2%	4.0%	2.4%	4.2%	14.6%	8.3%	1.5%	100.0%	

Sources: PSU, City of Prineville, Census, Environics Analytics, JOHNSON ECONOMICS

- Figure 4.4 presents estimates of need at key low-income affordability levels in 2018 and in 2039. There is existing and on-going need at these levels, based on income levels specified by Oregon Housing and Community Services for Crook County. An estimated 55% of households qualify as at least "low income" or lower on the income scale, while 17% of household qualify as "extremely low income". Typically, only rent-subsidized properties can accommodate these households at "affordable" housing cost levels.

FIGURE 4.4: PROJECTED NEED FOR HOUSING AFFORDABLE AT LOW INCOME LEVELS, PRINEVILLE

Affordablilty Level	Income Level		Current Need (2018)		Future Need (2039)		NEW Need (20-Year)	
			# of HH	% of All	# of HH	% of All	# of HH	% of All
Extremely Low Inc.	30% AMI	$16,410	862	17%	993	17%	131	13%
Very Low Income	50% AMI	$27,350	1,811	35%	2,086	35%	275	27%
Low Income	80% AMI	$43,760	2,876	55%	3,313	55%	437	43%

Sources: OHCS, Environics Analytics, JOHNSON ECONOMICS
* Income levels are based on OHCS guidelines for a family of four.

Comparison of Projected Need and Buildable Land Supply

- There is a total forecasted need for 1,021 units over the next 20 years. This is well below the estimated capacity of over 10,000 units. As Figure 5.3 below demonstrates, there is sufficient capacity to accommodate all projected new unit types. After this need is accommodated, there is an estimated remaining capacity of over 1,900 additional units, mostly in the medium-density residential zone.
- The following table shows the same comparison, converting the forecasted residential need and capacity by acres, rather than units. There is a projected need for 216 acres of new residential development, but a buildable capacity of 1,569 acres.
- There is currently sufficient buildable capacity within Prineville to accommodate projected need. Some of this capacity is in the form of parcels with the potential for infill or redevelopment for future multi-family units. The character of this supply can help guide housing policy and strategy recommendations to be included in subsequent reports and ultimately integrated in the City's updated Comprehensive Plan.

FIGURE 5.1: ESTIMATED BUILDABLE LANDS CAPACITY BY ACREAGE AND NO. OF UNITS (2019)

ZONE	Buildable Acreage				Projected Unit/ Net Acre	Housing Unit Capacity			
	Partially Vacant	Vacant	Total	Share		Partially Vacant	Vacant	Total	Share
R1 - Limited Residential	12	20	32	2%	4	42	93	135	1%
R2 - General Residential	171	728	899	57%	8	1,320	5,767	7,087	69%
R3 - County Residential	310	284	594	38%	4	1,097	1,523	2,620	26%
R4 - Resid. Redevelopment	3	4	7	0.4%	10	24	35	59	0.6%
CMU - Mixed Use	24	8	32	2%	10	239	77	316	3%
TOTALS:	*520*	*1,044*	*1,564*		*7*	*2,722*	*7,495*	*10,217*	
Low Density Residential	*322*	*304*	*626*	*40%*		*1,139*	*1,616*	*2,755*	*27%*
Medium Density Residential	*171*	*728*	*899*	*57%*		*1,320*	*5,767*	*7,087*	*69%*
High Density Residential	*27*	*12*	*39*	*2%*		*263*	*112*	*375*	*4%*

Source: Angelo Planning Group

FIGURE 5.3: COMPARISON OF FORECASTED FUTURE LAND NEED (2039) WITH AVAILABLE CAPACITY

	Unit Type			
LAND INVENTORY VS. LAND NEED	Single Family Detached	Medium-Density Attached*	Multi-Family	TOTAL
Buildable Land Inventory (Acres):	626	899	39	1,564
Estimated Land Need (Acres):	187	14	15	216
Land Surplus (Inventory - Need:)	***439***	***885***	***24***	***1,348***

Sources: Angelo Planning Group, Johnson Economics

For more detail on these findings please refer to the "Housing and Residential Land Needs Assessment Report" and the Buildable Lands Inventory (BLI) maps prepared for the city.

Potential Strategies to Accommodate Future Housing Needs

The Housing Needs Analysis and Buildable Lands Inventory conducted for the City in 2019 indicated that the City had and adequate supply of buildable residential land within its urban growth boundary (UGB) to meet projected housing needs during the next 20 years. If population growth occurs at a faster rate than projected at that time, the City could find that additional land is needed in the future.

Although the City is not anticipated to need to expand its UGB during the planning period, it can continue to consider and implement a variety of strategies in the future to further provide opportunities for a wide range of housing choices, efficient land use, and development of housing affordable to people with low and moderate incomes. For the purposes of this Plan, "affordable housing" is defined as housing that is affordable to a household that spends 30% or less of its income on housing, including rent or mortgage payments. Households with low incomes are those who make 80% or less of median household income. Those with moderate incomes make 81-95% of median household income.

The City is already implementing a variety of land use and other strategies that help provide for a wide range of housing options in Prineville. Potential strategies not currently being undertaken by the City, or existing strategies with the potential to be strengthened or enhanced, are described in more detail in the Housing Strategies Report prepared by the City as part of its Housing Needs Analysis project in 2019.

Housing Goal: Provide opportunities for a wide range of housing types that meet the needs of residents with a full range of incomes and circumstances.

Policies

1. The City shall apply zoning designations and standards that create opportunities for wide variety of housing types, including but not limited to single-family detached homes, manufactured homes, duplexes, triplexes, four-plexes, townhomes, apartments, accessory dwelling units, cottage cluster housing, recreational vehicle parks, and mixed commercial and residential use.

2. The City shall encourage development of higher density and multifamily housing in close proximity to services and major transportation corridors or other areas designated for this use and limit low-density housing in these locations.

3. The City shall seek partnerships with non-profit housing developers and other agencies to create the opportunity to provide moderate-and low-income housing development and rehabilitation activities within the City.

4. The City shall continue to implement its Natural Feature Overlay District (NFOD) to help reduce the amount of development in hazardous areas such as floodplains and steep slopes as well as natural areas such as wetlands and rimrock.

5. The City shall employ strategies that support federal and state Fair Housing laws and other federal and state fair housing requirements to affirmatively further fair housing.

6. The City shall allow and support the development of Accessory Dwelling Units in all residential zones where single-family detached homes are allowed, as required by State law.

7. The City shall allow for a mix of residential uses with other compatible uses in appropriate locations.

8. The City shall support the maintenance and development of manufactured homes as an affordable housing choice in appropriate locations.

9. The City shall continue to support and publicize programs implemented by partner organizations which promote energy efficiency and use of other sustainable building materials and practices in the construction and rehabilitation of housing.

10. The City shall consider supporting programs implemented by partnering agencies which address the needs of the unhoused, as well as people with specialized housing needs, including medical hardships.

11. The City shall encourage maintenance and rehabilitation of the existing housing stock, including the extension of services and support local or regional programs that provide funding for these efforts.

12. The City shall encourage efficient use of residential land within the Urban Growth Boundary.

13. The City shall regularly monitor its supply of buildable land and shall provide a sufficient amount of residential land to accommodate residential growth.

14. The City shall continue to provide opportunities for the flexible design and siting of housing through the use of its Planned Unit Development provisions and other alternative land use permitting procedures and processes.

15. The City shall support and encourage multi-modal transportation designs and provide access internally and adjacent to new and existing developments.

8

Public Services and Facilities (2024)

Chapter 8 Public Services and Facilities

Prineville's Comprehensive Plan

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Purpose and Intent

Goals & Policies

Goal 1: Provide public facilities, services and private utility systems at levels necessary and practical for existing and future uses.

Goal 2: Maintain and regularly update public facility plans and capital improvement programs and budgeting.

Purpose and Intent

Public Services and Facilities

Adopted July 2024

Purpose and Intent

Public Facilities are improvements, which provide services through various government entities or through franchise agreements with private utilities. The purpose of this chapter is to identify existing public and private facilities and services and identify present and future needs based on projected growth.

Key public facilities are typically described as transportation, water, wastewater, storm drainage, planning & zoning, parks & recreation, solid waste collection, energy, communication, schools, emergency services, health services and community governmental services. While the City and other local providers offer a wide range of services, these key elements are essential to accommodating growth and maintaining public health and safety. Likewise, the City is required to prepare and maintain planning tools that make sure adequate levels of key services are available and not stressed beyond their carrying capacities.

The City of Prineville manages key facilities such as governance, police, transportation, water, wastewater, stormwater and some elements of recreation, which are under their jurisdiction. Services such as; health, parks & recreation, fire protection, solid waste collection, building permitting, schools, energy, other utilities and communication services are provided by other entities and in some cases through franchise agreements with the City.

This chapter does not list specific current or needed public improvements. That information is found in various facility plans, commonly referred to as "master plans" from each serving entity. The City maintains and adopts Public Facility Plans for Transportation, Water, Wastewater and Stormwater. The City also adopts facility plans by local partnering agencies for Parks & Recreation, Airport and others as may be applicable. Transportation (Chapter 6) and Parks (Chapter 4) are separate individual Chapters in this Comprehensive Plan. The most current versions of the aforementioned plans are supporting documents to the Comprehensive Plan and are hereby referenced and made part of this chapter.

Goals and Policies

Statewide planning Goal 11, OAR 660-015 (Public Facilities and Services); requires that cities plan and develop a timely, orderly and efficient arrangement of public facilities and services to serve as a framework for urban and rural development.

Goal #1: Provide public facilities, services and private utility systems at levels necessary and practical for existing and future uses.

Policies

1. Plans and development impacting public facility and service shall consider; desired service levels, system and area protections, infrastructure needs and impacts to the following areas within the UGB.

    - Police Protection
    - Fire Protection
    - Emergency Medical Service
    - Transportation
    - Parks and Recreation
    - Natural Open Space
    - Natural Hazards
    - Public Buildings
    - Water System
    - Wastewater System
    - Stormwater System
    - Solid Waste Management
    - Schools
    - Airport
    - Railroad
    - Other Public/Private Utilities

2. Plans providing for public facilities and services should be coordinated with plans; for the designation of urban boundaries, zoning, urbanizable land, rural uses and for the transition of rural land to urban uses. The following factors shall be considered when determining public facility locations:

    - Availability and cost of usable land
    - Geographic restrictions
    - Carrying capacity of planning area
    - Operational efficiency
    - Related project improvements
    - Long term cost burden
    - Disruption of residential areas
    - Comprehensive Plan goals and policies

3. Public facilities and services in urban and urbanizable areas should be provided at levels necessary and suitable for urban uses without reducing service levels of existing residents.

4. A public facility or service should not be provided to outlying urbanizable areas within the UGB, unless there are provision for the coordinated annexation and development of all other urban facilities, services and rights-of-way appropriate to that area.

5. Collaborate with private utility companies to ensure equitable access to services throughout the City. Various agencies and entities other than the City of Prineville may be allowed to use City rights-of way. This may require the imposition of franchise agreements and special protocols and fees. In no case, shall these entities create a situation whereby the City must subsidize activity or repair damage caused by other service providers.

6. All utility lines and facilities should be located on or adjacent to existing public or private rights-of-way to avoid easements and dividing lots. Whenever feasible, all utility lines and components shall be placed underground.

7. New Development shall not exceed the carrying capacity of public facilities and services. New development shall provide appropriate infrastructure and public services or mitigate for such impact as a condition of development. Anticipated growth within the community may require expansion of facilities faster than the local government can provide. In these cases, it is essential that growth pay its own way in order to avoid unnecessary impacts upon existing residents and quality of life. This means that new development may need to supply an array of services to developments ahead of the City schedule and at their own cost, subject to City approval and authorization before development.

8. The City and other agencies and partners should utilize sustainability practices and other techniques for sustaining limited resources and facilities including such things as; recycling programs, preservation of natural areas, water conservation, wastewater reuse, air quality monitoring, energy production and energy consumption.

Goal #2: Maintain and regularly update public facility plans and capital improvement programs and budgeting.

Policies

1. City Facility Plans for transportation, wastewater, water and stormwater shall be adopted and periodically updated throughout the planning period.

2. The City shall periodically update short- and long-term Capital Improvement Plans (CIPs) for public facilities throughout the planning period, including property acquisition needs.

3. The City shall adopt and periodically update funding methodologies and coordinate investments to pay for and leverage planned capital improvements.

4. The City shall explore innovative ways of providing public facilities and services as well as funding alternatives to ensure the equitable and adequate development and implementation of public facilities and services

The Following table is a log of amendments to the adopted 2007 Prineville Comprehensive Plan.

ORD	DATE	DESCRIPTION
1151	May 28, 2008	Zone Map Amendment from Industrial to Residential
1157	October 14, 2008	Zone Map Amendment from Industrial to Residential
1159	December 9, 2008	Zone Map Amendment from Industrial to Outlying Commercial and Residential
1182	July 12, 2011	Zone Map Amendment from Heavy Industrial to Light Industrial
1193	August 14, 2012	UGB adjustment (swap) from and too Light Industrial
1197	May 28, 2013	UGB Expansion to Light Industrial
1199	August 27, 2013	Zone Map Amendment for Ochoco Lumber Site from Heavy Industrial to Mixed Use and adopting a Master Plan
1200	October 8, 2013	UGB Expansion to Light Industrial
1201	November 26, 2013	Adopting new Transportation Systems Plan (TSP)
1205	June 24, 2014	Amending TSP to address issues with Ochoco Lumber mixed use site.
1210	December 17, 2014	UGB Expansion to Light Industrial
1212	March 31, 2015	Text Amendment to include language for medical marijuana
1215	June 23, 2015	Text Amendment to include language for recreational marijuana
1221	February 9, 2016	UGB Expansion to Light Industrial
1222	March 28, 2017	Text Amendment amending Ordinance 1215
1226	November 7, 2016	Zone Map Amendment from light Industrial to Outlying Commercial
1228	January 24, 2017	Zone Map Amendment from Heavy Industrial to Residential
1237	April 24, 2018	Adopting Water Systems Master Plan
Res. 1327	October 10, 2017	UGB Expansion to Heavy Industrial
1232	October 24, 2017	Adopting Airport Master Plan
1233	October 24, 2017	Zone Map Amendment from Heavy Industrial to Residential
1238	May 22, 2018	Zone Map Amendment creating single airport zone designation
1239	May 22, 2018	Adopting Wastewater Facility Plan
1254	October 22, 2019	Text Amendment Updating and Replacing Chapter 7 (Housing)
1269	September 14, 2021	Text Amendment updating and Replacing Chapter 4 (Parks)
1279	October 25, 2022	Zone Map Amendment from Light Industrial to Outlying Commercial. (C4 zone node)
1289	April 23, 2024	Comp and zone map corrections
1291	June 11, 2024	Comp and zone map corrections
1292, 1293, 1294	July 9, 2024	Text Amendment updating and replacing Chapter 8 (Public Services and Facilities). Water and Wastewater Master Plans.
1298	February 11, 2025	Comp Plan Map correction
1304	September 23, 2025	Transportation System Plan, Chapter 6

DAS
DEPARTMENT OF ADMINISTRATIVE SERVICES

Oregon Economic and Revenue Forecast

March 2024

Volume XLIV, No. 1
Release Date: February 7th, 2024

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Foreword

This document contains the Oregon economic and revenue forecasts. The Oregon economic forecast is published to provide information to planners and policy makers in state agencies and private organizations for use in their decision making processes. The Oregon revenue forecast is published to open the revenue forecasting process to public review. It is the basis for much of the budgeting in state government.

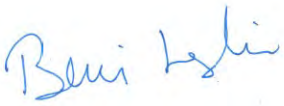
The report is issued four times a year; in March, June, September, and December.

The economic model assumptions and results are reviewed by the Department of Administrative Services Economic Advisory Committee and by the Governor's Council of Economic Advisors. The Department of Administrative Services Economic Advisory Committee consists of 15 economists employed by state agencies, while the Governor's Council of Economic Advisors is a group of 12 economists from academia, finance, utilities, and industry.

Members of the Economic Advisory Committee and the Governor's Council of Economic Advisors provide a two- way flow of information. The Department of Administrative Services makes preliminary forecasts and receives feedback on the reasonableness of such forecasts and assumptions employed. After the discussion of the preliminary forecast, the Department of Administrative Services makes a final forecast using the suggestions and comments made by the two reviewing committees.

The results from the economic model are in turn used to provide a preliminary forecast for state tax revenues. The preliminary results are reviewed by the Council of Revenue Forecast Advisors. The Council of Revenue Forecast Advisors consists of 15 specialists with backgrounds in accounting, financial planning, and economics. Members bring specific specialties in tax issues and represent private practices, accounting firms, corporations, government (Oregon Department of Revenue and Legislative Revenue Office), and the Governor's Council of Economic Advisors. After discussion of the preliminary revenue forecast, the Department of Administrative Services makes the final revenue forecast using the suggestions and comments made by the reviewing committee.

Readers who have questions or wish to submit suggestions may contact the Office of Economic Analysis by telephone at 503-378-3405.



Berri Leslie
DAS Director
Chief Operating
Officer

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Executive Summary

March 2024

Historically, inflationary economic booms have not ended well. The pandemic is increasingly looking like the exception. Inflation has cooled and is near the Federal Reserve's target. The labor market rebalanced last year. However, strong recent data in terms of consumer spending, job gains, and real GDP growth raise the possibility of inflation rebounding in the quarters ahead. The Fed is indicating they will cut interest rates this year, but appear to be in no real hurry given the economic strength.

Economic growth is combination of the number of workers and how productive each is. So far this cycle, Oregon's productivity gains have outpaced the nation, while local job growth is in the middle of the pack across states. The outlook for labor and capital are on differing, structural trends. Labor is both cyclically strong today, and structurally tight due to demographics. The recently released 2023 population estimates show that Oregon's population continued to stagnate during the pandemic. Our office has lowered the population outlook as a result. In the decade ahead Oregon's population is expected to rebound, but grow at just 0.6 percent per year. This lower population forecast feeds directly into a relatively smaller labor force and a bit less personal income earned in the years ahead.

The good news is that between the start-up boom, increased federal investment, and potential of generative AI, productivity is set to increase faster in the decade ahead. These gains will boost the overall economy and makeup for slower labor growth. Even so, one of the key dynamics for stronger business investment is a tight labor market. When workers are scarce, and expensive, firms are more willing, if not forced to invest in labor-saving technology and processes.

Oregon's state revenue outlook remains stable heading into the personal income tax filing season. The underlying economic outlook is relatively unchanged, and collections are tracking closely to expectations. Compared to the December 2023 forecast, General Fund revenues are raised $76 million. However, total available resources are increased $558 million in large part due to accountants closing the books on the previous 2021-23 biennium. Unspent allocations last biennium revert to the General Fund, boosting resources in 2023-25.

Although overall revenue collections are matching expectations, there have been some notable surprises. The most significant of which is the persistence of the six-year boom in Oregon's traditional corporate income and excise taxes. Tax collections have far outstripped growth in underlying corporate profits. The longer the surge in collections persists, the more likely it becomes that tax reforms enacted at the federal and state levels have permanently increased Oregon's corporate tax base, and that the step up in collections will remain with us going forward.

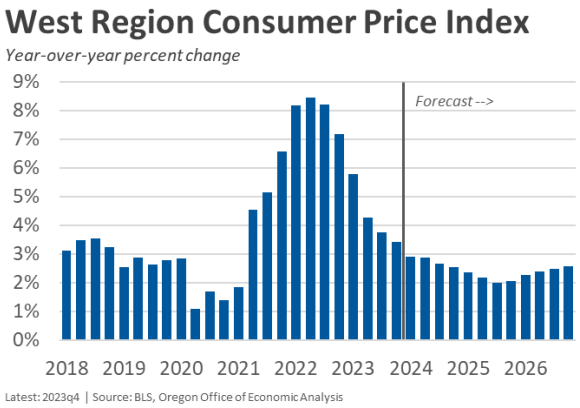
The modest reduction in expected population and job gains reflected in the underlying economic outlook filters through to a somewhat weaker long-term forecast for personal income taxes. That said, these changes do not change the general nature of the revenue forecast, with the largest reduction in expected General Fund resources amounting to less than one percent of revenue in the 2029-31 budget period.

Economic Outlook

Macroeconomic Setting

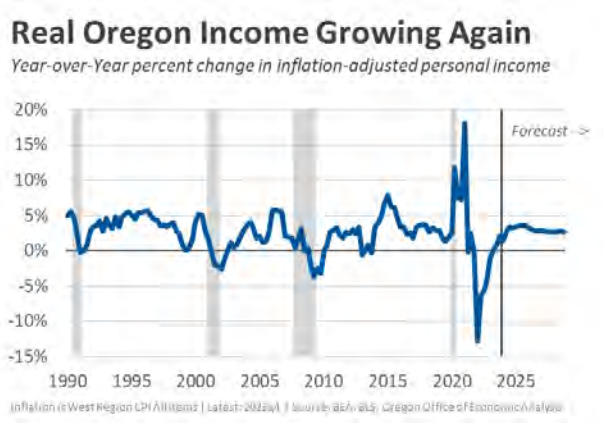
In recent years, economists were worried about the high probability of recession. Historically, inflationary economic booms have not ended well. The Federal Reserve was willing to risk a recession in order to get inflation under control. Encouragingly, the past year has gone better than economists could have hoped for. Inflation is at or near the Fed's target. The labor market has rebalanced and is no longer overheated. Importantly, underlying economic growth, as measured by real GDP and consumer spending, remains strong.

The challenge for the Fed is threading the needle for monetary policy to continue to keep inflation near target, and ensure the expansion continues. Today the Fed is indicating they will make three quarter point rate cuts this year. Given inflation is already near target, financial markets priced in more like six rate cuts , double what the Fed indicated.



As recent national economic data continues to show good to great gains, financial markets are repricing interest rates higher, realizing the Fed may not cut rates as quickly, or as deeply as market participants thought just a few weeks ago.

An important dynamic is that inflation has slowed further than headline economic growth, meaning real growth, or inflation-adjusted growth is picking up. In particular, personal income is once again outpacing inflation, raising the living standards of Americans and Oregonians. It may be somewhat tautological, but real income growth supports real consumer spending growth, which in turn results in real economic growth as firms produce more goods and services to sell to customers. And the need to produce and sell more products increases labor demand.



The pandemic and reopening bullwhip effects are still reverberating to some degree. However as consumer spending remains strong, and inventories dwindle, increased manufacturing and logistics activity is needed to restock. These cyclical industries have been down in the past year or so, which caused some of the recession concerns. However the outlook is brighter and goods-producing industries are expected to stabilize in terms of employment, and increase production this year.

Ultimately, the risk for the Fed is cutting rates too quickly, or deeply which may spur stronger economic growth and a rebound in inflation, versus not cutting rates quickly or deeply enough thus leaving

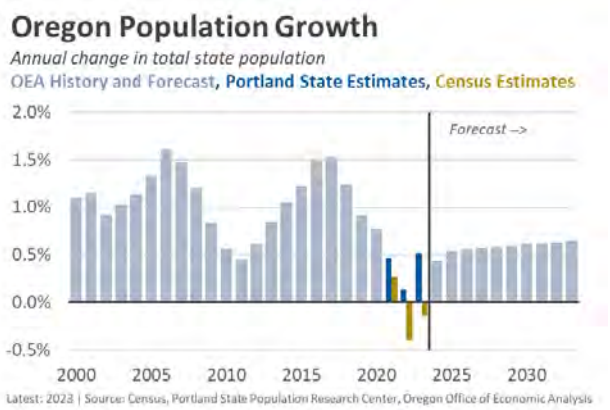
interest rates too high and ultimately chocking off growth. Practically speaking, the difference between three and six rate cuts and whether they start next month or in a handful of months likely does not amount to much for the macroeconomy. The key is that the Fed is generally moving policy in the right direction given the state of the economy. The risks lie with larger policy errors, and policy not being nimble enough to offset whatever unexpected shocks or trends there are just beyond the horizon. But should there be a growth scare for whatever reason, expectations are the Fed will cut rates a bit sooner, and/or deeper than they currently are indicating.

Oregon's Economic Outlook

Locally, economic growth is combination of the number of workers and how productive each is. So far this cycle, Oregon's productivity gains have outpaced the nation, while local job growth is in the middle of the pack across states. Looking forward the outlook for labor and capital are on differing, structural trends. Labor is both cyclically strong today, and structurally tight due to demographics. The good news is that between the start-up boom, increased federal investment, and potential of generative AI, productivity is set to increase faster in the decade ahead. These gains will boost the overall economy and makeup for slower labor growth. Even so, one of the key dynamics for stronger business investment is a tight labor market. When workers are scarce, and expensive, firms are more willing, if not forced to invest in labor-saving technology and processes.

2023 Population Estimates and Forecast Changes

Late last year both Portland State University's Population Research Center, and the Census Bureau release their 2023 mid-year estimates. Once again the estimates differed with PSU showing a small increase and Census showing a small decline. While the cumulative gap between the two estimates over the 2020-2023 period is larger – approximately 56,000 – the bottom line is Oregon's population growth continues to be much slower than in decades past.



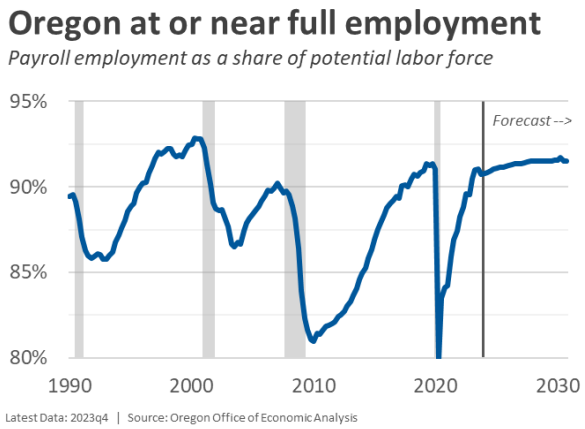
A slight gain or loss does matter from a big picture narrative, but the practical matter is the latest estimates are another indication that some of the pandemic migration patterns may be more permanent that previously believed. Our office's baseline has been, and continues to be for a modest rebound in growth in the years ahead. Oregon continues to have plentiful job opportunities and provide scenic and recreational amenities. However, the combination of bad housing affordability, and increased remote work opportunities likely means migration flows will be less than they have been historically.

Our office has lowered the population outlook over the forecast horizon. In the decade ahead, the forecast now calls for 0.6 percent annual growth, down from the 0.7 percent annual growth in the previous forecast. This lower population outlook does feed directly into a slight reduction in the

economic outlook of the state as well. Keep in mind that the state's population, labor force, income, housing demand and the like are expected to increase, just now at a slightly slower rate.

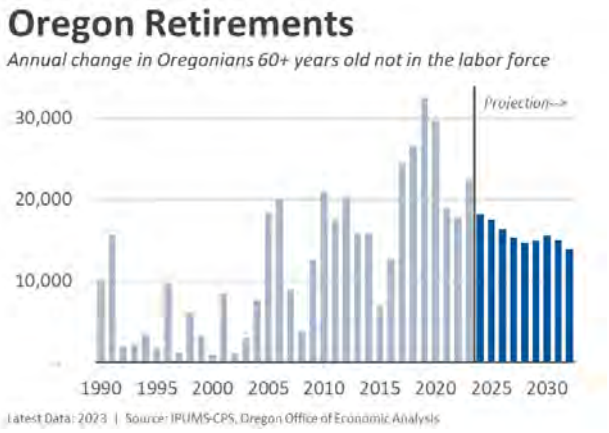
Labor is Cyclically Strong, and Structurally Tight

Employment in Oregon has fully recovered from the pandemic. On an age-adjusted basis, the share of Oregonians with a job is nearly as high as it has ever been in our recorded history. Economists tend to call this full employment. The nature of our economic forecast is that the labor market remains cyclically strong at these high employment rates until whenever the next recession comes. This is the main reason that firms are struggling to find workers, the simple fact that nearly everyone who wants a job, already has one, and those that do not cannot more readily find one given the number of job openings in the economy.



However, beyond the cyclical strength in the economy today, the labor market is structurally tight for demographic reasons. With a growing older adult population, the number of retirements picked up last decade.

With the large Baby Boomer generation continuing to reach their traditional retirement years in the decade ahead, retirements will be larger as well. It is economically difficult for firms to replace workers with a lifetime of experience and expertise, especially when it comes to within firm experience and institutional knowledge. As such there may be a short-term loss of productivity as firms train new workers, or employees move into new roles within the company. Such an impact is typically temporary, and difficult to see at the macro level even if at the micro level the impact is real.

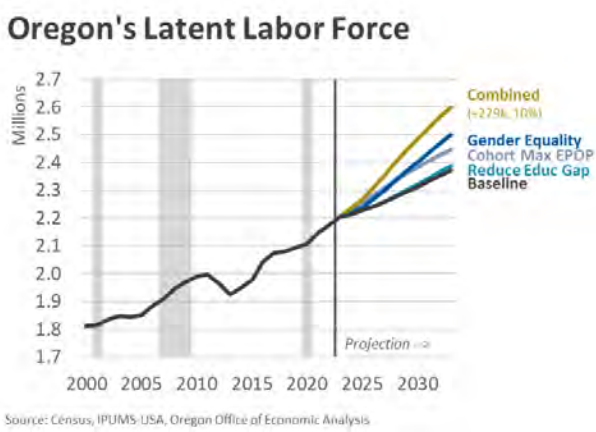


Now, Oregon's labor force is expected to grow in the years ahead. However, given the state's low birthrate in recent decades, and the slower migration outlook, the net labor gains are expected to be smaller than in decades past. Firms looking to hire will need to dig deeper into the resume stack and choose candidates they may have passed over in a weaker economy. This includes workers with an incomplete skillset, and on the job training becomes even more important than ever.

Additionally, firms are likely to begin to hire to a greater degree from the state's Latent Labor Force. The economy may be at the typical labor force constraint today, but that does not mean there are no more potential workers entirely. The Latent Labor Force is based on historical disparities when it comes to

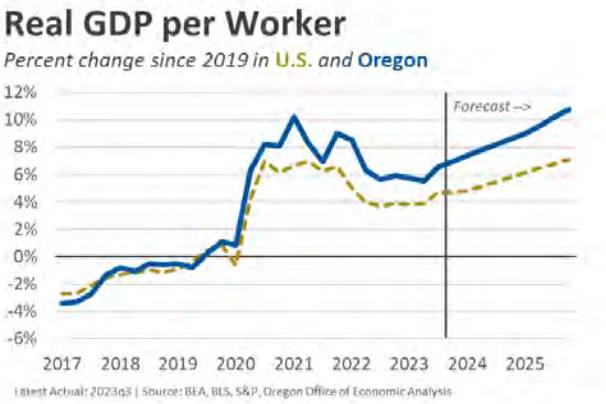
jobs and wages for Oregonians of different races and ethnicities, different levels of educational attainment, and different genders, or sex.

Today the Latent Labor Force finds that there remains a sizable pool of potential workers already living in Oregon when it comes to addressing, and reducing these historical disparities. Now, a bit of good news is that the Latent Labor Force today is a bit smaller than when our office previously did the analysis. Partially this is due to a slower population outlook, but also this is because these disparities are smaller today than a few years ago. Some progress on closing these economic gaps is being made already in the strong economy, even as gaps remain.

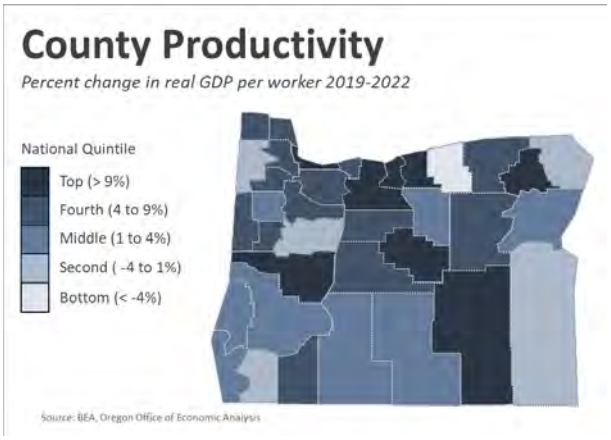


Productivity Boosts Economic Growth

Given the labor outlook, firms looking to expand will need to rely even more on capital investment in the years ahead. Faster productivity growth raises the speed limit of the overall economy. It also helps keep inflation in check, and can result in strong wage gains for existing workers. A key dynamic to increased investment is a tight labor market. When labor is scarce, and expensive, it provides a need and an incentive for firms to invest in labor-saving technologies and processes. Additionally the combination of the start-up boom, increased federal investment alongside private activity, and the potential for generative AI, productivity should be better in the years ahead.



So far this cycle, Oregon has seen stronger productivity gains than the nation and the typical state. However recent revisions to state GDP have brough Oregon's gains closer to the pack, but still above average. While real GDP per worker is a crude measure of productivity, the better measure of state productivity produced by the Bureau of Labor Statistics is only available once per year. 2023 state estimates are due out in May, and we will have a better idea at that time of how exactly Oregon compares across states.

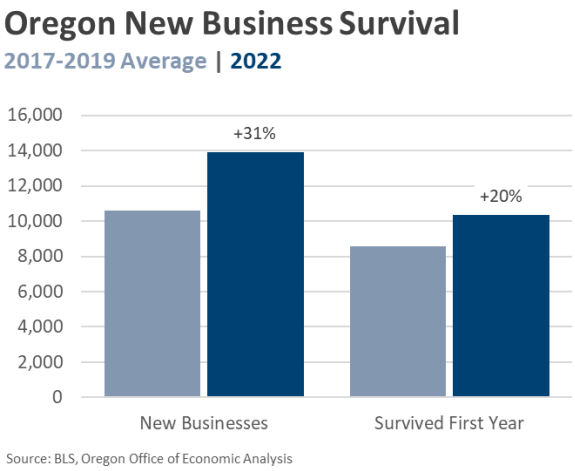


But for now, these gains are seen across the state. 28 of Oregon's 36 counties have seen faster productivity growth than the typical U.S. county nationwide. 10 Oregon counties, lead by Crook, are among the top

quintile nationwide, meaning among the Top 20% for gains through 2022. Note that 2022 county level data is the most recently available information and was released in December.

In addition to business investment in what economists call physical capital (generally plants, equipment, software etc) there are other types of capital. These include natural capital, financial capital, human capital, and social capital. Investment and growth among any of these types of capital should lead to stronger economic gains.

Another source of optimism on the outlook comes from the start-up boom during the pandemic. New businesses are key drivers of innovation as they are generally better able to bring new products, services, and efficiencies to the marketplace.



Since 2019, the number of new businesses has increased nationwide and here in Oregon and really has not slowed down. In terms of the outcome, even if the probability that any given new firm ultimately succeeds remains the same, having more ping pong balls in the hopper means the cumulative probability there are successes is higher today than before the pandemic start-up boom. The absolute number of business closures is rising as well, given the increase in start-ups, but the closure or failure rate, and the number of business bankruptcies remains tame. The net impact of the start-up boom is a macroeconomic tailwind and should continue in the years to come as the Millennials age into their peak-entrepreneurial years which are one's late 30s and early 40s.

Finally, as discussed in more detail in the September 2023 forecast1, the combination of increased federal investment, and the more speculative impact of generative AI on white-collar jobs is likely to boost productivity in the years ahead. In particular for Oregon, the CHIPS and Science Act is expected to result in tens of billions of dollars of semiconductor investment in the state, supporting thousands of near-term construction jobs, and creating thousands of permanent jobs once the projects are complete. The challenge for the outlook today is that the semiconductor industry is in a cyclical downswing. Local industry job losses are mounting, even if the medium- and long-run outlook are positive. For now, our office is keeping those investments and growth in the forecast, but tracking actual employment numbers lower as the industry adjusts to current market and economic conditions.

Zero Migration, a Demographic Alternative Scenario

Our office has developed a demographic alternative scenario of what the state's economy, and public tax revenues may look like should migration not rebound as expected. What follows is a short summary of

[1] https://digital.osl.state.or.us/islandora/object/osl%3A1015130/datastream/OBJ/view

that scenario. You may find the full report in the December 2023 forecast, and a standalone copy on our website[2].

Historically migration has been the primary reason Oregon's economy has outpaced the typical state over time. However the bottom line impacts of the Zero Migration scenario are smaller than our office first anticipated. There are at least three main reasons why this appears to be the case.

The first reason is simply that the baseline population forecast is already weak from an historical perspective. Removing the modest population gains of less than one percent per year has less of an impact than if the baseline had population growth of two or three percent, like Oregon experienced in decades past.

The second reason is due to inflation and rising incomes and asset values for existing residents. While the state's overall population may decline slowly given there is no migration to offset the fact deaths outnumber births, total incomes and taxes paid will increase. However, those aggregate increases will be slightly slower given the lack of any underlying population gains, even as incomes per worker or per household will increase in the years ahead.

The third reason is one of timing, and focusing on the first decade of no net migration. Given the age demographics of migration to Oregon, and the fact that middle-aged Oregonians, and in particular late middle-aged Oregonians have the largest incomes, of which many are taxed at the highest rate, the economic and revenue impacts are likely to be greater in the second or third decade than in the first.

As such, seemingly small differences in any given year have little long-run implications for the trajectory of Oregon's economy or state revenues. However, like a snowball just starting to roll down a mountain, as these small annual changes accumulate, so too do the long-run differences between the baseline outlook and the world in which migration does not return to the state.

Alternative Scenarios

The baseline outlook is our forecast for the most likely path for the Oregon economy. As with any forecast, however, many other scenarios are possible. The alternative scenarios below are not the upper or lower bounds to all outcomes, but rather are two plausible scenarios modeled on realistic assumptions. For the revenue implications, see page 20.

Boom/Bust Scenario: Moderate Recession

Inflation could rebound and remain above the Federal Reserve's target. As such, it is possible will need to raise interest rates further or hold them higher for longer, to cool the economy. The combination of high inflation, high interest rates, and slowing economic growth is problematic. Ultimately, the boom could turn into a bust later this year.

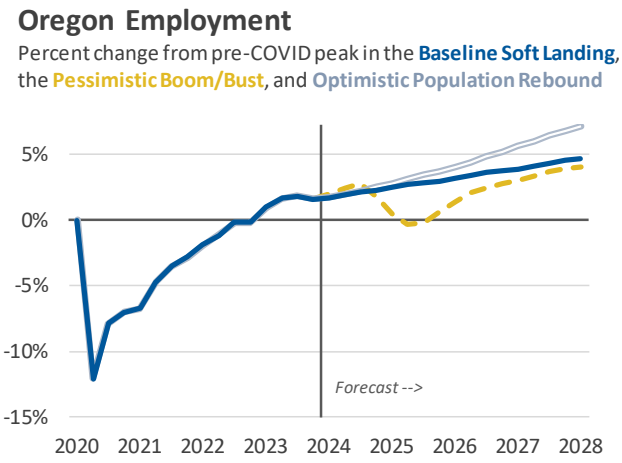
[2] https://oregoneconomicanalysis.com/2024/01/10/report-zero-migration-a-demographic-alternative-scenario/

For now, the most likely recession scenario is for a moderate sized downturn. There are no clear imbalances in the economy, household finances remains in good shape, and firms will be reluctant to let go of workers given the structurally tight labor market.

The moderate recession scenario is for a three quarter decline in employment totaling 2.9 percent, followed by a six quarter recovery period, more in line with the so-called jobless recoveries following the 1990 and 2001 cycles, compared to the faster recoveries in the 1950s, 1960s, and 1970s.

The three percent decline in employment is a loss of nearly 60,000 jobs. No industry is spared, but goods-producing ones see relatively larger losses at 4.5 percent, while services see slightly fewer losses at 2.8 percent, and the somewhat more stable public sectors experiences job losses of 2.3 percent. The unemployment rate increases to nearly 7 percent by early 2025. Nominal income does not fall outright but growth slows considerably. Next biennium, in 2025-27, total personal income in Oregon is 2.6 percent below the baseline.

Alternative Scenarios **Mar 2024**



	2023	2024	2025	2026	2027	2028
Employment						
Base: Soft Landing	2.4%	0.5%	0.7%	0.7%	0.7%	0.7%
Pes: Boom/Bust	2.4%	0.7%	-2.0%	2.0%	1.3%	0.8%
Opt: Pop Rebound	2.4%	0.6%	1.1%	1.3%	1.5%	1.3%
Unemployment Rate						
Base: Soft Landing	3.8%	3.9%	4.1%	4.1%	4.1%	4.1%
Pes: Boom/Bust	3.8%	4.7%	6.5%	5.5%	4.6%	4.2%
Opt: Pop Rebound	3.8%	3.7%	3.7%	3.7%	3.6%	3.6%
Personal Income						
Base: Soft Landing	4.8%	5.4%	5.7%	5.5%	5.3%	5.1%
Pes: Boom/Bust	4.8%	6.0%	2.1%	5.9%	5.8%	5.3%
Opt: Pop Rebound	4.8%	5.5%	6.1%	6.1%	6.0%	5.7%

Optimistic Scenario: Population Rebound

Pandemic migration patterns differ from recent history substantially. There is good reason to think some of those changes will remain in the decade ahead, particularly when it comes to the combination of housing affordability and working from home resulting in lower migration to Oregon than in decades past. However, such a slow growth baseline does leave upside risks. What would happen if Oregon were to see a typical cyclical rebound in migration in the years ahead?

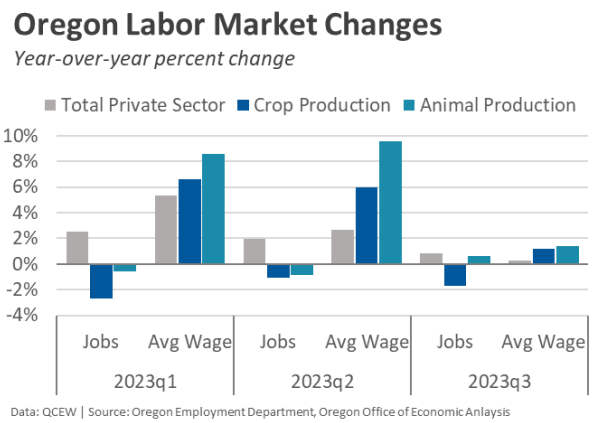
In the population rebound, Oregon's economy grows faster than in the baseline. A larger population increases local consumer demand, and boosts the labor force from which Oregon businesses can hire and expand at a faster rate. By 2033, Oregon's employment is 71,000 higher than in the baseline, and total personal income is 3.3 percent higher than in the baseline.

Oregon's Agricultural Economy

The Oregon Legislature passed HB 4002 (2022) which establishes maximum hour and overtime compensation requirements for agricultural workers. The law went into effect starting at the beginning of 2023. Moving forward, our office will analyze and monitor the economic and labor market data to assess any impacts from the law. Our office will work to incorporate these changes, if any, in the broader context of the state's agricultural economy. It will take some time before data is available to assess any impacts.

Even so, our office has been highlighting the importance of agriculture to the state's economy since the law's passage. We have dug into farm employment, income, and sales at the state and county level, in addition to international exports. Additionally we discussed how ag fits in with the broader food economy in the state and nation, and also the outlook for consumer spending on food and price forecasts related to revenues and costs. Note that the 2022 Census of Agriculture data will be released on February 13, 2024. This is the most detailed source of data at the state and county level and is done every five years. Our office will provide a summary of the 2022 Ag Census in the next forecast.

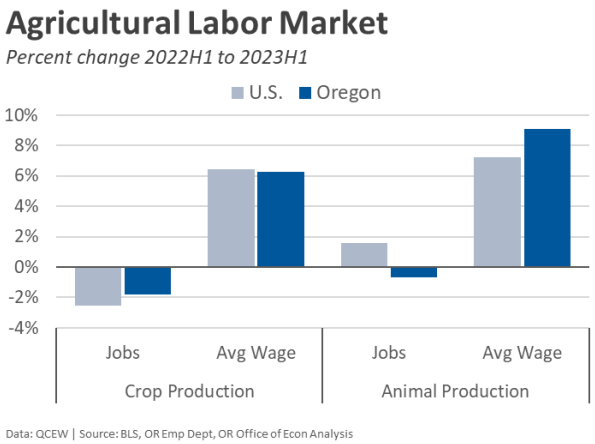
In recent quarters we have highlighted QCEW data, the nearly real-time data coming from businesses submitting records for unemployment insurance purposes. Agricultural data is very seasonal given harvests, so getting a clear handle on trends is a bit more challenging. However, our office will report the latest information as it become available. As of this forecast, there are now three quarters of 2023 Oregon data and two quarters of US (all states) data. The Bureau of Labor Statistics is set to release third quarter data for all states on February 21, 2024.



For now, our office will focus on high level changes in terms of employment and wages on a year-over-year basis. Here in Oregon, employment trends within agriculture are weaker than the broader economy in 2023. Both crop production and animal production employment has declined, while the private sector overall is growing. In terms of wage gains, Oregon wages are rising in a tight labor market, but average wages in both crop and animal production are far outstripping the statewide increases. At first blush, this pattern of weaker employment and strong wage gains likely fits the expected patterns of what the impact of the new law would be.

Keep in mind that this is still preliminary data. It is far from enough information to make any real assessments of how the law is impacting the state economy. It is also at a high level, using a simple year-over-year comparison. Further analysis looking at the number of hours worked per employee is needed to better gauge the impacts. That data will not become available for some time.

Additionally, these same general patterns are seen nationally as they are locally, at least for the first half of the year (January through June). Across all states, agricultural employment is lagging the broader economy while wages are rising faster. As such, without further, detailed analysis, it is hard to say whether Oregon's experiences are due to the new law, or more a reflection of broader industry trends given commodity prices and the like.



Moving forward, our office will work with other state agencies to gather and analyze the available data. Future quarterly forecasts will include updates to the underlying ag economy, when available, and any such analysis of the impacts of the new law.

Longer-Term Forecast Risks

The economic and revenue forecast is never certain. Our office will continue to monitor and recognize the potential impacts of risk factors on the Oregon economy. Although far from comprehensive, we have identified several major risks now facing the Oregon economy in the list below:

- U.S. Economy. While Oregon is usually more volatile than the nation overall, the state has never missed a U.S. recession or a U.S. expansion. In fact, Oregon's business cycle is perfectly aligned with the nation's when measuring peak and trough dates for total nonfarm employment.
- Housing Affordability. New housing supply has not kept pace with demand in either the ownership or rental markets. Oregon has underbuilt housing by 140,000 units in recent decades[3]. Our office will update the state's projected housing need this year. However, to the extent home prices and rents rise significantly faster than incomes, it is a clear risk to the outlook. Worse housing affordability hurts Oregonians as they need to devote a larger share of their household budget to the basic necessities. Furthermore, worse affordability may dampen future growth as fewer people can afford to live here, lowering net in-migration, and the size of the labor force in the years ahead.
- Global Spillovers. The international list of risks seems to change by the day. Right now there are ongoing wars in Europe and the Middle East, and the risk of war in Southeast Asia has been uncomfortably high in recent years. Longer-term concerns regarding commodity price spikes in Emerging Markets, or the strength of the Chinese economy – the top destination for Oregon exports – are top of mind.
- Federal Fiscal Policy. Changes in national spending impact regional economies. In terms of federal revenues, spending, and employment Oregon is generally in the middle of the pack across states. Oregon does see larger impacts related to land management and forest policies, including direct federal employment. Oregon ranks below average in terms of military-dependent industries and lacks a substantial military presence within the state.

[3] https://www.oregon.gov/ohcs/about-us/Documents/RHNA/RHNA-Technical-Report.pdf

- Climate and Natural Disasters. While the severity, duration, and timing of catastrophic events like earthquakes, wildfires, and droughts are difficult to predict, we know they impact regional economies. Fires damage forests with long-term impacts, and short-term disrupt tourism. Droughts impact our agricultural sector and rural economies to a greater degree. Whenever Cascadia, the big earthquake, hits, we know our economy and infrastructure will be crippled. Some economic modeling suggests that Cascadia's impact on Oregon will be similar to Hurricane Katrina's on New Orleans. Longer-term issues like the potential impact of climate change on migration patterns are hard to predict and generally thought to be outside our office's forecast horizon. Even so, it is a reasonable expectation that migration flows remain strong as the rest of the country becomes less habitable over time. The fact that private insurance markets in places like Florida (hurricanes and flooding) and California (wildfires) are now pricing in climate risks, means that climate migration could occur sooner than previously expected.
- Initiatives, Referendums, and Referrals. Generally, the ballot box and legislative changes bring a number of unknowns that could have sweeping impacts on the Oregon economic and revenue picture.

Extended Outlook

Oregon typically outperforms most states over the entire economic cycle. This time is no different, however the expectations are that the relative growth advantage may be a bit smaller than it has been historically. The primary reason being slower population, and labor force growth than in decades past. Our office is a bit more bullish on Oregon's economic and population growth than S&P Global is. Right now S&P has Oregon's growth from 2023 to 2028 right in the middle of the pack nationally. Their forecasts rank Oregon's real GDP growth to rank 24th fastest among all states, population gains are the 25th fastest, and employment growth ranks 26th fastest.

Over the extended forecast horizon our office has identified four main avenues of growth that are important to continue to monitor: the state's dynamic labor supply, the state's industrial structure, productivity, and the current number of start-ups, or new businesses formed.

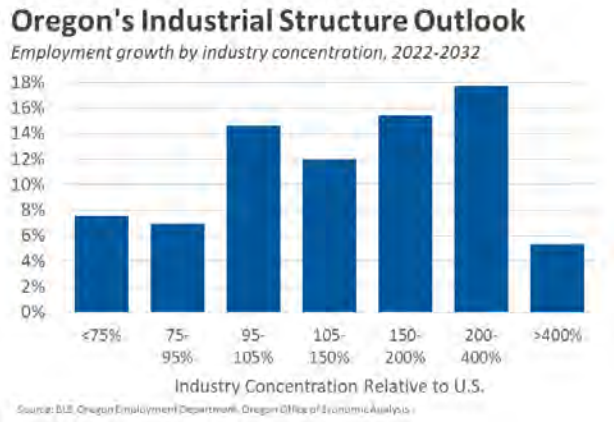
Labor Supply. Oregon has typically benefited from an influx of households from other states, including an ample supply of skilled workers. Households at least used to continue to move to Oregon even when local jobs are scarce, as long as the economy is equally bad elsewhere, particularly in California. Relative housing prices also contribute to migration flows in and out of the state. For Oregon's recent history – data available from 1976 – the labor force in the state has both grown faster than the nation overall and the labor force participation rate has typically been higher.

The good news today is that Oregon's labor force has never been larger, and the labor force participation rate has been higher that it was before the pandemic began, at least until the last handful of months of data. Even in this sometimes noisy, and unrevised data, the strength of Oregon's labor market is clear.

Moving forward, overall labor force participation rates will decline, simply due to the aging of the population. As more Baby Boomers enter into their retirement years, the share of all adults working or looking for work will fall as a result. As such, comparing Oregon's participation rates against a demographically-adjusted measure is important. Here, too, the current strength of the Oregon's labor market is evident, and encouraging.

The challenge moving forward is twofold. First, is overall population growth and whether that rebounds as expected in the years ahead. Second, whenever the next recession (or two) does come, maintaining a high participation rate and not seeing larger numbers of discouraged workers drop out of the labor force like they did following both the dotcom and housing busts. It was only once the economy became strong again in the late 2010s and early 2020s have some of those losses begun to be regained.

Industrial Structure. Oregon's industrial structure is very similar to the U.S. overall. However, Oregon's manufacturing industry is relatively larger, and weighted more toward semiconductors and wood products, compared to the nation which is more concentrated in transportation equipment (aerospace, and automobiles).



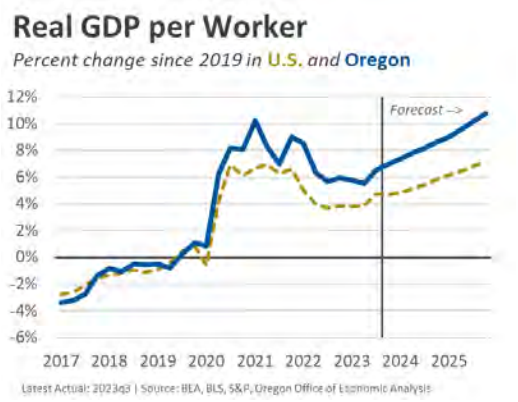
However, industries like timber and high-tech, which have been Oregon's strength in both the recent past and historically, are now expected to grow the slowest moving forward. Productivity and output from the state's technology producers is expected to continue growing quickly, however while employment will increase with expansions and the CHIPS Act, it will not increase as much as investment and sector productivity. Similarly, the timber industry remains under pressure from both market based conditions and federal regulations. Barring major changes to either, the slow growth to downward trajectory of the industry in Oregon is likely to continue.

With that being said, certainly not all hope is lost. Those top industries in which Oregon has a local concentration at least twice the national average comprise approximately 4 percent of all statewide employment. Slower growth moving forward is not a weight, but rather more of a lack of a boost.

Many industries in which Oregon has a larger concentration that then typical state are expected to perform quite well over the coming decade. These industries include management of companies, food and beverage manufacturing, published software along with some health care related firms.

The state's real challenges and opportunities will come in industries in which Oregon does not have a relatively large concentration. These industries, like consulting, computer system design, financial investment, and scientific R&D, are expected to grow quickly in the decade ahead. To the extent that

Oregon is behind the curve, then the state may not fully realize these gains if they rely more on clusters and concentrations of similar firms that may already exist elsewhere around the country.



Capital and Productivity. Ultimately, the economy's industrial structure combined with capital will result in increasing productivity. Higher productivity allows firms to produce and sell more products, and pay higher wages to its workers. Capital can come in many different forms including financial, natural, phsyical, human, and social. All can help raise firm productivity, benefiting the economy more broadly.

Today, the economy desparately needs better productivity, which has been sluggish this century. Early in the pandemic, productivity perked up as firms had to make due with reduced workforces at the same time consumer demand remained strong. However, as employment has rebounded, these productivity increases not entirely hold and eroded somewhat. The current outlook for producivity is more or less back to the pre-pandemic trend growth, although slightly above it. Increasing the stock and use of Oregon's capital would boost the economy overall. Increases in start-up activity, upcoming federal investment, and the potential of generative AI all point toward better productivty gains later this decade.

New Business Formation. New businesses are generally considered the primary source of innovation. New ideas, products, and services help propel future economic growth. Unfortunately in the decades leading up to the pandemic, start-up activity, while steady in level terms, was declining as a share of a growing economy. New businesses as a share of all businesses were at or near record lows in 2019. Employment at start-ups follow a similar pattern.

To the extent the lower levels of entrepreneurship were to continue in a post-pandemic world, and R&D more broadly is not being undertaken, slower productivity gains and overall economic growth is to be expected. However, to the extent that larger firms that have won out in today's marketplace are investing in R&D and making those investments themselves, then the worries about the number of start-ups today is overstated. It can be hard to say which is the correct view. That said, actual, realized productivity in the economy has been sluggish in recent decades.

Encouragingly, new business formation during the pandemic actually accelerated, stopping the long-run decline. New establishments continue to run at a higher level than in the year leading up to the pandemic. However, given the increased overall number of establishments, deaths or closures are now increasing as well simply due to the raw numbers, even if the death rate remains tame.

Looking forward, these gains provide some hope for future economic growth should some of these new firms bring new ideas, products, and efficiencies to market. Even if the per firm probability of success remains the same, having more ping pong balls in the lottery increases the overall probability that a few will survive and succeed tremendously.

Oregon Income Relative to U.S. One long-standing concern for some policymakers and analysts had been Oregon's relatively low income and wage compared to the rest of the nation. Encouragingly, the strong economic growth last decade did translate into meaningful increases in Oregon's per capita income and average wage. Today Oregon's per capita income relative to the U.S. is at its highest point since the dotcom bust two decades ago, and the state's average wage is at its highest relative point since the timber industry restructured and the mills started closing in the early 1980s.

Oregon's median household income in recent years has reach historic highs, even after adjusting for inflation. More importantly, it now stands 1.2 percent higher than the U.S. overall as of 2022. In recent years, this marks the first time in more than 50 years that Oregonian incomes for the typical household or family are higher than the nation. The fact that the strong regional growth translated into more money in the pockets of Oregonians, and regained the ground lost decades ago is one of the most important economic trends in recent generations.

Revenue Outlook

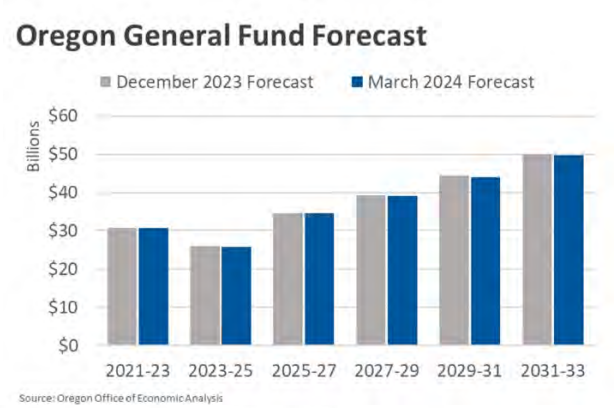
Revenue Summary

Oregon's state revenue outlook remains stable heading into the personal income tax filing season. The underlying economic outlook is relatively unchanged, and collections are tracking closely to expectations. As a result, overall revisions to the December 2023 forecast are small.

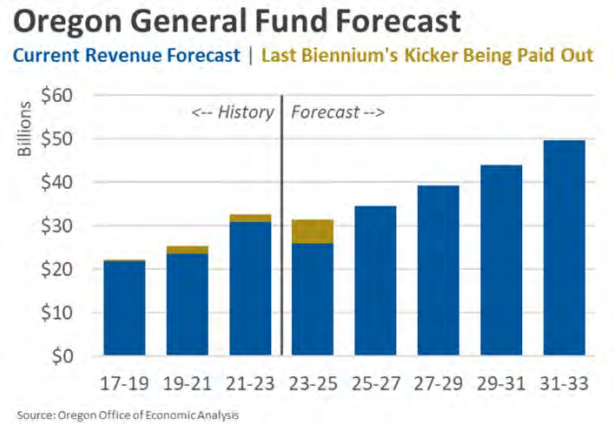
Although overall revenue collections are matching expectations, there have been some notable surprises. The most significant of which is the persistence of the six-year boom in Oregon's traditional corporate income and excise taxes. Tax collections have far outstripped growth in underlying corporate profits. The longer the surge in collections persists, the more likely it becomes that tax reforms enacted at the federal and state levels have permanently increased Oregon's corporate tax base, and that the step up in collections will remain with us going forward.

In addition to the surprising corporate income tax collections, forecasts for estate and liquor taxes have seen large revisions relative to the December 2023 outlook. Estate taxes have always been extremely volatile from month to month, but large outliers are clearly becoming more commonplace. As a result, the revenue outlook has been revised upward significantly. Offsetting this change, the outlook for liquor taxes has been revised downward as record sales during the pandemic appear to have plateaued.

The modest reduction in expected population and job gains reflected in the underlying economic outlook filters through to a somewhat weaker long-term forecast for personal income taxes. That said, these changes do not change the general nature of the revenue forecast, with the largest reduction in expected General Fund resources amounting to less than one percent of revenue in the 2029-31 budget period.



Even excluding the payment of the kicker credit, General Fund revenues were expected to be relatively unchanged when compared to the 2021-23 budget period. The unprecedented revenue boom seen during tax year 2021 is behind us, with collections expected to revert back to their long-term trends. Traditional gains in General Fund collections are expected to resume in the 2025-27 biennium and beyond.



The primary downside risk facing the near-term revenue forecast is the uncertain future of the

nationwide economic expansion. Should high interest rates, federal policy woes or economic weakness among our trading partners derail the U.S. economy, the expected growth in Oregon's tax collections will not come to pass.

Longer term, revenue growth in Oregon and other states will face considerable downward pressure over the 10-year extended forecast horizon. As the baby boom population cohort works less and spends less, traditional state tax instruments such as personal income taxes and general sales taxes will become less effective, and revenue growth will fail to match the pace seen in the past.

2023-25 General Fund Revenues

Gross General Fund revenues for the 2023-25 biennium are expected to reach $25.9 million. This represents an increase of $76 million from the December 2023 forecast, and an increase of $635 million relative to the Close of Session forecast. The vast majority of the increase can be attributed to collections of corporate income taxes, which continue to outstrip underllying corporate profits. Expected total available resources in the current 2023-25 biennium have been increased by $559 million after accounting for unspent appropriations during the 2021-23 budget period.

Table R.1

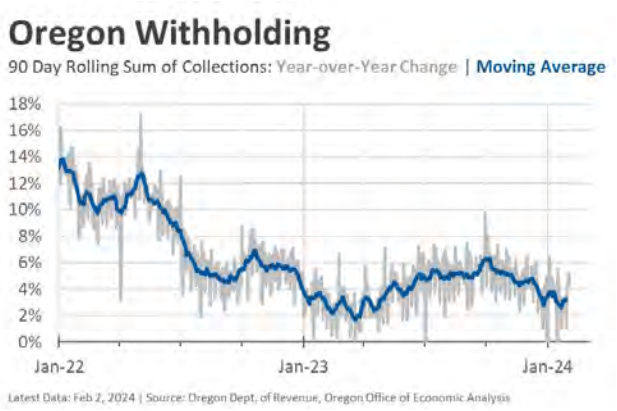
2023-25 General Fund Forecast Summary

(Millions)	2023 COS Forecast	December 2023 Forecast	March 2024 Forecast	Change from Prior Forecast	Change from COS Forecast
Structural Revenues					
Personal Income Tax	$21,019.7	$21,164.6	$21,180.1	$15.5	$160.4
Corporate Income Tax	$2,228.9	$2,647.2	$2,762.1	$114.9	$533.1
All Other Revenues	$2,011.3	$2,007.3	$1,953.1	-$54.3	-$58.2
Gross GF Revenues	$25,259.9	$25,819.1	$25,895.2	$76.1	$635.3
Offsets, Transfers, and Actions[1]	-$437.0	-$483.9	-$447.8	$36.1	-$10.8
Beginning Balance	$7,493.5	$7,636.2	$8,082.5	$446.3	$589.0
Net Available Resources	$32,316.4	$32,971.4	$33,529.9	$558.5	$1,213.5
Appropriations	$31,873.6	$31,873.6	$31,873.6	$0.0	$0.0
Ending Balance	$442.8	$1,097.8	$1,656.3	$558.5	$1,213.5
Confidence Intervals					
67% Confidence	+/- 6.7%		$1,739.9	$24.16B to $27.64B	
95% Confidence	+/- 13.4%		$3,479.8	$22.42B to $29.38B	

1 Reflects personal and corporate tax transfers, Rainy Day Fund tranfer, and Dept of Ag transfer

Personal Income Tax

Growth in withholdings of personal income taxes have slowed in recent months, consistent with a softening labor market Although there are other factors that drive withholdings of personal income taxes (e.g. retirement income, bonuses, and stock options), they are mostly driven by wages and salaries.



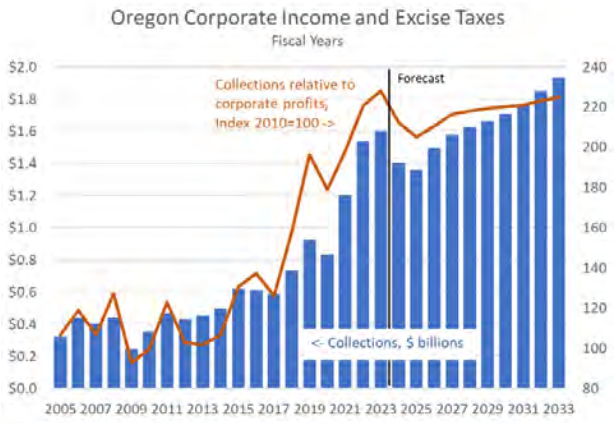
Although a cooling labor market makes an economic soft landing more likely, slow withholdings do cause concern. The majority of the time, withholding growth rates of 2% to 3% are only seen when Oregon is heading into, or coming out of, a recession.

Since the December 2023 forecast was released, Portland State University and the Census Bureau have released their 2023 mid-year population estimates. Although both estimates differ, each suggest that Oregon's population growth remains stalled. As a result, the baseline outlook for population and job gains has been lowered, putting downward pressure on expected income tax collections throughout the forecast horizon. However, in the current biennium, the weaker outlook for labor-related tax collections is offset by the surprising performance of investment income during 2023. In particular, the 25% growth seen in equity prices far outstripped the modest gains built into the personal income tax forecast.

Personal income tax collections will fall as we head into the 2024 tax season due to the record kicker credit being issued. Given that taxpayers are aware of the significant size of the credit, estimated personal income tax payments are down sharply at the beginning of the year. In the first months of 2024 large refunds will be issued, followed by relatively small year-end payments as April 15 approaches. After the extension filing season in the fall, the kicker will be largely paid out, and personal income taxes are expected to revert to trend.

Corporate Excise Tax

Oregon's traditional corporate income and excise tax collections have continued to outstrip expectations, and are growing faster than underlying corporate profits. Collections have nearly tripled over the past 3 biennia.



The source of this growth is difficult to pin down since corporate return data has only recently been released for tax year 2021. Since then, corporate collections have risen by one third.

However, given the timing of major tax reforms in 2017 (Federal TCJA, Oregon SB28) it is likely that some of the growth reflects a permanent increase in Oregon's corporate tax base. In particular, early data suggest that the switch to market-based sourcing in Oregon has driven additonal collections.

Tax liability for Tax Year 2021 grew by $210 million (20%), with about 75% of that coming from taxpayers that reported over $5 million in taxable income, largely from an increase in the number in that group. Most of this growth came from multi-state corporations. From 2020 to 2021, the industries with the largest growth were holding companies (up about $64 million), Manufacturing ($47 million), and Retail/Wholesale ($57 million together)

Other Sources of Revenue

Non-personal and non-corporate revenues in the General Fund usually account for approximately six or seven percent of the total. In the current 2023-25 biennium they account for 7.5 percent (largely driven by the record personal income tax kicker being paid out which reduces overall General Fund revenues.)

The largest such source are estate taxes, followed by interest earnings, liquor revenues, judicial revenues, and insurance taxes.

Relative to the previous forecast, these other revenue sources are lowered $54.3 million (-2.7%). This overall change is the net result of increases in estate taxes and interest earnings being offset by decreases in liquor earnings, judicial revenues, and tobacco taxes.

The liquor forecast is lowered significantly over the forecast horizon. Liquor sales boomed during the pandemic. So far this biennium topline sales have been fairly steady and are not showing continued growth like previous forecasts had built in. The updated outlook from OLCC adjusts to steady sales in the near-term, followed by longer-term growth. Compared to the December 2023 forecast, total liquor revenues in the current 2023-25 biennium are lowered by $132 million. This change reduces the General Fund outlook by $75 million, with the remainder impacting the other recipients of liquor revenues (see Table B.7 in Appendix B for more details.) OLCC will continue to monitor and analyze sales trends, and adjust the forecast accordingly moving forward.

Judicial revenues are also lowered sizably over the forecast horizon. In 2023-25 State Court Fees are lowered $10.7 million, while the Criminal Fine Account revenues are lowered $11.3 million. There are similar sized reductions to future biennia as well. These changes are in large part due to weaker revenues in the past year, indicating less of a rebound in court-related activity post pandemic than had been assumed in previous forecasts.

All types of tobacco – cigarettes, other tobacco products, and inhalant delivery devices – are tracking low in the most recent quarter. When combined with updated outlooks for consumer spending on tobacco, alongside usage rates, tobacco taxes are lowered over the forecast horizon. In 2023-25, cigarette revenues are lowered $15.1 million (-6.6%) overall, of which there is a $2.8 million reduction in the General Fund. Other tobacco products are lowered $3.1 million (-2.9%) overall, of which there is a $1.7 million reduction in the General Fund. Additionally, while outside of the General Fund, inhalant delivery revenues are lowered $0.7 million (-1.1%) due to tracking, while no long-run changes are made to the forecast. One potential issue for the revenue forecast is whether or not local (county) flavored tobacco bans go into effect or not. Such bans are not currently factored into the outlook as the issue is currently being debated in the courts.

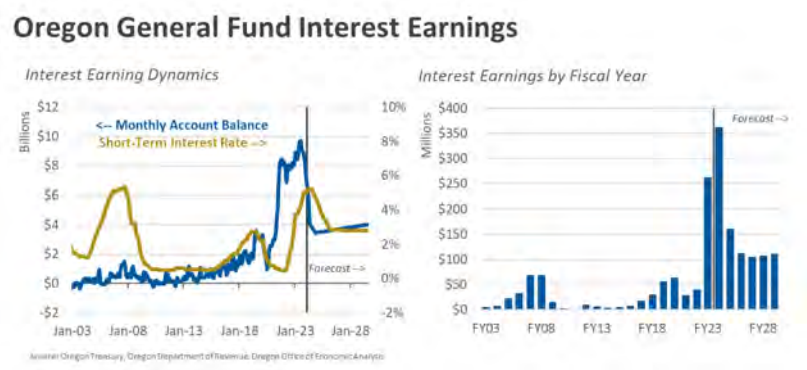
These larger revenue decreases are partially offset by increases to estate taxes and interest earnings.

Estate tax collections are significantly -- $35 million (+6.2%) – in the current 2023-25 biennium in large part due actual collections in November being the second largest month on record. However, due to stronger outlooks for home prices and asset markets, the longer term outlook is raised as well. In recent biennia, the strong estate tax collections are largely

driven by a small number of very highly valued estates.

The outlook for interest earnings is raised $11.6 million in the current 2023-25 biennium compared to the previous forecast, followed by upward revisions of approximately $1 million in subsequent biennia.

The combination of high fund balances today – the result of the inflationary economic boom outpacing forecast expectations – and high interest rates, means public sector interest earnings are now substantial. In the just completed Fiscal Year 2023, Oregon saw $262.5 million in interest earnings, which is more than the state received in the previous 10 years combined.



The forecast for interest earnings in the current Fiscal Year 2024 are expected to total $357.0 million.

The outlook for interest earnings is uncertain given potential timing issues. Today, fund balances are more than $6 billion higher than back in 2019. This tax season the record kicker will be returned to taxpayers, which is expected to reduce the balances from today's high-water mark. To the extent the timing of the kicker credits being paid out differ from expectations, or that short-term interest rates shift with broader changes in the financial markets or Fed policy, then the state's interest earnings will differ from this forecast.

Extended General Fund Outlook

Table R.2 exhibits the long-run forecast for General Fund revenues through the 2031-33 biennium. Users should note that the potential for error in the forecast increases substantially the further ahead we look.

Revenue growth in Oregon and other states will face considerable downward pressure over the 10-year extended forecast horizon. As the baby boom population cohort works less and spends less, traditional state tax instruments such as personal income taxes and general sales taxes will become less effective, and revenue growth will fail to match the pace seen in the past.

Table R.2

General Fund Revenue Forecast Summary (Millions of Dollars, Current Law)

Revenue Source	Forecast 2023-25 Biennium	% Chg	Forecast 2025-27 Biennium	% Chg	Forecast 2027-29 Biennium	% Chg	Forecast 2029-31 Biennium	% Chg	Forecast 2031-33 Biennium	% Chg
Personal Income Taxes	21,180.1	-17.5%	29,818.4	40.8%	34,057.8	14.2%	38,513.1	13.1%	43,827.3	13.8%
Corporate Income Taxes	2,762.1	-12.5%	3,072.1	11.2%	3,286.5	7.0%	3,477.0	5.8%	3,779.8	8.7%
All Others	1,953.0	0.7%	1,727.0	-11.6%	1,823.9	5.6%	1,926.6	5.6%	2,018.6	4.8%
Gross General Fund	25,895.2	-15.9%	34,617.4	33.7%	39,168.2	13.1%	43,916.7	12.1%	49,625.7	13.0%
Offsets and Transfers	*(202.9)*		*(216.3)*		*(231.3)*		*(208.5)*		*(55.0)*	
Net Revenue	25,692.3	-16.0%	34,401.1	33.9%	38,936.9	13.2%	43,708.2	12.3%	49,570.6	13.4%

Tax Law Assumptions

The revenue forecast is based on existing law, including measures and actions signed into law during the 2023 Oregon Legislative Session. OEA makes routine adjustments to the forecast to account for legislative and other actions not factored into the personal and corporate income tax models. These adjustments can include expected kicker refunds, when applicable, as well as any tax law changes not yet present in the historical data. A summary of actions taken during the 2023 Legislative Session can be found in Appendix B Table B.3. For a detailed treatment of the components of the 2023 Legislatively Enacted Budget, see:

Legislative Fiscal Office's 2023-25 Budget Summary[4]

Although based on current law, many of the tax policies that impact the revenue forecast are not set in stone. In particular, sunset dates for many large tax credits have been scheduled. As credits are allowed to disappear, considerable support is lent to the revenue outlook in the outer years of the forecast. To the extent that tax credits are extended and not allowed to expire when their sunset dates arrive, the outlook for revenue growth will be reduced. The current forecast relies on estimates taken from the Oregon Department of Revenue's 2023-25 Tax Expenditure Report[5] together with more timely updates produced by the Legislative Revenue Office.

General Fund Alternative Scenarios

The latest revenue forecast for the current biennium represents the most probable outcome given available information. Our office feels that it is important that anyone using this forecast for decision-

[4] https://www.oregonlegislature.gov/lfo/Documents/2023-25%20Legislatively%20Adopted%20Budget%20-%20General%20Fund%20and%20Lottery%20Funds%20Summary.pdf

[5] https://www.oregon.gov/DOR/programs/gov-research/Pages/research-tax-expenditure.aspx

making purposes recognize the potential for actual revenues to depart significantly from this projection.

The near-term outlook is particularly uncertain right now. The probability of the soft landing, no recession baseline scenario is rising but the odds of a recession in coming years remains uncomfortably high. Our office's economic alternative scenarios (see page 7) include a Boom/Bust cycle with a recession beginning in the second half of 2024, and an optimistic outlook where population and migration rebound as they have in past cycles.

Alternative Scenarios — March 2024

Changes relative to the baseline ($ millions)

General Fund

	2023-25	2025-27	2027-29	2029-31	2031-33
Optimistic	$42	$395	$954	$1,323	$1,600
Pessimistic	-$1,003	-$1,726	-$674	-$580	-$457

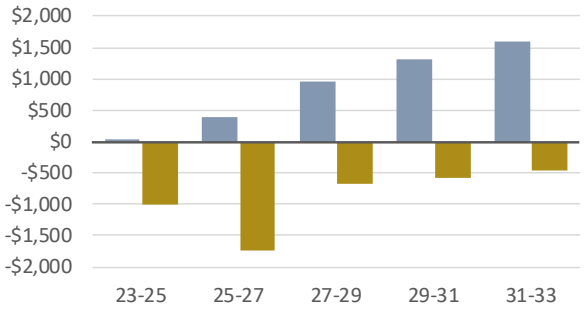
Corporate Activity Tax

	2023-25	2025-27	2027-29	2029-31	2031-33
Optimistic	$44	$77	$128	$161	$184
Pessimistic	-$59	-$132	-$112	-$103	-$91

Source: Oregon Office of Economic Analysis

General Fund Revenues

Change from baseline ($ millions) for the Pessimistic Boom/Bust, and Optimistic Population Rebound



In a Boom/Bust scenario, the revenue impact will be felt in both the current 2023-25 biennium and the next 2025-27 biennium. Looking at the current 2023-25 biennium, in the pessimistic scenario, General Fund revenues in Oregon would be $1.0 billion lower than in the baseline. Revenues in 2025-27 would be recovering, and growing sequentially, but still $1.7 billion below the current baseline outlook.

Changes would also be seen outside of the General Fund among Oregon's consumption-based revenues as well. Such taxes are generally less volatile than income taxes and help to stabilize Oregon's overall revenue base. Specifically in 2023-25, the Corporate Activity Tax would be $59 million lower than the baseline, while Lottery is expected to be $24 million lower, and Marijuana revenues $4 million lower.

In 2025-27, the Corporate Activity Tax would be $162 million lower than the baseline, while Lottery would be $59 million, and Marijuana $11 million. Over time the economy and state revenues would make up the recessionary lost ground and nearly converge with the baseline outlook. However, recessions tend to leave scars, and the Boom/Bust scenario never fully regains all of the lost ground economically or in terms of state revenues.

In the Optimistic Scenario of a normal rebound in migration patterns, Oregon's economy and state revenues would fundamentally be on a stronger growth trajectory. In the current 2023-25 biennium, General Fund revenues would be $42 million above the baseline, while the increases build to $1.6 billion in the 2031-33 biennium. The Corporate Activity Tax follows a similar pattern where revenues would be $44 million above the baseline in 2023-25 and $184 million in 2031-33.

Corporate Activity Tax

Oregon's new corporate activity tax (CAT) went into effect January 2020. Revenues from this tax on business receipts are dedicated to education through the Fund for Student Success. The tax was designed to generate approximately $1 billion per year in new state resources, or $2 billion per biennium.

According to the March 2024 outlook, the corporate activity tax is expected to generate around $2.8 billion during the current 2023-25 biennium. Strong consumer spending and the inflationary environment have both played roles in the large amount of collections.

Given the lack of historical experience, the outlook for the corporate activity tax remains uncertain. However, since the CAT is a tax on consumption, collections will prove to be less volatile than Oregon's dominant income taxes over time. The baseline outlook for tax liability is currently based on expected output growth across various industries as well as growth in consumer spending.

The outlook for CAT collections is further complicated by lags in filing and the processing of tax returns. Only in January of this year was return data for the 2021 tax year made available. Also, the pattern of collections changed drastically in 2021, with firms being allowed to file returns based on their own fiscal years rather than on a uniform April filing deadline. In addition, as a new tax, the number of CAT filers continues to grow as more firms are made aware of their liability.
The evolving pattern of CAT collections combined with a larger estimated beginning balance have combined to drive an increase in expected revenues relative to the December 2023 forecast.

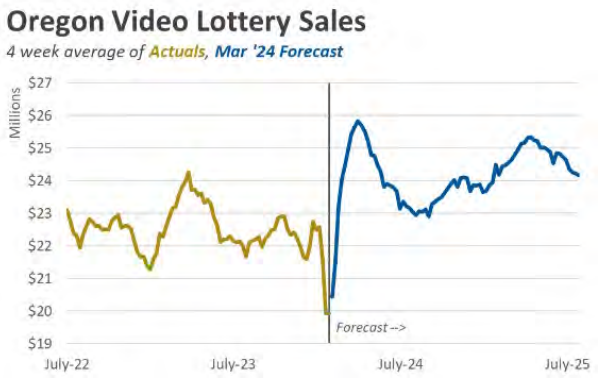
In the December 2023 forecast, expected CAT revenues were revised downward due to a steep decline in advanced tax payments. As additional data has become available, it has become clear that this decline was driven by an evolving pattern of payments rather than by a fundamental drop in underlying tax liability. In recent months, advanced tax payments have been replaced by filers applying the refunds that they are owed to future tax years. As a result, for the current 2023-25 budget period, the outlook for CAT collections has been increased by $43.4 million. The revenue forecast for future tax years have been revised upwards as well.

Table B.12 in Appendix B summarizes the 10-year forecast and the allocation of resources, while Table B.13 presents a more detailed quarterly breakdown of the forecast. The personal income tax reductions are built into the General Fund forecasts shown in Tables B.1 and B.2.

Lottery Forecast

Overall, total lottery resources are lowered by slightly in the current 2023-25 biennium, and increased in the future biennia relative to the previous forecast.

Near-term there are four changes to the 2023-25 forecast. The forecasts for both traditional lottery and sports betting are increased due to both stronger sales than forecasted, and an improved outlook. These increases are more than offset by a downward adjustment to the video lottery forecast.



In particular the recent ice storms, like previous extreme weather events, resulted in very low levels of sales as Oregonians were sheltering at home and getting out less. While not a long-run issue, or change in player behavior, a couple weeks of low sales does impact the revenue forecast. That said, sales were a bit below forecast in November as well, even as December sales met forecast.

Looking forward, the Lottery outlook calls for record video lottery sales in the coming months in part due to the ongoing strength in the economy, and in addition to the record $5.6 billion Oregon personal income tax kicker being paid out this tax filing season. Oregonians will spend some portion of the kicker on discretionary purchases be it going out to eat, on exercise equipment, on vacations, on gaming, or any other number of possibilities. The forecast continues to assume the normal share of personal income is spent on video lottery. As such, the historically large kicker presents both upside and downside risks to the near-term forecast. Should Oregonians choose to spend more of their disposable income gains on gaming, Lottery sales are likely to be above the baseline outlook, on the other hand should inflation take its toll on household budgets, or should Oregonians choose to disproportionately spend their kicker credits on other items, then sales may be below the baseline.

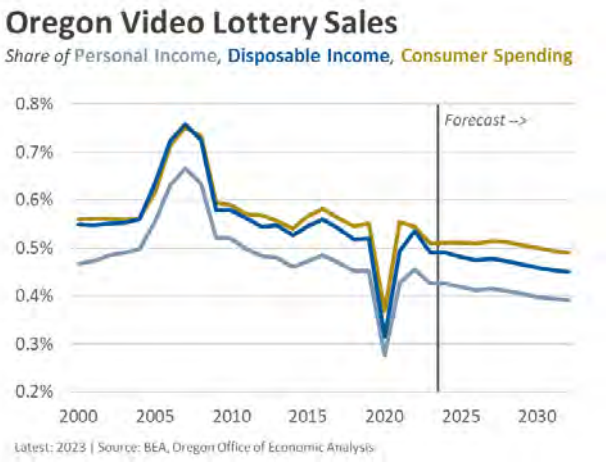
On net, between traditional, video, and sports betting, Lottery *revenues* for 2023-25 are lowered $7.1 million relative to the December 2023 forecast. However this reduction is nearly offset by reversions in the Economic Development Fund, which is where Lottery transfers go before being distributed to recipient programs, as accountants closed the books on the previous 2021-23 biennium. There were $5.7 million Lottery (EDF) reversions, meaning the net change to 2023-25 available resource is a reduction of $1.4 million.

Longer-Term Outlook

At a base level, forecasting Lottery revenues comes down to the number of players and their household budgets. Those are relatively straightforward, and Lottery trends generally follow the overall economy even if it is not a one to one relationship. However, Lottery revenues really are about consumer preferences for entertainment, and how they spend their disposable income. Do Oregonians choose to go out to eat more, or on vacations, or to sporting events, or even to destination-based gaming at tribal casinos or on trips to Las Vegas and the like?

As such, the big picture issues our offices monitors include the broader national trends in gaming markets, demographic preferences for recreational activities, and to what extent consumers increase the share of their incomes spent on gaming.

For much of last decade, consumers remained cautious with their disposable income. Increases in spending on gaming largely matched income growth at best. In fact, from 2010 to 2019, Oregon video lottery sales grew at a 3.7 percent annual pace, while Oregon personal income increased at a 5.3 percent annual pace. Lottery sales as a share of overall Oregonian consumer spending declined. This slow erosion is also seen in terms of the number of video lottery retailers, and Lottery revenues as a share of the state's All Funds budget.

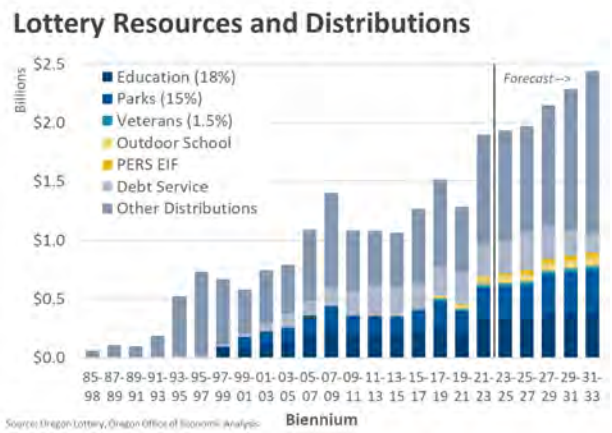


Trends in gaming during the pandemic differed significantly for a period of time. When bars and restaurants were takeout only, video lottery terminals were turned off as to not have Oregonians indoors when a deadly, contagious virus was spreading. Once the health restrictions were lifted, sales returned in full-force, and significantly outstripped expectations. These sales also outpaced current income games. Some of the strong sales since reopening were due to pent-up demand, strong household finances, and the fact that other entertainment options were either not available initially (concerts, spectator sports) or possibly less desirable due to the virus (long distance travel, movie theaters).

Since reopening, it has been an open question to what extent some of those relatively strong sales were part of a more permanent change in player behavior, or were just temporary, pandemic era changes. Over the past year or two it has become increasingly clear that the pandemic sales were more of a temporary change as sales have come off their peak and not kept up with income gains. Today, video lottery sales as a share of personal income is at its lowest point in decades.

Looking forward, our office expects increased competition for household entertainment dollars, increased competition within the gaming industry, and potentially shifts in generational preferences and tastes when it comes to gaming. As such, our outlook for video lottery sales is continued growth, however at a rate that is slightly slower than overall personal income growth. Lottery sales will continue to increase as Oregon's population and economy grows, however video lottery sales will likely be a slightly smaller slice of the overall pie.

The March 2024 forecast is not qualitatively different than previous outlooks. These same broad trends are apparent today as they were last quarter. However, updated player demographic information, alongside new modeling raises the long-term outlook slightly in future biennia. In 2025-27 the forecast change is +$8.2 million, in 2027-29 it is +$35.1 million, in 2029-31 it is +$35.7, and in 2031-33 it is +$46.1 million.



For more information on player demographics and the impact of the aging population, see the March 2023[6] forecast.

The full extended outlook for lottery earnings can be found in Table B.9 in Appendix B.

Budgetary Reserves

The state currently administers two general reserve accounts, the Oregon Rainy Day Fund[7] (ORDF) and the Education Stability Fund[8] (ESF). This section updates balances and recalculates the outlook for these funds based on the December revenue forecast.

As of this forecast the two reserve funds currently total a combined $2.2 billion. At the end of the current 2023-25 biennium, they will total $2.9 billion, which is equal to 11.2 percent of current revenues. Including the projected General Fund ending balance of $1.7 billion, the total effective reserves at the end of the current 2023-25 biennium are projected to be $4.5 billion, or 17.6 percent of current revenues.

The forecast for the ORDF includes two deposits for this biennium relating to the General Fund ending balance from the previous biennium (2021-23). A deposit of $264.7 million will be made in early 2024 after the accountants closed the books on last biennium. Additionally, a $98.9 million deposit relating to the increased corporate taxes from Measure 67 is expected at the end of the biennium in June 2025. This exact transfer amount is subject to some revision as corporate filings are processed, however the transfer itself will occur. At the end of 2023-25 the ORDF will total $1.9 billion.

[6] https://digital.osl.state.or.us/islandora/object/osl%3A1007538/datastream/OBJ/view

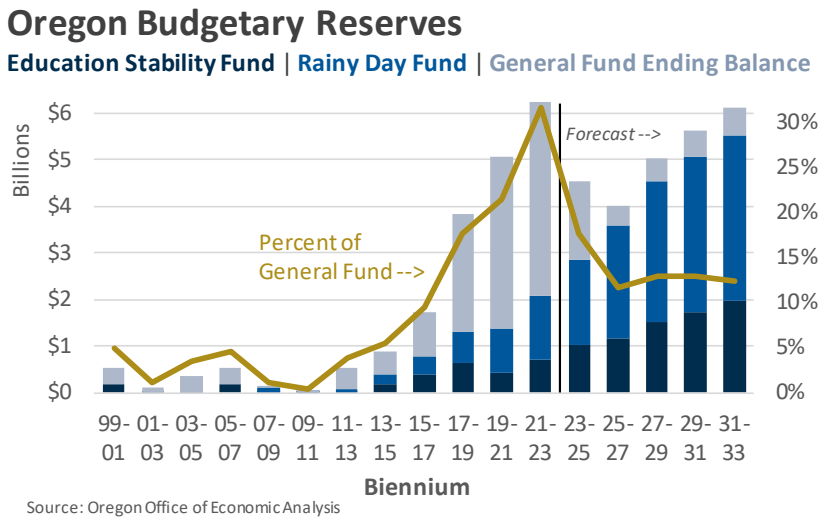
[7] The ORDF is funded from ending balances each biennium, up to one percent of appropriations. The Legislature can deposit additional funds, as it did in first populating the ORDF with surplus corporate income tax revenues from the 2005-07 biennium. The ORDF also retains interest earnings. Withdrawals from the ORDF require one of three triggers, including a decline in employment, a projected budgetary shortfall, or declaration of a state of emergency, plus a three-fifths vote of the Legislature. Withdrawals are capped at two-thirds of the balance as of the beginning of the biennium in question. Fund balances are capped at 7.5 percent of General Fund revenues in the prior biennium.

[8] [8] The ESF gained its current reserve structure and mechanics via constitutional amendment in 2002. The ESF receives 18 percent of lottery earnings, deposited on a quarterly basis – 10% of which are deposited in the Oregon Growth sub-account. The ESF does not retain interest earnings. The ESF has similar triggers as the ORDF, but does not have the two-thirds cap on withdrawals. The ESF balance is capped at five percent of General Fund revenues collected in the prior biennium.

Looking ahead to the 2025-27 biennium, the ORDF is not projected to hit its cap of 7.5 percent of revenues early in calendar year 2026. Back in the September 2023 forecast it was expected to hit the cap in 2026, but in the December 2023 forecast, and in the current March 2024 forecast, the cap is not expected to be reached. In the current forecast, the ORDF will be at 7.36 of the previous biennium's revenues at the time of the expected transfer. That leaves a $36 million difference between 7.36 and 7.5 percent. As the forecast and actual revenues and interest earnings change over the next couple of years, the ORDF may or may not reach that cap. Our office will adjust the outlook accordingly. Should the cap be reached, then the ending balance transfer would not occur, and those revenues would be retained in the General Fund to be appropriated by policymakers. Today, the ORDF is not expected to reach its cap and not make the ending balance transfer until FY2030, and then again in FY2032.

The ESF will receive an expected $298.7 million in deposits in the current 2023-25 biennium based on the current lottery forecast. At the end of current 2023-25 biennium the ESF will stand at $1.0 billion. The ESF is projected to hit its cap of 5 percent of revenues early in calendar year 2026, when the deposits will then accrue to the Capital Matching Account.

Together, the ORDF and ESF are projected to have a combined balance of $2.9 billion at the close of the 2023-25 biennium, or 11.2 percent of current revenues. At the close of 2025-27 the combined balance will be $3.6 billion, or 10.4 percent of revenues. Such levels of reserve balances are larger than Oregon has been able to accumulate in past cycles, and should help stabilize the budget when the next recession hits.



Source: Oregon Office of Economic Analysis

Effective Reserves ($ millions)

	Current Jan-24	*End of 2023-25*
ESF	$790	$1,007
RDF	$1,386	$1,859
Reserves	$2,175	$2,867
Ending Balance	$1,656	$1,656
Total	**$3,832**	**$4,523**
% of GF	14.9%	17.6%

Even with a higher probability of the economic soft landing, and a lower probability of recession today, should a boom/bust cycle occur, the state would be expected to meet the trigger for withdrawals at that time. In particular the reserve fund trigger of two consecutive quarters of employment declines would be expected to be met based on our office's alternative scenario of a moderate recession. The other triggers may or may not be met. If revenues come in below forecast this biennium, that could trigger a potential withdrawal. And for the ESF only, not the ORDF, a Governor's declaration of emergency could also trigger a potential withdrawal.

Finally, these are the technical considerations for using the reserve funds. Ultimately policymakers will decide whether to use the funds or not. Regardless of the trigger(s) met, the Legislature would need a three-fifths vote in each chamber to approve an ESF reserve fund withdrawal and a simple majority vote in each chamber to approve an ORDF withdrawal.

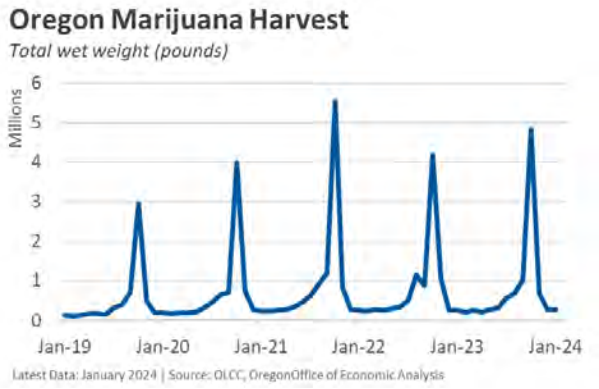
B.10 in Appendix B provides more details for Oregon's budgetary reserves.

Recreational Marijuana Forecast

Available resources in the current 2023-25 biennium are lowered $7 million (-2.2%) relative to the previous forecast. Future biennia are all lowered by $6-9 million as well, for a 1.5 to 2% reduction when compared to the December 2023 forecast.

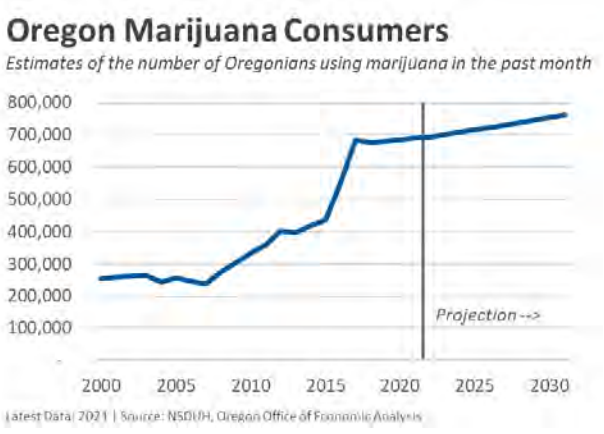
The basis for the lower forecast is the combination of sales coming in slightly below expectations, and ongoing weak prices. Encouragingly from an industry perspective, on a price-adjusted basis, usable marijuana sales are increasing again indicating the volumes sold is picking up following the pandemic boom and mini-bust.

However, not so encouraging from an industry perspective remains the large harvest last year that will keep downward pressure on prices in the year(s) ahead.



Given these market conditions of oversupply, firm saturation, and stable consumer demand, low prices make it difficult for businesses to be profitable. Additionally, they impact tax collections as well given Oregon levies its recreational marijuana tax based on the price of the products, plus the potential for delinquent taxes owed.

Looking forward, the low-hanging fruit for consumer demand growth is behind us. Marijuana usage rates are steady in recent years, after increasing considerably in the past decade. Note that the latest annual usage data will be released prior to the next forecast. Our office will include the new numbers at that time, along with an update to our estimates of the number of marijuana consumers in Oregon based on those usage rates.



Additionally, many former black market consumers have converted to the legal market, and those that remain may be harder to switch. And underlying population growth has slowed during the pandemic, with only a modest rebound expected in the

outlook. Given the age profile of marijuana users and our office's demographic forecast, our office's projection for the number of marijuana consumers in the state is expected to increase slightly faster than the overall population in the decade ahead. Total population is forecasted to increase 0.6 percent per year, while the marijuana consumer base is projected to increase 1.0 percent per year. While that growth will result in more sales, and more tax collections, faster gains will only be seen once industry pricing power returns.

See Table B.11 in Appendix B for a full breakdown of revenues and associated distributions to recipient programs.

Psilocybin Forecast

Ballot Measure 109 which voters passed in 2020 and legalized psilocybin, tasked our office with the revenue forecasting responsibilities. The current forecast remains unchanged from last quarter, however there is a large likelihood the revenue forecast will be revised lower, possibly significantly so, in the near future. While there has always been the expectation that a new program would ramp up over time as businesses get set up, consumers try it, and broader social acceptance and usage rises. Even so, through the first six months of the biennium, actual tax collections are minimal. As more data and quarterly tax returns become available, our office will adjust the outlook accordingly.

After speaking with other state agencies and private businesses entering the psilocybin industry there are a few important items to note up front.

First, the overall cost of a session to a customer is expected to be in the hundreds, and even thousands of dollar range. Second, the state's 15 percent retail sales tax which was part of BM109 only applies to the product itself and not the overall cost of the session. Third, by all accounts the cost of the product is relatively small compared to the overall cost of a session, where the vast majority of the revenue will go to cover the operational costs of the service center and facilitator.

This newly legal industry is just getting started. The Oregon Health Authority has recently issued some of the first licenses in the state. Once the industry is up and running, OHA will gather data, including the number of sessions, product prices and the like. Unfortunately for now there is no data and our office's initial forecasts are based entirely on assumptions. Those assumptions are as follows.

OHA estimates they will license 28 service centers in the first year. Assuming 20 customers per day, the equivalent of one large class, all year long results in 204,000 individual customers or session over the course of the first year. Some service center centers will accommodate many more customers while others may focus on smaller, more in-depth sessions. Anecdotal information to date indicates the first couple of service centers are serving just a handful of customers per week currently.

As uncertain as those projections are, the average product price assumption is even more so. Service centers may charge customers whatever price they want to for the actual product. There are two main ways to think through these possibilities, and for now our office is taking a middle ground approach.

On one hand, service centers may charge customers the traditional retail price that includes a markup over wholesale cost which largely relates to production, testing, and distribution costs. Whether the sales tax piece would be an additional charge on top of the session costs overall, or already factored that price is unknown. Tax revenues are estimated to be $1-2 million per year under these scenarios.

On the other hand, service center may charge customers a minimal product cost of $1 or $10, even if that is below their wholesale or acquisition costs. The benefit to doing so would be to increase revenues and profits for service centers and facilitators as less of the overall session price would be sent to pay taxes. This is more likely to be the case if the sales tax is folded into the total session price initially and not an add-on fee when the customer pays. Tax revenues are estimated to be tens of thousands or hundreds of thousands of dollars a year under these scenarios.

Oregon Psilocybin Retail Sales Tax Revenue

Average Product Price	Biennial Revenue (millions) 2023-25	2025-27	2027-29	2029-31
$1	$0.062	$0.064	$0.067	$0.068
$10	$0.618	$0.643	$0.666	$0.679
$25	$1.545	$1.608	$1.664	$1.698
$50	$3.091	$3.215	$3.329	$3.396

For now, given the uncertainty of a newly legal industry our office is taking a middle ground approach and assuming a $10 average product price per session. The state is likely to receive a bit more than $600,000 in the current 2023-25 biennium based on the assumptions discussed above. We know that business practices will vary and time will tell what ultimately becomes the industry standard. Our office will continue to update these estimates as we learn more. Expectations are by this fall there will be useful data to help guide these estimates and they will not be made entirely upon assumptions.

Population and Demographic Outlook

Population and Demographic Summary

Oregon's resident population count on April 1, 2020 was 4,237,256. This is from the newly released decennial census data administered by the U.S. Census Bureau. During the past decade, Oregon gained 406,182 residents or 10.6 percent. The gain was substantial enough that yielded one additional congressional seat for the state. Oregon now has a total of six members in the House of Representatives. We have been predicting this rare gain for a long time. This is rare because it took 40 years for Oregon to gain this seat and only five states gained one additional seat each and Texas gained two seats following the 2020 Census.

In Historical context, Oregon's population growth rate between the 2010 and 2020 censuses was the second lowest since the first census count in Oregon in 1860 after gaining statehood. The lowest growth rate was recorded between the 1980 and 1990 censuses, a decade characterized by a major recession. Oregon's population increased by 441 percent in the last century spanning 1920-2020. The gain of 406,182 persons in the last decade alone was nearly the same as the total population count of Oregon in the year 1900 when the state had 413,536 residents. Oregon's population growth of 10.6 percent in the last decade was 11th highest in the nation, excluding Washington D.C. Still, our growth rate for the decade lagged all our neighboring states, except California. During the prior decade between 2000 and 2010, Oregon's population growth rate ranked 18th highest in the nation when Oregon was hit hard by the double recessions during the decade. As a result of such economic downturn during the Great Recession and sluggish recovery that followed, Oregon's population increased at a slow pace between 2000 and 2010 decade. However, Oregon's population was showing moderately strong growth since then because of state's strong economic recovery. The recent COVID-19 pandemic has caused dire economic and employment situations and has caused slow population growth. The population growth is expected to rebound after the year 2023. However, current economic turmoil is likely to slow the pace of expected growth. The average population growth between 2021 and 2023 was lowest since 1985-86. Oregon's population is expected to reach 4.547 million in the year 2033 with an annual rate of growth of 0.6 percent between 2023 and 2033.

Oregon's economic condition heavily influences the state's population growth. Its economy determines the ability to retain existing work force as well as attract job seekers from national and international labor market. As Oregon's total fertility rate remains well below the replacement level and number of deaths continue to rise due to aging population, long-term growth comes from net in-migration. The COVID-19 pandemic has left noticeable impact on demographic processes. Due to the declining births and rising deaths, past forecasts projected natural increase (births minus deaths) to turn negative after the year 2025. However, Oregon's natural increase has already turned negative because of the COVID effect. Even during this pandemic, Oregon gained people through net-migration as the workers are able to work from home in many sectors. Working-age adults come to Oregon as long as we have favorable economic conditions and offers better quality of life. During the 1980s, which included a major recession and a net loss of population during the early years, net migration contributed to 22 percent of the population change. On the other extreme of the economic cycle, net migration accounted for 73 percent of the population change during the booming economy of early 1990s. This share of migration to population change declined to 25 percent in 2010-11 as a result of the economic recession, lowest since early 1980s when we had negative net migration for several years. As a sign of slow to modest

economic gain and declining natural increase (excess of deaths over births), the ratio of net migration-to-population change has registered at 90 percent in 2020. As a result of sudden rise in the number of deaths and drop in the number of births coinciding with the COVID-19 pandemic, the natural increase turned negative starting in the year 2020 and will continue through 2033 and beyond. So, in the future, all of Oregon's population growth and more will come from the net migration due to the combination of continued positive net migration, well below replacement level fertility, and the rise in the number of deaths associated with the increase in the elderly population. Thus, migration will be solely responsible for Oregon's future population growth. Without the gain due to migration, Oregon's population will start to decline. The negative natural increase caused by excess of deaths over births is expected to continue. However, under a few scenarios this trend may reverse itself. Such reversal can happen if the women start to have more children due to behavioral or motivational factors, or mortality and life expectancy improve suddenly resulting in fewer deaths or large number of women in childbearing age move into Oregon. Since all the states in the country are already experiencing below replacement level fertility (2.1 children per woman), the natural increase will eventually turn negative nationwide even if the trend is mitigated for the short term because of the large number of women in childbearing age.

Age structure and its change affect employment, state revenue, and expenditure as the demand for services varies by age groups. Demographics are the major budget drivers, which are modified by policy choices on service coverage and delivery. Births, deaths, and migration history of decades past do impact the current age-sex structure. Growth in many age groups will show the effects of the baby-boom and their echo generations during the forecast period of 2023-2033. It will also reflect demographics impacted by the depression era smaller birth cohort combined with changing migration of working age population and elderly retirees through history. After a period of relatively slow growth during the 1990s and early 2000s, the elderly population (65+) has picked up a faster pace of growth since 2005. The high growth of this population will taper off as the tail end of the baby era birth cohort enter this age group. This age cohort, however, has hit the plateau of high growth rates exceeding 4 percent annually between 2011 and 2019. The group will experience continued high but diminishing rate of growth. The average annual growth of the elderly population will be 1.6 percent during the 2023-2033 forecast period. Different age groups among the elderly population show quite varied and fascinating growth trends. The youngest elderly (aged 65-74), which was growing at an extremely fast pace in the recent past averaging 5.1 percent annually between 2010 and 2020 due to the direct impact of the baby-boom generation entering and smaller pre-baby boom cohort exiting this 65-74 age group. This fast-paced growth rate will taper off to negative growth by the end of the forecast period of 2023-2033 as a sign of the end of the baby-boom generation transitioning to elderly age group. This high growth transitioning into a net loss of this youngest elderly population resulting in -0.5 percent annual average loss in the coming ten years. The next older generation of population aged 75-84 has been growing rapidly for a decade after several years of slow growth and a period of shrinking until a decade ago. The elderly aged 75-84 started to show growth as the effect of depression era birth-cohort matured out of this age group. An unprecedented fast pace of growth of population in this age group has already started as the baby-boom generation is maturing from the youngest elderly into and depression era birth cohort exiting this 75-84 age group. Annual growth rate during the forecast period of 2023-2033 is expected to be unusually high 3.8 percent. However, during the first half of the forecast period, the annual growth rate will exceed 4 percent per year. The oldest elderly population (aged 85+) will resume growth at a strong rate steadily gaining momentum due to the combination of cohort change, continued positive net migration, and improving longevity. The average annual rate of growth

for this oldest elderly over the forecast horizon will be 4.9 percent. An unprecedented growth in oldest elderly will commence near the end of the forecast horizon as the fast growing 75-84 age group population transition into this oldest elderly age cohort. As a sign of massive demographic structural change of Oregon's population, starting in 2023 the number of elderly will exceed the number of children under the age of 18. To illustrate the contrast, in 2000 elderly population numbered a little over half of the number of children in Oregon, now the elderly outnumber the children.

The oldest working age population aged 45-64 also has seen the dramatic demographic impact as the baby-boom generation matures out of the oldest working-age cohort which is replaced by smaller baby-bust cohort or Gen X. As the effect of this demographic transition combined with slowing net migration, the once fast-paced growth of population aged 45-64 has gradually tapered off to below zero percent rate of growth by 2012 and has remained at slow or below zero growth phase until now. The growth rate will reverse to positive and will see slowly gaining momentum over the forecast horizon. The size of this older working-age population will see about 0.9 percent annualized rate of change over the forecast horizon of next ten years. The younger working-age population of 25-44 age group had recovered from several years of declining and slow growing trend. However, the slow growth of this young working-age population will continue throughout the forecast period. This group will increase by 0.4 percent annual average rate during the forecast horizon mainly because of the exiting smaller birth (baby-bust) cohort being replaced by slightly larger baby-boom-echo cohort. The young adult population (aged 18-24) will see only a small change over the forecast period due to the combination of negative and slow growth years. Although the slow growth of college-age population (age 18-24), in general, tend to ease the pressure on public spending on higher education, but college enrollment typically goes up during the time of very competitive job market, high unemployment, and scarcity of well-paying jobs when even the older people flock back to colleges to better position themselves in a tough job market. The growth in K-12 population (aged 5-17) has been very slow or negative in the past and is expected to decline through the forecast years. This will translate into slow growth or decline in the school enrollments. On average for the forecast period, this school-age population will decline by -1.1 percent annually. The growth rate for children under the age of five has remained near or below zero percent in the recent past and will continue negative or slow growth the near future due to the sharp decline in the number of births. We expect a rebound in the number of births in the forecast period due to a small increase in fertility rate and increase in the women in the child-bearing ages. During the forecast horizon, the children under the age of five will increase at the rate of 0.5 percent annually. Although the number of children under the age of five declined in the recent years, the demand for childcare services and pre-Kindergarten program will be additionally determined by the labor force participation and poverty rates of the parents.

Overall, elderly population over age 65 will increase rapidly whereas the number of children will decline over the forecast horizon. The number of working-age adults in general will show slow growth during the forecast horizon. Hence, based solely on demographics of Oregon, demand for public services geared towards children and young adults will likely decline or increase only at a slower pace, whereas demand for elderly care and services will increase rapidly.

Procedure and Assumptions

Population forecasts by age and sex are developed using the cohort-component projection procedure. The population by single year of age and sex is projected based on the specific assumptions of vital events and migrations. Oregon's estimated population of July 1, 2020 based on the most recent

decennial census is the base for the forecast. To explain the cohort-component projection procedure very briefly, the forecasting model "survives" the initial population distribution by age and sex to the next age-sex category in the following year, and then applies age-sex-specific birth and migration rates to the mid-period population. Further iterations subject the in-and-out migrants to the same mortality and fertility rates. Hence, the age-sex group we start with become one year older the next year accounting for the deaths during the year, births to the women in childbearing ages, and add/subtract net migration for that age during the year.

The U.S. Census Bureau has released the age-sex details of the resident population count of April 1, 2020 for the states. This is the crucial information as the base for all future postcensal population estimates and projections. The 2020 census population total and age-sex detail are used to determine the error of closure, which is the difference between the actual census enumeration and the estimate based on the previous census of 2010. Again, the error of closure is used to correct and adjust all previous annual postcensal estimates for the time between 2011 and 2019. OEA has estimated the total intercensal population for Oregon based on 2010 and 2020 census counts and postcensal estimates of Population Research Center, Portland State University. Therefore, Oregon's *intercensal* population estimates for the years 2011 through 2019 in this forecast shown in Appendix C are different from prior *postcensal* numbers and PSU's original estimates. The Bureau released age-sex detail of the census population in June of last year. OEA has produce preliminary readjusted intercensal estimates by age and sex for each of the years from 2011 through 2019. The numbers of births and deaths through 2022 are from Oregon's Center for Health Statistics. All other numbers and age-sex detail are generated by OEA.

Annual numbers of births are determined from the age-specific fertility rates projected based on Oregon's past trends and past and projected national trends. Oregon's total fertility rate is assumed to be 1.4 per woman in 2020 and this rate is projected to 1.5 children per woman by 2033 which is well below the replacement level fertility of 2.1 children per woman. Oregon's fertility level is tracking below the national level.

Life Table survival rates are developed for the year 2020. Male and female life expectancies for the 2020-2033 period are projected based on the past three decades of trends and national projected life expectancies. After a sudden decline during the COVID pandemic, gradual improvements in life expectancies are expected over the forecast period. At the same time, the difference between the male and female life expectancies will continue to shrink. The male life expectancy at births of 77.3 and the female life expectancy of 81.8 in 2010. Due to the effect of the COVID-19 pandemic, number of deaths suddenly increased and the actual life expectancies declined. The life expectancy at birth in 2020 was 76.9 and 81.7 years respectively for males and females. This is expected to improve to 78.4 years for women and 83.1 years for men by 2033.

Estimates and forecasts of the number of net migrations are based on the residuals from the difference between population change and natural increase (births minus deaths) in a forecast period. The migration forecasting takes into account Oregon's employment, unemployment rates, income/wage data from Oregon and neighboring states, past trends and migration to population ratio. Distribution of migrants by age and sex is based on detailed data from the American Community Survey. In the recent past, slowdown in Oregon's economy resulted in smaller net migration and slow population growth. Estimated population growth and net migration rates in 2010-2011 were the lowest

in over two decades. Migration is intrinsically related to economy and employment situation of the state. Still, high unemployment and job loss in the recent past have impacted net migration and population growth, but not to the extent in the early 1980s. Main reason for this is the fact that other states of potential destination for Oregon out-migrants were not faring any better either, limiting the potential destination choices. The role of net migration in Oregon's population growth will get more prominence as the natural increase has begun to turn negative. The increasing excess of deaths over births will continue due to the rapid increase in the number of deaths associated with the aging population and relatively fewer number of births largely due to the decline in fertility rate associated with life-style choices. Such a trend was expected, but the COVID-19 has hastened the process. The annual net migration is expected to be low due to the after-effect of COVID-19 like remote working and economic slowdown. However, the migration is expected to recover after 2024. Between 2023 and 2033 net migration is expected to be in the range of 24,140 to 36,150, averaging 32,800 persons annually with net migration rate ranging between 5.61 to 7.98 per thousand population.

Appendix A: Economic Forecast Detail

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Table A.1 – Employment Forecast Tracking

Total Nonfarm Employment, 4th quarter 2023

(Employment in thousands, Annualized Percent Change)

	Preliminary Estimate		Forecast		Forecast Error		Y/Y Change
	level	% ch	level	% ch	level	%	% ch
Total Nonfarm	1,994.2	(1.1)	1,999.3	1.7	(5.1)	(0.3)	1.8
Total Private	1,685.8	(1.7)	1,692.0	1.8	(6.2)	(0.4)	1.5
Mining and Logging	6.1	0.7	6.1	1.3	0.1	1.3	2.3
Construction	120.2	5.3	117.1	(0.9)	3.1	2.7	2.8
Manufacturing	189.9	(2.6)	194.6	4.1	(4.6)	(2.4)	(2.1)
Durable Goods	132.2	(3.9)	135.1	4.2	(2.9)	(2.1)	(3.1)
Wood Product	22.9	(0.2)	23.0	3.6	(0.2)	(0.7)	(1.4)
Metals and Machinery	37.1	(3.1)	37.9	1.8	(0.8)	(2.1)	(3.0)
Computer and Electronic Product	40.1	(8.5)	41.5	0.2	(1.4)	(3.4)	(5.0)
Transportation Equipment	11.2	(3.8)	11.2	1.7	(0.0)	(0.0)	1.5
Other Durable Goods	21.0	(0.4)	21.5	19.4	(0.5)	(2.2)	(3.4)
Nondurable Goods	57.7	0.6	59.5	4.1	(1.8)	(3.0)	0.0
Food	28.7	0.0	29.2	0.8	(0.5)	(1.7)	(0.1)
Other Nondurable Goods	29.0	1.1	30.3	7.4	(1.3)	(4.2)	0.2
Trade, Transportation & Utilities	364.6	(1.9)	361.9	0.1	2.7	0.7	(0.2)
Retail Trade	207.6	(2.9)	207.6	(0.5)	(0.0)	(0.0)	(1.1)
Wholesale Trade	79.0	0.9	77.2	0.6	1.8	2.3	2.2
Transportation, Warehousing & Utilities	78.0	(2.1)	77.1	1.4	0.9	1.2	(0.3)
Information	34.3	(20.6)	37.8	2.8	(3.5)	(9.2)	(6.5)
Financial Activities	104.3	(5.5)	106.0	0.8	(1.8)	(1.7)	0.3
Professional & Business Services	265.5	(2.6)	270.8	2.4	(5.4)	(2.0)	0.2
Educational & Health Services	326.5	1.9	320.5	3.3	6.0	1.9	6.0
Educational Services	35.0	(0.1)	34.7	0.7	0.2	0.7	0.8
Health Services	291.6	2.2	285.8	3.6	5.8	2.0	6.6
Leisure and Hospitality	209.1	(2.9)	210.8	2.2	(1.7)	(0.8)	3.5
Other Services	65.2	(2.2)	66.4	(0.2)	(1.2)	(1.9)	3.5
Government	308.4	2.4	307.3	1.1	1.1	0.4	3.4
Federal	28.8	5.0	28.4	0.1	0.4	1.3	3.3
State	46.0	3.2	45.9	9.0	0.1	0.3	5.1
State Education	1.4	34.0	1.4	2.3	(0.0)	(0.0)	13.1
Local	233.6	1.9	233.0	(0.2)	0.7	0.3	3.1
Local Education	131.3	2.8	130.9	1.0	0.5	0.4	1.2

Table A.2 – Short-Term Oregon Economic Summary

Oregon Forecast Summary

	Quarterly					Annual					
	2023:3	2023:4	2024:1	2024:2	2024:3	2022	2023	2024	2025	2026	2027
Personal Income ($ billions)											
Nominal Personal Income	277.4	281.6	286.0	289.9	294.0	264.2	276.9	291.9	308.6	325.4	342.6
% change	4.0	6.3	6.4	5.6	5.8	0.7	4.8	5.4	5.7	5.5	5.3
Real Personal Income (base year=2017)	229.6	232.1	234.9	236.6	238.5	227.7	230.1	237.6	246.3	254.4	262.2
% change	1.3	4.5	4.8	3.1	3.2	(5.4)	1.1	3.3	3.6	3.3	3.1
Nominal Wages and Salaries	143.3	145.4	147.3	149.2	151.1	135.2	142.8	150.1	157.3	164.7	172.5
% change	6.8	6.0	5.5	5.3	5.0	7.0	5.6	5.2	4.8	4.7	4.7
Other Indicators											
Per Capita Income ($1,000)	64.6	65.5	66.5	67.3	68.2	61.9	64.5	67.7	71.2	74.7	78.2
% change	3.5	5.8	6.0	5.1	5.2	0.5	4.3	4.9	5.2	4.9	4.7
Average Wage rate ($1,000)	71.2	72.0	73.3	74.1	74.8	69.0	71.1	74.4	77.4	80.5	83.7
% change	6.0	4.6	7.2	4.4	4.2	3.4	3.0	4.8	4.0	4.0	4.0
Population (Millions)	4.3	4.3	4.3	4.3	4.3	4.27	4.29	4.31	4.33	4.36	4.38
% change	0.5	0.5	0.3	0.5	0.5	0.1	0.5	0.4	0.5	0.6	0.6
Housing Starts (Thousands)	17.5	16.9	16.8	16.9	17.0	20.0	18.2	17.1	18.4	19.4	19.8
% change	(30.7)	(13.2)	(3.1)	3.8	2.6	(1.4)	(9.0)	(6.1)	7.8	5.5	2.0
Unemployment Rate	3.4	3.6	3.7	3.8	3.9	4.1	3.8	3.9	4.1	4.1	4.1
Point Change	(0.3)	0.2	0.1	0.1	0.1	(1.1)	(0.3)	0.0	0.2	0.0	0.0
Employment (Thousands)											
Total Nonfarm	1,999.5	1,994.2	1,996.3	2,000.3	2,004.4	1,946.3	1,992.9	2,002.3	2,017.2	2,031.7	2,046.2
% change	0.8	(1.1)	0.4	0.8	0.8	3.7	2.4	0.5	0.7	0.7	0.7
Private Nonfarm	1,692.9	1,685.8	1,687.6	1,691.8	1,696.0	1,652.0	1,686.9	1,693.9	1,709.4	1,724.1	1,738.7
% change	0.8	(1.7)	0.4	1.0	1.0	3.9	2.1	0.4	0.9	0.9	0.8
Construction	118.6	120.2	119.7	120.5	121.3	115.8	118.7	120.9	123.3	125.5	127.0
% change	1.6	5.3	(1.7)	2.7	2.6	4.0	2.5	1.9	2.0	1.8	1.2
Manufacturing	191.2	189.9	190.7	190.6	190.5	193.2	191.9	190.5	189.9	190.6	191.3
% change	(3.4)	(2.6)	1.5	(0.1)	(0.2)	3.5	(0.7)	(0.7)	(0.3)	0.4	0.3
Durable Manufacturing	133.6	132.2	132.6	132.6	132.5	135.4	134.1	132.5	132.1	133.0	133.6
% change	(4.1)	(3.9)	1.2	(0.1)	(0.2)	4.9	(1.0)	(1.2)	(0.3)	0.7	0.4
Wood Product Manufacturing	22.9	22.9	23.1	23.0	23.0	23.3	22.9	23.0	23.0	22.9	22.9
% change	(0.3)	(0.2)	3.4	(1.3)	(0.1)	2.5	(1.8)	0.5	(0.2)	(0.1)	(0.1)
High Tech Manufacturing	41.0	40.1	40.1	40.0	39.9	41.3	41.1	39.9	40.1	41.5	42.5
% change	(3.9)	(8.5)	(0.2)	(0.8)	(1.1)	8.7	(0.4)	(2.8)	0.4	3.6	2.3
Transportation Equipment	11.3	11.2	11.3	11.3	11.4	10.9	11.2	11.4	11.5	11.5	11.4
% change	(0.5)	(3.8)	3.5	1.5	1.4	1.8	3.0	1.3	1.2	0.4	(1.1)
Nondurable Manufacturing	57.6	57.7	58.0	58.1	58.0	57.8	57.8	58.0	57.8	57.6	57.7
% change	(1.8)	0.6	2.3	0.2	(0.3)	0.4	(0.1)	0.4	(0.5)	(0.3)	0.2
Private nonmanufacturing	1,501.7	1,495.8	1,497.0	1,501.1	1,505.5	1,458.8	1,495.1	1,503.4	1,519.5	1,533.4	1,547.4
% change	1.4	(1.5)	0.3	1.1	1.2	3.9	2.5	0.6	1.1	0.9	0.9
Retail Trade	209.1	207.6	207.0	207.2	207.4	210.6	209.3	207.3	207.5	207.8	208.0
% change	(1.3)	(2.9)	(1.0)	0.4	0.2	0.7	(0.6)	(0.9)	0.1	0.1	0.1
Wholesale Trade	78.8	79.0	78.4	78.3	78.3	77.0	78.5	78.3	78.4	78.3	78.5
% change	2.3	0.9	(3.2)	(0.6)	0.4	2.7	2.0	(0.3)	0.1	(0.1)	0.2
Information	36.3	34.3	34.5	34.6	34.9	36.8	36.3	34.8	36.0	36.3	36.5
% change	(8.1)	(20.6)	2.8	1.3	3.1	4.8	(1.4)	(3.9)	3.3	1.0	0.5
Professional and Business Services	267.2	265.5	266.2	267.6	269.0	263.7	267.3	268.2	271.7	274.7	280.0
% change	(2.6)	(2.6)	1.1	2.2	2.0	4.8	1.4	0.3	1.3	1.1	1.9
Health Services	290.0	291.6	292.2	293.0	293.7	269.5	286.5	293.4	297.5	302.0	306.2
% change	7.5	2.2	0.9	1.0	1.0	0.9	6.3	2.4	1.4	1.5	1.4
Leisure and Hospitality	210.7	209.1	210.1	211.2	212.0	198.4	208.6	211.6	214.6	216.9	218.5
% change	5.6	(2.9)	1.9	2.0	1.6	13.4	5.1	1.4	1.4	1.1	0.7
Government	306.6	308.4	308.6	308.5	308.4	294.3	306.0	308.4	307.8	307.7	307.5
% change	0.6	2.4	0.3	(0.2)	(0.1)	3.0	4.0	0.8	(0.2)	(0.0)	(0.0)

Table A.3 – Oregon Economic Forecast Change

Oregon Forecast Change (Current vs Previous)

	Quarterly					Annual					
	2023:3	2023:4	2024:1	2024:2	2024:3	2022	2023	2024	2025	2026	2027
Personal Income ($ billions)											
Nominal Personal Income	277.4	281.6	286.0	289.9	294.0	264.2	276.9	291.9	308.6	325.4	342.6
% change	(1.3)	(1.1)	(1.2)	(1.4)	(1.4)	0.0	(0.8)	(1.4)	(1.2)	(0.9)	(0.7)
Real Personal Income (base year=2017)	229.6	232.1	234.9	236.6	238.5	227.7	230.1	237.6	246.3	254.4	262.2
% change	(1.2)	(0.8)	(0.9)	(1.1)	(1.1)	0.0	(0.7)	(1.0)	(0.8)	(0.6)	(0.5)
Nominal Wages and Salaries	143.3	145.4	147.3	149.2	151.1	135.2	142.8	150.1	157.3	164.7	172.5
% change	(1.8)	(1.7)	(1.5)	(1.5)	(1.4)	0.0	(1.1)	(1.5)	(1.5)	(1.5)	(1.5)
Other Indicators											
Per Capita Income ($1,000)	64.6	65.5	66.5	67.3	68.2	61.9	64.5	67.7	71.2	74.7	78.2
% change	(1.2)	(1.0)	(1.1)	(1.3)	(1.3)	0.3	(0.6)	(1.2)	(1.0)	(0.6)	(0.2)
Average Wage rate ($1,000)	71.2	72.0	73.3	74.1	74.8	69.0	71.1	74.4	77.4	80.5	83.7
% change	(1.8)	(2.0)	(1.2)	(1.2)	(1.2)	(0.0)	(1.4)	(1.2)	(1.3)	(1.4)	(1.4)
Population (Millions)	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.4	4.4
% change	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.3)	(0.1)	(0.1)	(0.2)	(0.3)	(0.5)
Housing Starts (Thousands)	17.5	16.9	16.8	16.9	17.0	20.0	18.2	17.1	18.4	19.4	19.8
% change	0.0	(3.3)	(2.5)	(4.7)	(7.2)	0.0	(0.8)	(4.9)	(5.0)	(4.8)	(5.4)
Unemployment Rate	3.4	3.6	3.7	3.8	3.9	4.1	3.8	3.9	4.1	4.1	4.1
Point Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Employment (Thousands)											
Total Nonfarm	1,999.5	1,994.2	1,996.3	2,000.3	2,004.4	1,946.3	1,992.9	2,002.3	2,017.2	2,031.7	2,046.2
% change	0.4	(0.3)	(0.3)	(0.3)	(0.3)	0.0	0.2	(0.3)	(0.2)	(0.2)	(0.2)
Private Nonfarm	1,692.9	1,685.8	1,687.6	1,691.8	1,696.0	1,652.0	1,686.9	1,693.9	1,709.4	1,724.1	1,738.7
% change	0.5	(0.4)	(0.4)	(0.4)	(0.4)	0.0	0.2	(0.4)	(0.3)	(0.3)	(0.3)
Construction	118.6	120.2	119.7	120.5	121.3	115.8	118.7	120.9	123.3	125.5	127.0
% change	1.1	2.7	2.1	1.6	1.1	0.0	1.2	1.4	0.6	0.5	0.4
Manufacturing	191.2	189.9	190.7	190.6	190.5	193.2	191.9	190.5	189.9	190.6	191.3
% change	(0.7)	(2.4)	(2.2)	(2.3)	(2.4)	(0.0)	(0.9)	(2.4)	(2.4)	(2.2)	(1.8)
Durable Manufacturing	133.6	132.2	132.6	132.6	132.5	135.4	134.1	132.5	132.1	133.0	133.6
% change	(0.1)	(2.1)	(2.1)	(2.1)	(2.4)	0.0	(0.5)	(2.3)	(2.3)	(2.1)	(1.5)
Wood Product Manufacturing	22.9	22.9	23.1	23.0	23.0	23.3	22.9	23.0	23.0	22.9	22.9
% change	0.2	(0.7)	0.0	0.0	0.0	0.0	(0.1)	0.0	0.0	0.0	0.0
High Tech Manufacturing	41.0	40.1	40.1	40.0	39.9	41.3	41.1	39.9	40.1	41.5	42.5
% change	(1.2)	(3.4)	(3.6)	(3.6)	(3.7)	(0.0)	(1.4)	(3.6)	(3.3)	(2.9)	(2.3)
Transportation Equipment	11.3	11.2	11.3	11.3	11.4	10.9	11.2	11.4	11.5	11.5	11.4
% change	1.4	(0.0)	(0.1)	(0.4)	(0.6)	0.0	0.9	(0.5)	(1.7)	(2.2)	(1.5)
Nondurable Manufacturing	57.6	57.7	58.0	58.1	58.0	57.8	57.8	58.0	57.8	57.6	57.7
% change	(2.1)	(3.0)	(2.6)	(2.5)	(2.4)	(0.0)	(1.8)	(2.5)	(2.4)	(2.4)	(2.5)
Private nonmanufacturing	1,501.7	1,495.8	1,497.0	1,501.1	1,505.5	1,458.8	1,495.1	1,503.4	1,519.5	1,533.4	1,547.4
% change	0.7	(0.1)	(0.2)	(0.2)	(0.2)	0.0	0.4	(0.2)	(0.1)	(0.1)	(0.1)
Retail Trade	209.1	207.6	207.0	207.2	207.4	210.6	209.3	207.3	207.5	207.8	208.0
% change	0.6	(0.0)	(0.0)	(0.0)	(0.0)	0.0	0.3	(0.0)	(0.0)	(0.0)	(0.0)
Wholesale Trade	78.8	79.0	78.4	78.3	78.3	77.0	78.5	78.3	78.4	78.3	78.5
% change	2.2	2.3	1.6	1.5	1.5	0.0	1.7	1.5	1.8	1.7	1.7
Information	36.3	34.3	34.5	34.6	34.9	36.8	36.3	34.8	36.0	36.3	36.5
% change	(3.1)	(9.2)	(9.0)	(8.3)	(7.0)	0.0	(3.5)	(7.7)	(4.8)	(3.4)	(2.9)
Professional and Business Services	267.2	265.5	266.2	267.6	269.0	263.7	267.3	268.2	271.7	274.7	280.0
% change	(0.7)	(2.0)	(2.0)	(2.0)	(1.9)	0.0	(0.6)	(1.9)	(1.5)	(1.4)	(1.4)
Health Services	290.0	291.6	292.2	293.0	293.7	269.5	286.5	293.4	297.5	302.0	306.2
% change	2.4	2.0	2.2	2.0	1.8	0.0	1.8	1.9	1.7	1.5	1.4
Leisure and Hospitality	210.7	209.1	210.1	211.2	212.0	198.4	208.6	211.6	214.6	216.9	218.5
% change	0.5	(0.8)	(0.7)	(0.6)	(0.5)	0.0	0.3	(0.6)	(0.5)	(0.5)	(0.5)
Government	306.6	308.4	308.6	308.5	308.4	294.3	306.0	308.4	307.8	307.7	307.5
% change	0.1	0.4	0.5	0.5	0.6	0.0	0.3	0.5	0.6	0.5	0.4

Table A.4 – Annual Economic Forecast

Mar 2024 - Personal Income

(Billions of Current Dollars)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Personal Income*												
Oregon	264.2	276.9	291.9	308.6	325.4	342.6	360.0	377.8	396.4	415.8	435.7	456.2
% Ch	0.7	4.8	5.4	5.7	5.5	5.3	5.1	5.0	4.9	4.9	4.8	4.7
U.S.	21,840.8	22,965.7	24,050.8	25,243.9	26,403.7	27,590.7	28,806.0	30,015.9	31,257.1	32,549.3	33,913.7	35,346.1
% Ch	2.0	5.2	4.7	5.0	4.6	4.5	4.4	4.2	4.1	4.1	4.2	4.2
Wage and Salary												
Oregon	135.2	142.8	150.1	157.3	164.7	172.5	180.7	189.1	197.9	207.0	216.2	225.9
% Ch	7.0	5.6	5.2	4.8	4.7	4.7	4.7	4.7	4.7	4.6	4.4	4.5
U.S.	11,116.0	11,807.0	12,333.7	12,801.0	13,290.4	13,807.1	14,353.5	14,910.8	15,486.8	16,089.7	16,737.5	17,425.0
% Ch	7.8	6.2	4.5	3.8	3.8	3.9	4.0	3.9	3.9	3.9	4.0	4.1
Other Labor Income												
Oregon	31.9	33.4	35.5	37.4	39.3	41.2	43.2	45.2	47.4	49.5	51.8	54.1
% Ch	2.9	4.6	6.5	5.2	5.0	4.9	4.8	4.8	4.7	4.6	4.5	4.5
U.S.	1,559.1	1,621.2	1,688.6	1,752.6	1,819.6	1,890.4	1,965.2	2,041.5	2,120.4	2,202.9	2,291.6	2,385.7
% Ch	2.1	4.0	4.2	3.8	3.8	3.9	4.0	3.9	3.9	3.9	4.0	4.1
Nonfarm Proprietor's Income												
Oregon	22.8	23.8	25.8	27.4	28.4	29.6	31.0	32.6	34.3	36.2	38.1	40.1
% Ch	1.3	4.7	8.5	6.0	3.8	4.0	4.8	5.1	5.3	5.4	5.3	5.3
U.S.	1,709.1	1,791.8	1,914.4	2,016.6	2,071.4	2,133.2	2,215.8	2,303.6	2,404.1	2,515.4	2,632.9	2,753.6
% Ch	1.9	4.8	6.8	5.3	2.7	3.0	3.9	4.0	4.4	4.6	4.7	4.6
Dividend, Interest and Rent												
Oregon	50.8	53.2	57.2	61.4	65.5	69.5	73.1	76.8	80.6	84.7	88.9	93.0
% Ch	4.0	4.8	7.4	7.3	6.7	6.0	5.3	5.0	4.9	5.2	4.9	4.6
U.S.	4,310.3	4,580.9	4,885.0	5,246.3	5,588.0	5,908.9	6,193.4	6,449.2	6,702.4	6,964.0	7,236.6	7,520.1
% Ch	7.0	6.3	6.6	7.4	6.5	5.7	4.8	4.1	3.9	3.9	3.9	3.9
Transfer Payments												
Oregon	55.1	57.0	58.1	61.3	65.1	69.1	73.1	77.0	81.1	85.4	89.8	94.3
% Ch	(12.3)	3.5	1.9	5.5	6.2	6.1	5.8	5.5	5.3	5.3	5.2	5.0
U.S.	3,903.0	3,992.7	4,096.2	4,291.9	4,518.3	4,770.1	5,036.8	5,304.8	5,574.5	5,849.8	6,132.3	6,425.5
% Ch	(14.3)	2.3	2.6	4.8	5.3	5.6	5.6	5.3	5.1	4.9	4.8	4.8
Contributions for Social Security												
Oregon	24.9	26.1	27.3	28.4	29.5	30.8	32.2	33.8	35.4	37.0	38.7	40.4
% Ch	8.5	4.9	4.4	4.0	4.0	4.4	4.7	4.7	4.7	4.7	4.4	4.4
U.S.	937.7	988.0	1,025.7	1,058.9	1,095.7	1,125.8	1,167.5	1,212.8	1,259.8	1,309.2	1,362.3	1,418.5
% Ch	10.1	5.4	3.8	3.2	3.5	2.7	3.7	3.9	3.9	3.9	4.1	4.1
Residence Adjustment												
Oregon	(7.2)	(7.5)	(8.0)	(8.3)	(8.6)	(8.9)	(9.3)	(9.7)	(10.1)	(10.5)	(10.9)	(11.4)
% Ch	12.9	4.9	5.9	3.8	3.8	4.0	4.1	4.1	4.2	4.1	4.1	4.3
Farm Proprietor's Income												
Oregon	0.5	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6
% Ch	110.1	(28.7)	(2.8)	39.9	10.9	(7.4)	(1.5)	6.2	5.0	2.0	2.3	3.0
Per Capita Income (Thousands of $)												
Oregon	61.9	64.5	67.7	71.2	74.7	78.2	81.7	85.2	88.8	92.6	96.4	100.3
% Ch	0.5	4.3	4.9	5.2	4.9	4.7	4.5	4.3	4.3	4.3	4.1	4.0
U.S.	65.4	68.5	71.4	74.6	77.6	80.8	84.0	87.2	90.5	93.9	97.5	101.3
% Ch	1.6	4.6	4.2	4.5	4.1	4.1	4.0	3.8	3.7	3.8	3.8	3.9

* Personal Income includes all classes of income minus Contributions for Social Security

Mar 2024 - Employment By Industry

(Oregon - Thousands, U.S. - Millions)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Nonfarm												
Oregon	1,946.3	1,992.9	2,002.3	2,017.2	2,031.7	2,046.2	2,060.9	2,074.1	2,088.0	2,099.6	2,109.0	2,118.8
% Ch	3.7	2.4	0.5	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.4	0.5
U.S.	152.6	156.2	157.4	157.8	158.0	158.2	158.6	159.0	159.5	159.8	160.2	160.5
% Ch	4.3	2.3	0.8	0.2	0.2	0.1	0.3	0.3	0.3	0.2	0.2	0.2
Private Nonfarm												
Oregon	1,652.0	1,686.9	1,693.9	1,709.4	1,724.1	1,738.7	1,753.1	1,765.8	1,778.2	1,789.9	1,798.6	1,807.7
% Ch	3.9	2.1	0.4	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.5	0.5
U.S.	130.4	133.5	134.3	134.6	134.7	134.8	135.2	135.5	135.8	136.1	136.4	136.7
% Ch	4.9	2.3	0.6	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Mining and Logging												
Oregon	6.3	6.1	6.2	6.2	6.2	6.3	6.3	6.3	6.4	6.4	6.4	6.4
% Ch	(4.8)	(2.7)	1.2	0.7	0.8	0.6	0.4	0.2	0.5	0.2	0.3	(0.2)
U.S.	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
% Ch	8.0	5.9	0.8	3.9	3.7	3.8	1.6	(0.5)	(1.5)	(1.1)	1.4	2.1
Construction												
Oregon	115.8	118.7	120.9	123.3	125.5	127.0	127.9	128.6	129.9	131.4	132.7	134.1
% Ch	4.0	2.5	1.9	2.0	1.8	1.2	0.7	0.6	1.0	1.2	1.0	1.1
U.S.	7.7	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0
% Ch	4.2	2.7	2.1	0.9	1.3	1.0	1.4	1.3	1.3	0.7	0.8	1.1
Manufacturing												
Oregon	193.2	191.9	190.5	189.9	190.6	191.3	191.4	191.5	191.4	190.9	190.4	189.9
% Ch	3.5	(0.7)	(0.7)	(0.3)	0.4	0.3	0.1	0.1	(0.0)	(0.3)	(0.3)	(0.2)
U.S.	12.8	13.0	12.8	12.2	11.9	11.8	11.6	11.6	11.6	11.5	11.4	11.3
% Ch	3.8	1.2	(1.3)	(4.6)	(2.3)	(1.4)	(1.2)	(0.5)	(0.2)	(0.5)	(0.6)	(0.8)
Durable Manufacturing												
Oregon	135.4	134.1	132.5	132.1	133.0	133.6	133.1	132.6	132.0	131.5	130.8	130.3
% Ch	4.9	(1.0)	(1.2)	(0.3)	0.7	0.4	(0.3)	(0.4)	(0.4)	(0.4)	(0.5)	(0.4)
U.S.	8.0	8.1	8.0	7.6	7.4	7.3	7.1	7.1	7.1	7.0	7.0	6.9
% Ch	3.8	1.8	(1.0)	(5.2)	(2.8)	(1.7)	(1.8)	(0.9)	(0.3)	(0.5)	(0.6)	(0.8)
Wood Products												
Oregon	23.3	22.9	23.0	23.0	22.9	22.9	22.9	22.8	22.8	22.8	22.8	22.6
% Ch	2.5	(1.8)	0.5	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	0.1	(0.3)	(0.7)
U.S.	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
% Ch	4.6	(1.3)	(4.7)	(6.3)	3.5	4.6	3.9	4.0	5.2	2.3	0.9	(0.9)
Metal and Machinery												
Oregon	38.0	37.6	37.0	36.7	36.3	36.2	35.8	35.5	35.4	35.1	34.8	34.6
% Ch	4.7	(1.2)	(1.6)	(0.6)	(1.2)	(0.4)	(1.1)	(0.7)	(0.4)	(0.7)	(0.9)	(0.5)
U.S.	2.9	3.0	2.9	2.8	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6
% Ch	4.0	1.8	(1.0)	(4.9)	(2.1)	(1.4)	(2.0)	(1.2)	(0.5)	0.0	(0.2)	(0.5)
Computer and Electronic Products												
Oregon	41.3	41.1	39.9	40.1	41.5	42.5	42.9	42.8	42.7	42.6	42.5	42.4
% Ch	8.7	(0.4)	(2.8)	0.4	3.6	2.3	0.9	(0.3)	(0.3)	(0.2)	(0.2)	(0.2)
U.S.	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
% Ch	2.7	1.2	(0.8)	(1.4)	(0.6)	(1.2)	(1.7)	(1.6)	(1.3)	(0.6)	(0.2)	0.0
Transportation Equipment												
Oregon	10.9	11.2	11.4	11.5	11.5	11.4	11.3	11.2	11.1	10.9	10.7	10.7
% Ch	1.8	3.0	1.3	1.2	0.4	(1.1)	(1.3)	(0.6)	(1.2)	(1.5)	(1.4)	(0.7)
U.S.	1.7	1.8	1.8	1.7	1.6	1.5	1.4	1.4	1.4	1.4	1.3	1.3
% Ch	4.9	5.1	1.2	(7.5)	(6.9)	(4.7)	(3.8)	(1.7)	(1.7)	(2.9)	(1.9)	(1.7)
Other Durables												
Oregon	21.9	21.3	21.2	20.9	20.7	20.6	20.3	20.2	20.1	20.1	20.0	20.0
% Ch	2.5	(2.8)	(0.4)	(1.8)	(0.8)	(0.5)	(1.1)	(0.7)	(0.4)	(0.2)	(0.3)	(0.2)
U.S.	2.3	2.3	2.2	2.1	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.0
% Ch	3.5	(0.4)	(3.0)	(5.6)	(1.6)	(0.2)	(0.3)	0.5	1.5	0.4	(0.3)	(0.9)

Mar 2024 - Employment By Industry

(Oregon - Thousands, U.S. - Millions)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Nondurable Manufacturing												
Oregon	57.8	57.8	58.0	57.8	57.6	57.7	58.3	59.0	59.4	59.4	59.5	59.6
% Ch	0.4	(0.1)	0.4	(0.5)	(0.3)	0.2	1.0	1.2	0.7	0.0	0.2	0.2
U.S.	4.9	4.9	4.8	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.4	4.4
% Ch	3.8	0.2	(1.8)	(3.6)	(1.5)	(0.7)	(0.3)	0.1	(0.0)	(0.5)	(0.7)	(0.9)
Food Manufacturing												
Oregon	28.8	28.8	28.8	29.0	29.1	29.1	29.3	29.8	30.1	30.2	30.4	30.5
% Ch	0.8	0.0	0.2	0.8	0.2	0.1	0.8	1.4	1.0	0.5	0.6	0.5
U.S.	1.7	1.7	1.7	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.8
% Ch	3.6	1.5	(1.1)	(3.5)	(0.4)	0.7	1.2	1.6	1.4	0.9	0.6	0.3
Other Nondurable												
Oregon	29.1	29.0	29.2	28.7	28.5	28.6	28.9	29.2	29.3	29.2	29.1	29.1
% Ch	(0.1)	(0.2)	0.6	(1.7)	(0.7)	0.2	1.2	1.0	0.4	(0.5)	(0.2)	(0.2)
U.S.	3.2	3.1	3.1	3.0	2.9	2.9	2.8	2.8	2.8	2.7	2.7	2.7
% Ch	3.9	(0.5)	(2.2)	(3.6)	(2.1)	(1.5)	(1.1)	(0.8)	(0.9)	(1.4)	(1.6)	(1.6)
Trade, Transportation, and Utilities												
Oregon	366.8	366.2	363.5	364.2	364.7	365.7	366.5	367.1	367.2	367.0	366.5	365.9
% Ch	1.5	(0.2)	(0.8)	0.2	0.1	0.3	0.2	0.2	0.0	(0.1)	(0.1)	(0.2)
U.S.	28.7	28.9	28.5	28.2	28.1	28.1	27.9	27.7	27.5	27.5	27.4	27.3
% Ch	3.6	0.7	(1.1)	(1.3)	(0.1)	(0.2)	(0.7)	(0.8)	(0.6)	(0.1)	(0.2)	(0.4)
Retail Trade												
Oregon	210.6	209.3	207.3	207.5	207.8	208.0	208.3	208.7	208.8	208.8	208.7	208.8
% Ch	0.7	(0.6)	(0.9)	0.1	0.1	0.1	0.1	0.2	0.1	(0.0)	(0.0)	0.0
U.S.	15.5	15.5	15.2	14.7	14.6	14.6	14.4	14.3	14.3	14.3	14.4	14.4
% Ch	1.5	0.2	(2.2)	(3.1)	(0.4)	(0.5)	(0.9)	(0.8)	(0.2)	0.3	0.3	0.3
Wholesale Trade												
Oregon	77.0	78.5	78.3	78.4	78.3	78.5	78.7	78.7	78.7	78.7	78.5	78.2
% Ch	2.7	2.0	(0.3)	0.1	(0.1)	0.2	0.2	0.1	(0.0)	(0.1)	(0.2)	(0.4)
U.S.	6.0	6.1	6.1	6.2	6.2	6.2	6.1	6.1	6.0	6.0	5.9	5.9
% Ch	4.5	1.7	0.7	0.9	0.2	0.3	(0.6)	(1.0)	(1.2)	(0.6)	(0.6)	(0.9)
Transportation and Warehousing, and Utilities												
Oregon	79.2	78.4	77.8	78.3	78.6	79.1	79.5	79.6	79.6	79.5	79.2	78.9
% Ch	2.4	(1.0)	(0.7)	0.6	0.5	0.6	0.5	0.2	(0.1)	(0.2)	(0.3)	(0.4)
U.S.	7.2	7.3	7.2	7.3	7.3	7.3	7.3	7.3	7.2	7.2	7.1	7.0
% Ch	7.8	0.7	(0.4)	0.7	0.4	0.1	(0.3)	(0.6)	(0.8)	(0.7)	(0.9)	(1.2)
Information												
Oregon	36.8	36.3	34.8	36.0	36.3	36.5	36.9	37.4	37.6	37.7	37.9	38.0
% Ch	4.8	(1.4)	(3.9)	3.3	1.0	0.5	1.3	1.2	0.6	0.3	0.3	0.4
U.S.	3.1	3.1	3.0	3.1	3.1	3.0	3.0	3.1	3.1	3.1	3.0	3.0
% Ch	7.6	(0.3)	(0.9)	3.1	(0.9)	(1.7)	(0.1)	0.5	(0.0)	(0.3)	(0.1)	(0.8)
Financial Activities												
Oregon	105.1	104.9	104.6	104.8	105.1	104.7	104.5	104.2	103.7	103.7	103.8	103.9
% Ch	0.9	(0.1)	(0.3)	0.2	0.2	(0.4)	(0.2)	(0.3)	(0.4)	(0.0)	0.1	0.1
U.S.	9.0	9.1	9.2	9.4	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
% Ch	2.7	1.0	1.1	2.0	0.6	0.4	0.1	(0.1)	(0.5)	0.1	0.5	0.1
Professional and Business Services												
Oregon	263.7	267.3	268.2	271.7	274.7	280.0	286.4	292.4	298.7	304.7	309.2	313.5
% Ch	4.8	1.4	0.3	1.3	1.1	1.9	2.3	2.1	2.2	2.0	1.5	1.4
U.S.	22.6	23.0	23.0	23.4	23.3	23.2	23.6	24.1	24.4	24.7	25.0	25.3
% Ch	5.6	1.7	0.2	1.7	(0.4)	(0.2)	1.6	1.8	1.6	1.3	1.2	1.3

Mar 2024 - Employment By Industry

(Oregon - Thousands, U.S. - Millions)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Education and Health Services												
Oregon	304.1	321.9	328.1	332.4	336.9	341.1	344.3	347.0	350.0	352.1	353.3	354.9
% Ch	1.6	5.9	1.9	1.3	1.3	1.3	0.9	0.8	0.9	0.6	0.3	0.4
U.S.	24.4	25.4	26.2	26.4	26.5	26.7	26.9	27.1	27.2	27.4	27.6	27.8
% Ch	3.0	4.2	3.1	0.9	0.3	0.8	0.8	0.5	0.5	0.8	0.8	0.8
Educational Services												
Oregon	34.6	35.4	34.8	34.9	34.9	34.9	34.9	34.8	34.7	34.7	34.6	34.5
% Ch	7.9	2.4	(1.8)	0.3	0.1	(0.0)	(0.1)	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)
U.S.	3.8	3.9	3.9	3.8	3.8	3.9	3.9	3.9	3.9	3.9	3.8	3.8
% Ch	5.9	3.6	(0.4)	(2.1)	(0.4)	0.9	1.0	0.2	(0.8)	(0.4)	(0.4)	(0.2)
Health Care and Social Assistance												
Oregon	269.5	286.5	293.4	297.5	302.0	306.2	309.4	312.1	315.2	317.5	318.8	320.4
% Ch	0.9	6.3	2.4	1.4	1.5	1.4	1.1	0.9	1.0	0.7	0.4	0.5
U.S.	20.6	21.5	22.3	22.6	22.7	22.9	23.0	23.2	23.3	23.6	23.8	24.0
% Ch	2.4	4.4	3.8	1.5	0.4	0.8	0.7	0.5	0.8	1.0	1.0	0.9
Leisure and Hospitality												
Oregon	198.4	208.6	211.6	214.6	216.9	218.5	220.7	222.6	224.2	226.3	228.2	230.4
% Ch	13.4	5.1	1.4	1.4	1.1	0.7	1.0	0.9	0.7	0.9	0.9	0.9
U.S.	15.9	16.6	16.9	17.0	17.3	17.2	17.1	16.9	16.8	16.6	16.4	16.2
% Ch	12.0	4.8	1.5	0.9	1.5	(0.1)	(1.0)	(0.7)	(1.0)	(1.3)	(1.2)	(0.8)
Other Services												
Oregon	61.9	65.0	65.6	66.2	67.0	67.7	68.3	68.7	69.2	69.7	70.2	70.7
% Ch	4.5	5.1	0.8	1.0	1.2	1.1	0.9	0.6	0.6	0.7	0.7	0.7
U.S.	5.7	5.9	5.9	5.9	6.0	6.1	6.2	6.3	6.3	6.4	6.4	6.4
% Ch	4.6	2.7	0.4	0.5	1.3	1.9	1.9	1.2	0.5	0.6	0.4	0.2
Government												
Oregon	294.3	306.0	308.4	307.8	307.7	307.5	307.8	308.3	309.7	309.7	310.5	311.2
% Ch	3.0	4.0	0.8	(0.2)	(0.0)	(0.0)	0.1	0.2	0.5	0.0	0.2	0.2
U.S.	22.2	22.7	23.1	23.2	23.3	23.4	23.5	23.5	23.7	23.7	23.8	23.8
% Ch	0.9	2.5	1.6	0.5	0.4	0.4	0.3	0.3	0.6	0.0	0.3	0.3
Federal Government												
Oregon	27.8	28.4	28.7	28.7	28.6	28.6	28.5	28.5	29.2	28.4	28.4	28.3
% Ch	(2.3)	2.1	1.1	(0.2)	(0.2)	(0.2)	(0.2)	(0.1)	2.4	(2.8)	(0.0)	(0.0)
U.S.	2.9	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
% Ch	(0.6)	2.0	0.9	0.0	0.0	0.0	0.0	0.0	2.3	(2.3)	0.0	0.0
State Government, Oregon												
Total	43.1	45.6	46.2	46.3	46.2	46.2	46.7	47.0	47.3	47.7	48.0	48.2
% Ch	1.2	5.8	1.4	0.2	(0.2)	0.1	0.9	0.8	0.7	0.8	0.6	0.5
Education	1.2	1.3	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1
% Ch	18.6	12.8	7.1	(3.2)	(3.3)	(2.8)	(2.5)	(2.1)	(2.2)	(1.8)	(1.6)	(1.5)
Non-Education	41.9	44.2	44.8	44.9	44.9	44.9	45.4	45.8	46.1	46.5	46.8	47.1
% Ch	0.7	5.6	1.2	0.3	(0.1)	0.2	1.0	0.9	0.8	0.8	0.7	0.6
Local Government, Oregon												
Total	223.4	232.0	233.5	232.9	232.9	232.7	232.6	232.8	233.2	233.7	234.1	234.6
% Ch	4.1	3.9	0.6	(0.3)	0.0	(0.1)	(0.0)	0.1	0.2	0.2	0.2	0.2
Education	128.0	131.1	131.2	130.7	130.3	129.4	128.6	128.0	127.6	127.3	126.9	126.5
% Ch	4.8	2.4	0.1	(0.4)	(0.3)	(0.7)	(0.7)	(0.4)	(0.3)	(0.3)	(0.3)	(0.3)
Non-Education	95.4	100.9	102.3	102.2	102.6	103.3	104.1	104.8	105.6	106.4	107.2	108.0
% Ch	3.2	5.8	1.4	(0.1)	0.4	0.7	0.7	0.7	0.7	0.8	0.8	0.8

Mar 2024 - Other Economic Indicators

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Real GDP,												
Chain Weight (Bil of 2017$)	21,822.0	22,341.4	22,721.9	23,063.8	23,383.1	23,704.8	24,061.8	24,407.1	24,767.7	25,140.2	25,542.7	25,962.7
% Ch	1.9	2.4	1.7	1.5	1.4	1.4	1.5	1.4	1.5	1.5	1.6	1.6
Price and Wage Indicators												
GDP Implicit Price Deflator,												
Chain Weight U.S., 2017=100	118.0	122.3	124.7	127.4	130.2	133.2	136.3	139.5	142.7	146.0	149.4	152.8
% Ch	7.1	3.6	2.0	2.2	2.2	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Personal Consumption Deflator,												
Chain Weight U.S., 2017=100	116.0	120.4	122.9	125.3	127.9	130.7	133.3	136.0	138.7	141.5	144.3	147.1
% Ch	6.5	3.7	2.1	2.0	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0
CPI, Urban Consumers,												
1982-84=100												
West Region	310.5	323.8	332.7	339.9	348.1	356.8	365.2	373.7	382.4	391.4	400.5	409.6
% Ch	8.0	4.3	2.7	2.1	2.4	2.5	2.4	2.3	2.3	2.4	2.3	2.3
U.S.	292.6	304.7	313.1	319.3	326.9	334.7	342.2	349.8	357.3	365.1	373.1	381.2
% Ch	8.0	4.1	2.7	2.0	2.4	2.4	2.2	2.2	2.2	2.2	2.2	2.2
Oregon Average Wage												
Rate (Thous $)	69.0	71.1	74.4	77.4	80.5	83.7	87.1	90.6	94.2	98.0	101.9	106.0
% Ch	3.4	3.0	4.8	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
U.S. Average Wage												
Wage Rate (Thous $)	72.8	75.6	78.4	81.1	84.1	87.3	90.5	93.7	97.1	100.7	104.5	108.5
% Ch	3.3	3.8	3.7	3.5	3.7	3.7	3.7	3.6	3.6	3.7	3.8	3.9
Housing Indicators												
FHFA Oregon Housing Price Index												
1991 Q1=100	613.8	616.3	642.1	667.8	693.1	719.0	748.1	780.9	814.3	850.3	888.3	928.3
% Ch	10.4	0.4	4.2	4.0	3.8	3.7	4.1	4.4	4.3	4.4	4.5	4.5
FHFA National Housing Price Index												
1991 Q1=100	384.9	399.8	439.6	452.7	461.1	469.7	480.1	492.9	506.9	522.0	538.6	556.5
% Ch	13.9	3.9	9.9	3.0	1.9	1.9	2.2	2.7	2.8	3.0	3.2	3.3
Housing Starts												
Oregon (Thous)	20.0	18.2	17.1	18.4	19.4	19.8	20.0	20.1	20.1	20.1	20.1	20.1
% Ch	(1.4)	(9.0)	(6.1)	7.8	5.5	2.0	1.4	0.1	0.2	0.0	(0.1)	(0.2)
U.S. (Millions)	1.6	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
% Ch	(3.4)	(9.3)	(1.1)	(1.8)	(1.9)	(1.4)	0.4	0.3	(0.0)	(0.2)	(0.4)	(2.2)
Other Indicators												
Unemployment Rate (%)												
Oregon	4.1	3.8	3.9	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Point Change	(1.1)	(0.3)	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U.S.	3.6	3.6	4.0	4.1	4.3	4.4	4.3	4.3	4.3	4.3	4.3	4.3
Point Change	(1.7)	(0.0)	0.4	0.1	0.1	0.1	(0.0)	(0.0)	0.0	0.0	(0.0)	(0.0)
Industrial Production Index												
U.S, 2017 = 100	102.6	102.8	102.9	103.9	105.0	105.8	106.9	108.0	109.0	109.9	110.9	111.9
% Ch	3.4	0.2	0.1	1.0	1.0	0.8	1.0	1.0	0.9	0.8	0.9	0.9
Prime Rate (Percent)	4.9	8.2	8.1	6.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
% Ch	49.3	68.7	(1.5)	(17.2)	(13.6)	(0.3)	0.0	0.0	0.0	0.0	0.0	0.0
Population (Millions)												
Oregon	4.27	4.29	4.31	4.33	4.36	4.38	4.41	4.43	4.46	4.49	4.52	4.55
% Ch	0.1	0.5	0.4	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
U.S.	333.7	335.4	337.0	338.6	340.1	341.4	342.8	344.1	345.4	346.6	347.9	349.0
% Ch	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Timber Harvest (Mil Bd Ft)												
Oregon	3,652.0	3,677.5	3,613.4	3,643.2	3,689.2	3,738.7	3,736.6	3,724.1	3,715.2	3,708.3	3,702.6	3,701.4
% Ch	(5.9)	0.7	(1.7)	0.8	1.3	1.3	(0.1)	(0.3)	(0.2)	(0.2)	(0.2)	(0.0)

Appendix B: Revenue Forecast Detail

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Table B.1 – General Fund Revenues – 2023-25

Table B.1
General Fund Revenue Statement -- 2023-25

		Forecasts Dated: 12/1/2023			Forecasts Dated: 3/1/2024			Difference	
	Estimate at COS 2023	2023-24	2024-25	Total 2023-25	2023-24	2024-25	Total 2023-25	3/1/2024 Less 12/1/2023	3/1/2024 Less COS
Taxes									
Personal Income Taxes	21,019,693,000	8,628,483,000	12,536,136,000	21,164,619,000	8,599,084,000	12,581,007,000	21,180,091,000	15,472,000	160,398,000
Transfers & Offsets	(37,030,000)	(33,251,000)	(70,783,000)	(104,034,000)	(33,251,000)	(70,783,000)	(104,034,000)	0	(67,004,000)
Corporate Income Taxes	2,228,945,000	1,313,304,000	1,333,900,000	2,647,204,000	1,402,089,000	1,359,987,000	2,762,076,000	114,872,000	533,131,000
Transfer to Rainy Day Fund (Minimum Tax)	(91,604,000)	0	(108,595,000)	(108,595,000)	0	(98,901,000)	(98,901,000)	9,694,000	(7,297,000)
Insurance Taxes	145,011,000	50,506,000	63,934,000	114,440,000	42,628,000	74,071,000	116,699,000	2,259,000	(28,312,000)
Estate Taxes	539,732,000	272,850,000	274,280,000	547,130,000	307,850,000	275,080,000	582,930,000	35,800,000	43,198,000
Transfer to PERS UAL	0	0	0	0	0	0	0	0	0
Cigarette Taxes	43,144,000	21,459,000	21,297,000	42,756,000	19,947,000	19,996,000	39,943,000	(2,813,000)	(3,201,000)
Other Tobacco Products Taxes	61,303,000	29,310,000	28,984,000	58,294,000	27,996,000	28,627,000	56,623,000	(1,671,000)	(4,680,000)
Other Taxes	1,796,000	898,000	898,000	1,796,000	898,000	898,000	1,796,000	0	0
Fines and Fees									
State Court Fees	123,317,000	60,398,000	62,919,000	123,317,000	55,354,000	57,254,000	112,608,000	(10,709,000)	(10,709,000)
Secretary of State Fees	101,804,000	51,642,000	50,162,000	101,804,000	50,342,000	50,162,000	100,504,000	(1,300,000)	(1,300,000)
Criminal Fines & Assessments	15,514,000	7,757,000	7,757,000	15,514,000	2,095,000	2,095,000	4,190,000	(11,324,000)	(11,324,000)
Securities Fees	31,595,000	14,972,000	15,301,000	30,273,000	14,666,000	14,671,000	29,337,000	(936,000)	(2,258,000)
Central Service Charges	16,100,000	8,050,000	8,050,000	16,100,000	8,050,000	8,050,000	16,100,000	0	0
Liquor Apportionment	401,822,000	194,482,000	207,340,000	401,822,000	158,100,000	168,553,000	326,653,000	(75,169,000)	(75,169,000)
Interest Earnings	473,325,000	352,844,000	142,513,000	495,357,000	357,044,000	149,923,000	506,967,000	11,610,000	33,642,000
Miscellaneous Revenues	16,000,000	8,000,000	8,000,000	16,000,000	8,000,000	8,000,000	16,000,000	0	0
One-time Transfers	40,834,635	2,085,000	40,615,000	42,700,000	2,085,000	40,615,000	42,700,000	0	1,865,365
Gross General Fund Revenues	25,259,935,635	11,017,040,000	14,802,086,000	25,819,126,000	11,056,228,000	14,838,989,000	25,895,217,000	76,091,000	635,281,365
Total Transfers	(128,634,000)	(33,251,000)	(179,378,000)	(212,629,000)	(33,251,000)	(169,684,000)	(202,935,000)	9,694,000	(74,301,000)
Net General Fund Revenues	25,131,301,635	10,983,789,000	14,622,708,000	25,606,497,000	11,022,977,000	14,669,305,000	25,692,282,000	85,785,000	560,980,365
Plus Beginning Balance	7,493,482,790			7,636,234,556			8,082,487,603	446,253,046	589,004,812
Less Anticipated Administrative Actions*	0			0			0	0	0
Less Statutory Transfers**	(308,375,734)			(271,306,279)			(244,888,372)	26,417,907	63,487,362
Available Resources	32,316,408,692			32,971,425,278			33,529,881,231	558,455,953	1,213,472,539
Appropriations	31,873,575,550			31,873,575,550			31,873,575,550	*0*	0
Estimated Ending Balance	442,833,142			1,097,849,728			1,656,305,681	558,455,953	1,213,472,539

Notes: Corporate income tax figure includes Corporate Multistate taxes. Other taxes include General Fund portions of the Eastern Oregon Severance Tax, Western Oregon Severance Tax and Amusement Device Tax. Cigarette, Other Tobacco, and Liquor are the General Fund portions only, see Table B.6 and B.7 for more.

* The Anticipated Administrative Actions line includes items like Tax Anticipation Note borrowing costs. None of these costs are anticipated for the 2023-25 biennium.
** "Statutory Transfers" amounts to the $264.7 million Rainy Day Fund transfer and the return of $19.8 million in unexpended balance from the Department of Agriculture per SB 892 (2021 second special session). The BM 110 Transfer that was included for the Close of Session forecast is now included in the PIT "Transfers and Offsets" line. The amount of the BM 110 transfer is $2,157,766 in FY 2024 and $37,512,017 in FY 2025.

Table B.2 – General Fund Revenues by Fiscal Year

General Fund Revenue Forecast — **March 2024**

($Millions)

Fiscal Years	2021-22 Fiscal Year	2022-23 Fiscal Year	2023-24 Fiscal Year	2024-25 Fiscal Year	2025-26 Fiscal Year	2026-27 Fiscal Year	2027-28 Fiscal Year	2028-29 Fiscal Year	2029-30 Fiscal Year	2030-31 Fiscal Year	2031-32 Fiscal Year	2032-33 Fiscal Year
Taxes												
Personal Income	12,436.6	13,246.9	8,599.1	12,581.0	14,549.8	15,268.6	16,481.1	17,576.7	18,660.0	19,853.1	21,218.3	22,609.1
Film & Video, Gain Share, Industrial Lands	(26.2)	(27.4)	(33.3)	(70.8)	(32.8)	(73.5)	(35.6)	(78.1)	(30.6)	(53.4)	(8.2)	(46.9)
Corporate Excise & Income	1,538.5	1,618.5	1,402.1	1,360.0	1,495.8	1,576.3	1,623.9	1,662.6	1,707.0	1,770.0	1,845.9	1,933.9
Transfer to RDF & PERS UAL	0.0	(128.6)	0.0	(98.9)	0.0	(110.0)	0.0	(117.7)	0.0	(124.5)	0.0	0.0
Insurance	86.2	96.0	42.6	74.1	95.6	97.7	100.1	102.3	104.5	106.7	109.1	111.6
Estate	325.5	297.6	307.8	275.1	292.0	306.5	321.1	335.8	349.2	361.5	373.4	385.1
Transfer to PERS UAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cigarette	24.4	21.4	19.9	20.0	19.7	19.3	18.9	18.4	18.0	17.5	17.1	16.7
Other Tobacco Products	30.3	29.4	28.0	28.6	28.2	27.8	27.4	27.2	26.7	26.5	26.3	26.3
Other Taxes	1.0	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Other Revenues												
Licenses and Fees	111.8	113.3	122.5	124.2	126.5	125.9	127.9	127.1	128.9	128.1	129.9	129.0
Charges for Services	6.4	6.4	8.1	8.1	8.7	8.7	9.4	9.4	10.0	10.0	10.7	10.7
Liquor Apportionment	160.0	172.3	158.1	168.6	164.2	170.2	176.9	184.5	191.3	196.3	201.4	206.7
Interest Earnings	40.0	262.5	357.0	149.9	112.9	105.2	108.2	111.6	115.0	118.4	121.8	125.2
Others	103.2	50.1	10.1	48.6	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Gross General Fund	14,863.9	15,915.2	11,056.2	14,839.0	16,902.4	17,715.1	19,003.8	20,164.4	21,319.6	22,597.0	24,062.7	25,563.0
Net General Fund	14,837.7	15,759.2	11,023.0	14,669.3	16,869.6	17,531.5	18,968.2	19,968.7	21,289.0	22,419.2	24,054.5	25,516.1

Biennial Totals	2021-23 BN	Change (%)	2023-25 BN	Change (%)	2025-27 BN	Change (%)	2027-29 BN	Change (%)	2029-31 BN	Change (%)	2031-33 BN	Change (%)
Taxes												
Personal Income	25,683.5	28.4%	21,180.1	-17.5%	29,818.4	40.8%	34,057.8	14.2%	38,513.1	13.1%	43,827.3	13.8%
Corporate Excise & Income	3,157.0	60.5%	2,762.1	-12.5%	3,072.1	11.2%	3,286.5	7.0%	3,477.0	5.8%	3,779.8	8.7%
Insurance	182.3	14.5%	116.7	-36.0%	193.3	65.7%	202.4	4.7%	211.2	4.4%	220.7	4.5%
Estate Taxes	623.0	18.9%	582.9	-6.4%	598.5	2.7%	657.0	9.8%	710.7	8.2%	758.5	6.7%
Cigarette	45.8	-17.0%	39.9	-12.7%	39.0	-2.3%	37.3	-4.4%	35.5	-4.8%	33.7	-5.0%
Other Tobacco Products	59.8	-2.5%	56.6	-5.3%	56.1	-1.0%	54.6	-2.6%	53.2	-2.5%	52.5	-1.3%
Other Taxes	1.9	85.4%	1.8	-3.0%	1.8	0.0%	1.8	0.0%	1.8	0.0%	1.8	0.0%
Other Revenues												
Licenses and Fees	225.1	-9.7%	246.6	9.6%	252.4	2.3%	255.0	1.0%	257.0	0.8%	258.9	0.7%
Charges for Services	12.7	11.1%	16.1	26.3%	17.4	8.1%	18.7	7.5%	20.0	7.0%	21.3	6.5%
Liquor Apportionment	332.4	-2.5%	326.7	-1.7%	334.4	2.4%	361.3	8.0%	387.6	7.3%	408.1	5.3%
Interest Earnings	302.5	225.5%	507.0	67.6%	218.1	-57.0%	219.9	0.8%	233.4	6.2%	247.0	5.8%
Others	153.3	-17.5%	58.7	-61.7%	16.0	-72.7%	16.0	0.0%	16.0	0.0%	16.0	0.0%
Gross General Fund	30,779.1	30.1%	25,895.2	-15.9%	34,617.4	33.7%	39,168.2	13.1%	43,916.7	12.1%	49,625.7	13.0%
Net General Fund	30,596.9	30.0%	25,692.3	-16.0%	34,401.1	33.9%	38,936.9	13.2%	43,708.2	12.3%	49,570.6	13.4%

Table B.3 – Summary of 2023 Legislative Session Adjustments

	23-25	25-27	27-29	Revenue Impact Statement
Personal Income Tax Impacts (millions)				
R&D Tax Credit – HB 2009	-$0.9	-$2.0	-$2.2	HB 2009
Gain Share (5 year extension)	$0.0	-$18.1	-$36.8	
Omnibus & Tax Credits – HB 2071	-$0.30	-$30.2	-$60.4	HB 2071
Child Tax Credit – HB 3235	-$71.5	-$74.1	-$77.5	HB 3235
Opportunity Grant Tax Credit – SB 129	$5.0	$0.1	$0.0	SB 129
Wildfire Deduction – HB 2812	-$0.6	-$0.2	$0.0	HB 2812
Film Tax Credit – HB 2093	Minimal			HB 2093
Reconnect – SB 141	Minimal			SB 141
SALT Workaround – HB 2083	Minimal			HB 2083
Personal Income Tax Total	**-$68.3**	**-$124.4**	**-$177.0**	
Corporate Income Tax Impacts (millions)				
R&D Tax Credit – HB 2009	-$24.0	-$53.6	-$61.3	HB 2009
Omnibus & Tax Credits – HB 2071	-$0.4	-$3.1	-$9.0	HB 2071
Opportunity Grant Tax Credit – SB 129	$8.7	$0.2	$0.0	SB 129
Film Tax Credit – HB 2093	Minimal			HB 2093
Reconnect – SB 141	Minimal			SB 141
Corporate Income Tax Total	**-$15.7**	**-$56.5**	**-$70.3**	
Other Tax/Revenue Impacts (millions)				
Estate Tax – SB 498	-$8.0	-$15.5	-$16.4	SB 498
Criminal Fine Account, Photo Radar – HB 2095	$5.2	$8.9	$8.5	HB 2095
OLCC, Alcohol Delivery – HB 3308	$3.9	$5.7	$6.0	HB 3308
Close Wildfire Account – HB 3215	$0.2	$0.0	$0.0	HB 3215
Program Change – SB 1049	$40.6	$0.0	$0.0	SB 1049
Forestland Tax Credit – HB 2161	Minimal			HB 2161
Other Tax Total	**$42.0**	**-$0.9**	**-$1.9**	

Table B.4 – Personal Income Tax Forecast

TABLE B.4 **OREGON PERSONAL INCOME TAX REVENUE FORECAST - QUARTERLY COLLECTIONS**

Thousands of Dollars - Not Seasonally Adjusted **March 2024**

	2017:3	2017:4	2018:1	2018:2	FY 2018	2018:3	2018:4	2019:1	2019:2	FY 2019
WITHHOLDING	1,748,844	1,836,249	2,011,564	1,851,177	7,447,834	1,925,880	2,039,120	2,079,900	1,999,015	8,043,914
%CHYA	4.4%	7.7%	9.6%	4.6%	6.6%	10.1%	11.0%	3.4%	8.0%	8.0%
EST. PAYMENTS	321,032	451,037	464,534	512,671	1,749,274	367,772	284,002	321,858	532,273	1,505,905
%CHYA	6.7%	41.3%	21.5%	13.9%	20.4%	14.6%	-37.0%	-30.7%	3.8%	-13.9%
FINAL PAYMENTS	92,364	169,785	174,096	878,587	1,314,832	104,644	156,592	225,515	1,385,562	1,872,312
%CHYA	-10.9%	17.7%	-0.6%	-4.4%	-2.0%	13.3%	-7.8%	29.5%	57.7%	42.4%
REFUNDS	133,143	266,467	686,100	610,486	1,696,196	140,701	335,635	546,225	445,573	1,468,133
%CHYA	-4.1%	4.6%	19.4%	34.2%	19.2%	5.7%	26.0%	-20.4%	-27.0%	-13.4%
OTHER	(192,251)	-	-	237,300	45,049	(237,300)	-	-	222,477	(14,823)
TOTAL	1,836,845	2,190,604	1,964,094	2,869,249	8,860,793	2,020,295	2,144,078	2,081,049	3,693,754	9,939,176
%CHYA	7.7%	14.5%	8.0%	-0.2%	6.6%	10.0%	-2.1%	6.0%	28.7%	12.2%

	2019:3	2019:4	2020:1	2020:2	FY 2020	2020:3	2020:4	2021:1	2021:2	FY 2021
WITHHOLDING	2,059,715	2,223,410	2,183,444	1,997,661	8,464,230	2,127,124	2,291,161	2,321,603	2,266,779	9,006,667
%CHYA	6.9%	9.0%	5.0%	-0.1%	5.2%	3.3%	3.0%	6.3%	13.5%	6.4%
EST. PAYMENTS	413,316	296,072	376,127	428,769	1,514,284	497,544	292,601	432,742	701,877	1,924,764
%CHYA	12.4%	4.3%	16.9%	-19.4%	0.6%	20.4%	-1.2%	15.1%	63.7%	27.1%
FINAL PAYMENTS	131,560	195,074	159,708	330,328	816,671	758,710	142,228	220,765	1,500,229	2,621,931
%CHYA	25.7%	24.6%	-29.2%	-76.2%	-56.4%	476.7%	-27.1%	38.2%	354.2%	221.1%
REFUNDS	144,251	289,464	1,120,326	735,922	2,289,962	432,836	360,529	558,588	672,421	2,024,375
%CHYA	2.5%	-13.8%	105.1%	65.2%	56.0%	200.1%	24.6%	-50.1%	-8.6%	-11.6%
OTHER	(222,477)	-	-	175,167	(47,310)	(175,167)	-	-	194,880	19,713
TOTAL	2,237,864	2,425,092	1,598,954	2,196,004	8,457,914	2,775,375	2,365,460	2,416,522	3,991,345	11,548,702
%CHYA	10.8%	13.1%	-23.2%	-40.5%	-14.9%	24.0%	-2.5%	51.1%	81.8%	36.5%

	2021:3	2021:4	2022:1	2022:2	FY 2022	2022:3	2022:4	2023:1	2023:2	FY 2023
WITHHOLDING	2,393,995	2,525,865	2,611,195	2,467,726	9,998,782	2,509,729	2,641,474	2,680,227	2,569,226	10,400,656
%CHYA	12.5%	10.2%	12.5%	8.9%	11.0%	4.8%	4.6%	2.6%	4.1%	4.0%
EST. PAYMENTS	495,468	340,639	508,064	904,746	2,248,917	659,287	713,409	575,127	789,444	2,737,267
%CHYA	-0.4%	16.4%	17.4%	28.9%	16.8%	33.1%	109.4%	13.2%	-12.7%	21.7%
FINAL PAYMENTS	153,160	208,665	255,615	2,115,965	2,733,405	162,621	255,669	349,752	1,658,281	2,426,323
%CHYA	-79.8%	46.7%	15.8%	41.0%	4.3%	6.2%	22.5%	36.8%	-21.6%	-11.2%
REFUNDS	162,428	300,852	1,062,458	960,617	2,486,355	293,038	559,280	822,472	720,282	2,395,072
%CHYA	-62.5%	-16.6%	90.2%	42.9%	22.8%	80.4%	85.9%	-22.6%	-25.0%	-3.7%
OTHER	(194,880)	-	-	183,017	(11,863)	(183,017)	-	-	284,139	101,122
TOTAL	2,685,315	2,774,318	2,312,417	4,710,837	12,482,887	2,855,581	3,051,273	2,782,635	4,580,808	13,270,296
%CHYA	-3.2%	17.3%	-4.3%	18.0%	8.1%	6.3%	10.0%	20.3%	-2.8%	6.3%

	2023:3	2023:4	2024:1	2024:2	FY 2024	2024:3	2024:4	2025:1	2025:2	FY 2025
WITHHOLDING	2,622,334	2,773,397	2,796,773	2,680,120	10,872,624	2,736,499	2,897,175	2,984,293	2,810,425	11,428,391
%CHYA	4.5%	5.0%	4.3%	4.3%	4.5%	4.4%	4.5%	6.7%	4.9%	5.1%
EST. PAYMENTS	577,023	524,217	435,003	761,211	2,297,454	554,693	600,229	471,293	853,903	2,480,118
%CHYA	-12.5%	-26.5%	-24.4%	-3.6%	-16.1%	-3.9%	14.5%	8.3%	12.2%	8.0%
FINAL PAYMENTS[1]	195,731	260,845	184,060	576,503	1,217,138	113,130	164,670	270,791	1,772,944	2,321,535
%CHYA	20.4%	2.0%	-47.4%	-65.2%	-49.8%	-42.2%	-36.9%	47.1%	207.5%	90.7%
REFUNDS	339,947	574,864	2,726,115	2,156,933	5,797,859	436,638	1,010,867	1,270,209	945,610	3,663,324
%CHYA	16.0%	2.8%	231.5%	199.5%	142.1%	28.4%	75.8%	-53.4%	-56.2%	-36.8%
OTHER	(284,139)	-	-	293,865	9,726	(293,865)	-	-	308,153	14,288
TOTAL	2,771,003	2,983,595	689,721	2,154,765	8,599,084	2,673,818	2,651,207	2,456,167	4,799,815	12,581,007
%CHYA	-3.0%	-2.2%	-75.2%	-53.0%	-35.2%	-3.5%	-11.1%	256.1%	122.8%	46.3%

Note: "Other" includes July withholding accrued to June.

Tax law impacts are reflected in the collections numbers to produce more meaningful projections.

TABLE B.4 **OREGON PERSONAL INCOME TAX REVENUE FORECAST - QUARTERLY COLLECTIONS**

Thousands of Dollars - Not Seasonally Adjusted **March 2024**

	2025:3	2025:4	2026:1	2026:2	FY 2026	2026:3	2026:4	2027:1	2027:2	FY 2027
WITHHOLDING	2,869,535	3,038,020	3,126,685	2,944,196	11,978,436	3,006,123	3,182,629	3,299,971	3,110,311	12,599,035
%CHYA	4.9%	4.9%	4.8%	4.8%	4.8%	4.8%	4.8%	5.5%	5.6%	5.2%
EST. PAYMENTS	622,238	673,319	523,374	875,219	2,694,149	637,771	690,127	538,215	924,734	2,790,848
%CHYA	12.2%	12.2%	11.1%	2.5%	8.6%	2.5%	2.5%	2.8%	5.7%	3.6%
FINAL PAYMENTS[1]	178,331	288,039	317,098	1,995,504	2,778,971	191,597	311,480	318,344	1,990,251	2,811,671
%CHYA	57.6%	74.9%	17.1%	12.6%	19.7%	7.4%	8.1%	0.4%	-0.3%	1.2%
REFUNDS	211,141	458,847	1,255,187	991,255	2,916,430	229,272	497,426	1,244,287	980,170	2,951,155
%CHYA	-51.6%	-54.6%	-1.2%	4.8%	-20.4%	8.6%	8.4%	-0.9%	-1.1%	1.2%
OTHER	(308,153)	-	-	322,821	14,667	(322,821)	-	-	341,036	18,215
TOTAL	3,150,809	3,540,530	2,711,970	5,146,484	14,549,793	3,283,398	3,686,810	2,912,243	5,386,162	15,268,615
%CHYA	17.8%	33.5%	10.4%	7.2%	15.6%	4.2%	4.1%	7.4%	4.7%	4.9%

	2027:3	2027:4	2028:1	2028:2	FY 2028	2028:3	2028:4	2029:1	2029:2	FY 2029
WITHHOLDING	3,175,698	3,362,155	3,478,290	3,277,440	13,293,582	3,346,351	3,542,829	3,676,808	3,465,885	14,031,873
%CHYA	5.6%	5.6%	5.4%	5.4%	5.5%	5.4%	5.4%	5.7%	5.7%	5.6%
EST. PAYMENTS	673,852	729,171	567,686	961,813	2,932,522	700,871	758,407	589,835	990,824	3,039,937
%CHYA	5.7%	5.7%	5.5%	4.0%	5.1%	4.0%	4.0%	3.9%	3.0%	3.7%
FINAL PAYMENTS[1]	193,684	316,953	374,002	2,258,891	3,143,529	229,879	368,253	402,230	2,394,611	3,394,974
%CHYA	1.1%	1.8%	17.5%	13.5%	11.8%	18.7%	16.2%	7.5%	6.0%	8.0%
REFUNDS	228,640	492,973	1,222,368	962,887	2,906,868	225,309	484,851	1,230,476	970,148	2,910,784
%CHYA	-0.3%	-0.9%	-1.8%	-1.8%	-1.5%	-1.5%	-1.6%	0.7%	0.8%	0.1%
OTHER	(341,036)	-	-	359,361	18,325	(359,361)	-	-	380,024	20,663
TOTAL	3,473,559	3,915,306	3,197,610	5,894,616	16,481,090	3,692,432	4,184,638	3,438,397	6,261,196	17,576,663
%CHYA	5.8%	6.2%	9.8%	9.4%	7.9%	6.3%	6.9%	7.5%	6.2%	6.6%

	2029:3	2029:4	2030:1	2030:2	FY2030	2030:3	2030:4	2031:1	2031:2	FY 2031
WITHHOLDING	3,538,743	3,746,514	3,890,550	3,667,644	14,843,452	3,744,740	3,964,605	4,118,070	3,882,252	15,709,667
%CHYA	5.7%	5.7%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.9%	5.8%
EST. PAYMENTS	722,012	781,283	609,487	1,049,699	3,162,481	764,914	827,708	647,557	1,140,938	3,381,116
%CHYA	3.0%	3.0%	3.3%	5.9%	4.0%	5.9%	5.9%	6.2%	8.7%	6.9%
FINAL PAYMENTS[1]	246,183	392,090	420,818	2,495,303	3,554,394	257,586	410,285	450,268	2,670,935	3,789,074
%CHYA	7.1%	6.5%	4.6%	4.2%	4.7%	4.6%	4.6%	7.0%	7.0%	6.6%
REFUNDS	227,199	488,766	1,233,840	972,618	2,922,423	227,557	489,810	1,303,724	1,029,240	3,050,331
%CHYA	0.8%	0.8%	0.3%	0.3%	0.4%	0.2%	0.2%	5.7%	5.8%	4.4%
OTHER	(380,024)	-	-	402,146	22,122	(402,146)	-	-	425,677	23,531
TOTAL	3,899,715	4,431,121	3,687,016	6,642,174	18,660,027	4,137,537	4,712,788	3,912,170	7,090,563	19,853,058
%CHYA	5.6%	5.9%	7.2%	6.1%	6.2%	6.1%	6.4%	6.1%	6.8%	6.4%

	2031:3	2031:4	2032:1	2032:2	FY2032	2032:3	2032:4	2033:1	2033:2	FY 2033
WITHHOLDING	3,963,857	4,196,588	4,352,167	4,102,125	16,614,737	4,188,361	4,434,275	4,600,867	4,336,802	17,560,306
%CHYA	5.9%	5.9%	5.7%	5.7%	5.8%	5.7%	5.7%	5.7%	5.7%	5.7%
EST. PAYMENTS	831,400	899,651	704,704	1,253,529	3,689,283	913,445	988,431	771,908	1,340,814	4,014,598
%CHYA	8.7%	8.7%	8.8%	9.9%	9.1%	9.9%	9.9%	9.5%	7.0%	8.8%
FINAL PAYMENTS[1]	276,618	440,166	486,614	2,917,659	4,121,057	298,975	478,017	530,957	3,213,168	4,521,117
%CHYA	7.4%	7.3%	8.1%	9.2%	8.8%	8.1%	8.6%	9.1%	10.1%	9.7%
REFUNDS	239,317	517,399	1,382,713	1,091,487	3,230,917	253,037	548,081	1,514,831	1,196,751	3,512,699
%CHYA	5.2%	5.6%	6.1%	6.0%	5.9%	5.7%	5.9%	9.6%	9.6%	8.7%
OTHER	(425,677)	-	-	449,785	24,108	(449,785)	-	-	475,517	25,732
TOTAL	4,406,880	5,019,006	4,160,771	7,631,611	21,218,268	4,697,959	5,352,643	4,388,901	8,169,550	22,609,053
%CHYA	6.5%	6.5%	6.4%	7.6%	6.9%	6.6%	6.6%	5.5%	7.0%	6.6%

Note: "Other" includes July withholding accrued to June. Tax law impacts are reflected in the collections numbers to produce more meaningful projections.

Table B.5 – Corporate Income Tax Forecast

TABLE B.5 **OREGON CORPORATE INCOME TAX REVENUE FORECAST - QUARTERLY COLLECTIONS**

Thousands of Dollars - Not Seasonally Adjusted **March 2024**

	2017:3	2017:4	2018:1	2018:2	FY 2018	2018:3	2018:4	2019:1	2019:2	FY 2019
ADVANCE PAYMENTS	179,603	185,787	182,395	303,835	851,620	222,891	249,768	158,748	264,445	895,852
%CHYA	31.4%	-13.9%	77.7%	55.5%	30.9%	24.1%	34.4%	-13.0%	-13.0%	5.2%
FINAL PAYMENTS	42,600	66,460	46,270	108,539	263,869	74,735	102,942	68,818	174,861	421,356
%CHYA	-4.8%	-28.9%	-11.3%	32.6%	-3.1%	75.4%	54.9%	48.7%	61.1%	59.7%
REFUNDS	72,225	129,963	122,291	54,224	378,703	43,428	167,871	128,586	50,616	390,501
%CHYA	82.0%	-22.0%	67.4%	-6.1%	12.4%	-39.9%	29.2%	5.1%	-6.7%	3.1%
TOTAL	149,978	122,284	106,374	358,150	736,786	254,198	184,839	98,980	388,690	926,707
%CHYA	5.8%	-14.2%	30.1%	63.2%	25.8%	69.5%	51.2%	-7.0%	8.5%	25.8%

	2019:3	2019:4	2020:1	2020:2	FY 2020	2020:3	2020:4	2021:1	2021:2	FY 2021
ADVANCE PAYMENTS	236,341	346,651	137,782	263,138	983,912	260,668	378,192	249,855	381,413	1,270,128
%CHYA	6.0%	38.8%	-13.2%	-0.5%	9.8%	10.3%	9.1%	81.3%	44.9%	29.1%
FINAL PAYMENTS	67,657	105,446	66,346	111,149	350,598	114,684	98,371	78,356	263,524	554,935
%CHYA	-9.5%	2.4%	-3.6%	-36.4%	-16.8%	69.5%	-6.7%	18.1%	137.1%	58.3%
REFUNDS	73,866	247,403	91,312	86,858	499,439	62,538	254,020	154,026	153,392	623,976
%CHYA	70.1%	47.4%	-29.0%	71.6%	27.9%	-15.3%	2.7%	68.7%	76.6%	24.9%
TOTAL	230,132	204,694	112,816	287,429	835,071	312,814	222,543	174,185	491,545	1,201,087
%CHYA	-9.5%	10.7%	14.0%	-26.1%	-9.9%	35.9%	8.7%	54.4%	71.0%	43.8%

	2021:3	2021:4	2022:1	2022:2	FY 2022	2022:3	2022:4	2023:1	2023:2	FY 2023
ADVANCE PAYMENTS	356,491	494,937	288,546	416,777	1,556,751	428,034	568,160	406,675	468,642	1,871,511
%CHYA	36.8%	30.9%	15.5%	9.3%	22.6%	20.1%	14.8%	40.9%	12.4%	20.2%
FINAL PAYMENTS	56,491	96,179	115,111	261,579	529,360	72,368	50,907	83,324	304,427	511,026
%CHYA	-50.7%	-2.2%	46.9%	-0.7%	-4.6%	28.1%	-47.1%	-27.6%	16.4%	-3.5%
REFUNDS	49,631	255,602	197,775	44,052	547,060	116,377	247,875	320,324	92,796	777,372
%CHYA	-20.6%	0.6%	28.4%	-71.3%	-12.3%	134.5%	-3.0%	62.0%	110.7%	42.1%
TOTAL	363,352	335,513	205,882	634,304	1,539,051	384,025	371,192	169,675	680,273	1,605,165
%CHYA	16.2%	50.8%	18.2%	29.0%	28.1%	5.7%	10.6%	-17.6%	7.2%	4.3%

	2023:3	2023:4	2024:1	2024:2	FY 2024	2024:3	2024:4	2025:1	2025:2	FY 2025
ADVANCE PAYMENTS	378,791	584,136	317,338	409,745	1,690,010	369,467	477,028	300,561	410,159	1,557,215
%CHYA	-11.5%	2.8%	-22.0%	-12.6%	-9.7%	-2.5%	-18.3%	-5.3%	0.1%	-7.9%
FINAL PAYMENTS	106,469	77,027	126,824	271,178	581,498	109,475	133,152	232,585	315,055	790,267
%CHYA	47.1%	51.3%	52.2%	-10.9%	13.8%	2.8%	72.9%	83.4%	16.2%	35.9%
REFUNDS	63,414	297,105	351,816	157,085	869,420	104,112	363,722	352,469	167,191	987,494
%CHYA	-45.5%	19.9%	9.8%	69.3%	11.8%	64.2%	22.4%	0.2%	6.4%	13.6%
TOTAL	421,846	364,058	92,346	523,839	1,402,089	374,830	246,457	180,677	558,023	1,359,987
%CHYA	9.8%	-1.9%	-45.6%	-23.0%	-12.7%	-11.1%	-32.3%	95.7%	6.5%	-3.0%

TABLE B.5 **OREGON CORPORATE INCOME TAX REVENUE FORECAST - QUARTERLY COLLECTIONS**

Thousands of Dollars - Not Seasonally Adjusted **March 2024**

	2025:3	2025:4	2026:1	2026:2	FY 2026	2026:3	2026:4	2027:1	2027:2	FY 2027
ADVANCE PAYMENTS	379,587	522,577	327,907	446,259	1,676,331	409,590	562,522	350,312	477,176	1,799,600
%CHYA	2.7%	9.5%	9.1%	8.8%	7.6%	7.9%	7.6%	6.8%	6.9%	7.4%
FINAL PAYMENTS	109,163	265,967	234,802	326,818	936,751	104,700	261,996	235,967	332,970	935,632
%CHYA	-0.3%	99.7%	1.0%	3.7%	18.5%	-4.1%	-1.5%	0.5%	1.9%	-0.1%
REFUNDS	115,693	457,295	368,792	175,484	1,117,264	120,007	473,761	382,772	182,439	1,158,980
%CHYA	11.1%	25.7%	4.6%	5.0%	13.1%	3.7%	3.6%	3.8%	4.0%	3.7%
TOTAL	373,057	331,250	193,917	597,594	1,495,818	394,283	350,757	203,506	627,706	1,576,252
%CHYA	-0.5%	34.4%	7.3%	7.1%	10.0%	5.7%	5.9%	4.9%	5.0%	5.4%

	2027:3	2027:4	2028:1	2028:2	FY 2028	2028:3	2028:4	2029:1	2029:2	FY 2029
ADVANCE PAYMENTS	434,460	597,229	366,132	500,050	1,897,871	456,454	629,393	380,914	521,485	1,988,245
%CHYA	6.1%	6.2%	4.5%	4.8%	5.5%	5.1%	5.4%	4.0%	4.3%	4.8%
FINAL PAYMENTS	99,573	261,359	235,630	330,932	927,493	92,564	257,046	236,711	328,797	915,117
%CHYA	-4.9%	-0.2%	-0.1%	-0.6%	-0.9%	-7.0%	-1.7%	0.5%	-0.6%	-1.3%
REFUNDS	125,056	494,283	393,980	188,151	1,201,470	129,142	511,568	405,907	194,119	1,240,735
%CHYA	4.2%	4.3%	2.9%	3.1%	3.7%	3.3%	3.5%	3.0%	3.2%	3.3%
TOTAL	408,977	364,305	207,782	642,831	1,623,894	419,875	374,871	211,718	656,163	1,662,627
%CHYA	3.7%	3.9%	2.1%	2.4%	3.0%	2.7%	2.9%	1.9%	2.1%	2.4%

	2029:3	2029:4	2030:1	2030:2	FY 2030	2030:3	2030:4	2031:1	2031:2	FY 2031
ADVANCE PAYMENTS	476,929	658,980	399,978	548,530	2,084,417	502,643	695,527	424,055	581,104	2,203,328
%CHYA	4.5%	4.7%	5.0%	5.2%	4.8%	5.4%	5.5%	6.0%	5.9%	5.7%
FINAL PAYMENTS	85,933	254,488	238,649	328,912	907,982	79,588	252,985	242,951	331,739	907,262
%CHYA	-7.2%	-1.0%	0.8%	0.0%	-0.8%	-7.4%	-0.6%	1.8%	0.9%	-0.1%
REFUNDS	133,441	529,358	420,995	201,640	1,285,435	138,807	551,270	439,989	210,483	1,340,549
%CHYA	3.3%	3.5%	3.7%	3.9%	3.6%	4.0%	4.1%	4.5%	4.4%	4.3%
TOTAL	429,421	384,110	217,632	675,801	1,706,964	443,423	397,243	227,017	702,359	1,770,042
%CHYA	2.3%	2.5%	2.8%	3.0%	2.7%	3.3%	3.4%	4.3%	3.9%	3.7%

	2031:3	2031:4	2032:1	2032:2	FY 2032	2032:3	2032:4	2033:1	2033:2	FY 2033
ADVANCE PAYMENTS	528,094	724,067	437,290	594,150	2,283,600	540,259	741,262	446,985	608,866	2,337,372
%CHYA	5.1%	4.1%	3.1%	2.2%	3.6%	2.3%	2.4%	2.2%	2.5%	2.4%
FINAL PAYMENTS	77,372	256,924	247,070	353,181	934,547	88,513	267,450	254,415	377,908	988,286
%CHYA	-2.8%	1.6%	1.7%	6.5%	3.0%	14.4%	4.1%	3.0%	7.0%	5.8%
REFUNDS	143,874	567,056	448,089	213,246	1,372,266	145,819	575,040	454,528	216,359	1,391,746
%CHYA	3.7%	2.9%	1.8%	1.3%	2.4%	1.4%	1.4%	1.4%	1.5%	1.4%
TOTAL	461,592	413,935	236,270	734,085	1,845,882	482,954	433,672	246,871	770,415	1,933,912
%CHYA	4.1%	4.2%	4.1%	4.5%	4.3%	4.6%	4.8%	4.5%	4.9%	4.8%

Table B.6 – Cigarette and Tobacco Tax Distribution

TABLE B.6 March 2024

Cigarette & Tobacco Tax Distribution (Millions of $)

	Cigarette Tax Distribution*								Other Tobacco Tax Distribution				Inhalent Delivery Distribution		
						Tobacco Use Reduction[2]									
	Total	General Fund	Health Plan	Mental Health	Health Authority[1]	Old	New	Cities, Counties & Public Transit	Total	General Fund	Health Plan	Tobacco Use Reduction	Total	Health Authority	Tobacco Use Reduction
Distribution Forecast															
2021-22	363.6	24.4	93.0	16.3	197.1	3.7	21.7	7.4	56.5	30.3	23.5	2.6	35.9	32.3	3.6
2022-23	328.0	21.4	84.5	14.8	177.5	3.4	19.7	6.7	55.0	29.4	23.0	2.6	31.9	28.7	3.2
2021-23 Biennium	691.6	45.8	177.5	31.1	374.6	7.1	41.4	14.2	111.5	59.8	46.6	5.2	67.8	61.0	6.8
2023-24	301.9	19.9	77.7	13.6	163.2	3.1	18.1	6.2	52.0	28.0	21.6	2.4	31.0	27.9	3.1
2024-25	302.7	20.0	77.9	13.6	163.6	3.1	18.2	6.2	53.2	28.6	22.1	2.5	30.2	27.1	3.0
2023-25 Biennium	604.6	39.9	155.7	27.2	326.8	6.2	36.3	12.4	105.2	56.6	43.7	4.9	61.2	55.0	6.1
2025-26	298.6	19.7	76.9	13.5	161.4	3.1	17.9	6.1	52.4	28.2	21.8	2.4	30.4	27.4	3.0
2026-27	292.0	19.3	75.2	13.2	157.9	3.0	17.5	6.0	51.7	27.8	21.5	2.4	30.7	27.6	3.1
2025-27 Biennium	590.7	39.0	152.1	26.6	319.3	6.1	35.5	12.1	104.1	56.1	43.3	4.8	61.1	55.0	6.1
2027-28	285.8	18.9	73.6	12.9	154.5	2.9	17.2	5.9	51.0	27.4	21.2	2.4	30.9	27.8	3.1
2028-29	279.2	18.4	71.9	12.6	150.9	2.9	16.8	5.7	50.5	27.2	21.0	2.3	31.2	28.0	3.1
2027-29 Biennium	565.0	37.3	145.5	25.4	305.4	5.8	33.9	11.6	101.5	54.6	42.1	4.7	62.1	55.9	6.2
2029-30	272.2	18.0	70.1	12.3	147.1	2.8	16.3	5.6	49.6	26.7	20.6	2.3	31.4	28.3	3.1
2030-31	265.5	17.5	68.4	12.0	143.5	2.7	15.9	5.5	49.2	26.5	20.5	2.3	31.6	28.5	3.2
2029-31 Biennium	537.7	35.5	138.5	24.2	290.7	5.5	32.3	11.0	98.9	53.2	41.1	4.6	63.0	56.7	6.3
2031-32	258.5	17.1	66.6	11.6	139.7	2.7	15.5	5.3	48.8	26.3	20.3	2.3	31.9	28.7	3.2
2032-33	252.2	16.7	64.9	11.4	136.3	2.6	15.1	5.2	48.8	26.3	20.3	2.3	32.1	28.9	3.2
2031-33 Biennium	510.7	33.7	131.5	23.0	276.1	5.2	30.7	10.5	97.6	52.5	40.5	4.5	64.0	57.6	6.4

[1] Includes the cigarette floor tax

[2] Old and New refere to pre- and post-Measure 108 (2020) taxes and programs

Table B.7 – Liquor Apportionment and Revenue Distribution to Local Government

TABLE B.7 **March 2024**

Liquor Apportionment and Revenue Distribution to Local Governments (Millions of $)

	Liquor Apportionment Distribution								
					City Revenue				
	Total Liquor Revenue Available	General Fund (56%)	Mental Health [1]	Oregon Wine Board	Revenue Sharing	Regular	Total	Counties	Cigarette Tax Distribution [2]
2021-22	311.292	176.701	10.675	0.359	56.163	39.314	95.476	28.081	7.419
2022-23	325.841	186.102	8.430	0.307	59.546	41.682	101.229	29.773	6.742
2021-23 Biennium	637.133	362.804	19.104	0.666	115.709	80.996	196.705	57.854	14.161
2023-24	277.556	158.100	9.824	0.361	49.669	34.768	84.437	24.834	6.202
2024-25	295.907	168.553	10.473	0.384	52.953	37.067	90.020	26.476	6.217
2023-25 Biennium	573.463	326.654	20.297	0.745	102.621	71.835	174.456	51.311	12.418
2025-26	282.541	164.242	11.516	0.429	58.658	41.060	73.708	32.647	6.134
2026-27	293.718	170.173	11.826	0.443	60.776	42.543	76.910	34.366	5.999
2025-27 Biennium	576.260	334.415	23.342	0.872	119.434	83.604	150.617	67.014	12.133
2027-28	306.348	176.852	12.168	0.458	63.161	44.213	80.541	36.328	5.870
2028-29	320.523	184.471	12.518	0.474	65.883	46.118	84.589	38.471	5.735
2027-29 Biennium	626.871	361.323	24.687	0.933	129.044	90.331	165.130	74.799	11.604
2029-30	334.341	191.331	12.930	0.493	68.333	47.833	88.710	40.877	5.591
2030-31	345.784	196.313	13.330	0.511	70.112	49.078	92.354	43.276	5.454
2029-31 Biennium	680.125	387.644	26.260	1.003	138.444	96.911	181.064	84.153	11.045

[1] Mental Health Alcoholism and Drug Services Account, per ORS 471.810

[2] For details on cigarette revenues see TABLE B.6 on previous page

Table B.8 Track Record for the December 2023 Forecast

(Quarter ending December 31, 2023)

Personal Income Tax	Forecast Comparison			Year/Year Change	
(Millions of dollars)	Actual Revenues	Latest Forecast	Percent Difference	Prior Year	Percent Change
Withholding	$2,773.4	$2,699.6	2.7%	$2,641.5	5.0%
Dollar difference		$73.8			
Estimated Payments*	$524.2	$312.8	67.6%	$713.4	-26.5%
Dollar difference		$211.4			
Final Payments*	$260.8	$241.5	8.0%	$255.7	2.0%
Dollar difference		$19.4			
Refunds	-$574.9	-$352.6	63.1%	-$559.3	2.8%
Dollar difference		-$222.3			
Total Personal Income Tax	**$2,983.6**	**$2,901.4**	**2.8%**	**$3,051.3**	**-2.2%**
Dollar difference		$82.2			

Corporate Income Tax	Forecast Comparison			Year/Year Change	
(Millions of dollars)	Actual Revenues	Latest Forecast	Percent Difference	Prior Year	Percent Change
Advanced Payments	$584.1	$524.0	11.5%	$568.2	2.8%
Dollar difference		$60.1			
Final Payments	$77.0	$80.8	-4.6%	$50.9	51.3%
Dollar difference		-$3.7			
Refunds	-$297.1	-$359.5	-17.4%	-$247.9	19.9%
Dollar difference		$62.4			
Total Corporate Income Tax	**$364.1**	**$245.2**	**48.5%**	**$371.2**	**-1.9%**
Dollar difference		$118.8			

Total Income Tax	Forecast Comparison			Year/Year Change	
(Millions of dollars)	Actual Revenues	Latest Forecast	Percent Difference	Prior Year	Percent Change
Corporate and Personal Tax	**$3,347.7**	**$3,146.6**	**6.4%**	**$3,422.5**	**-2.2%**
Dollar difference		$201.1		-$74.8	

* Data separating estimated and other personal income tax payments is no longer available. Tracking represents estimates based on banking data.

Table B.9 – Lottery Forecast

TABLE B.9 **Mar 2024 Forecast**

Summary of Lottery Resources

(in millions of dollars)	2023-25 Current Forecast	2023-25 Change from Dec-23	2023-25 Change from COS 2023	2025-2027 Current Forecast	2025-2027 Change from Dec-23	2027-29 Current Forecast	2027-29 Change from Dec-23	2029-31 Current Forecast	2029-31 Change from Dec-23	2031-33 Current Forecast	2031-33 Change from Dec-23
LOTTERY EARNINGS											
Traditional Lottery	189.708	*2.679*	*26.012*	166.435	*0.983*	167.737	2.538	166.487	1.317	165.896	0.707
Video Lottery	1,592.029	*(15.793)*	*(32.956)*	1,743.378	*(3.924)*	1,913.441	19.820	2,048.909	21.220	2,203.540	31.849
Sports Betting[1]	52.636	*6.032*	*8.321*	60.066	*11.092*	64.159	12.741	66.836	13.145	69.593	13.529
Administrative Actions	9.152	*0.000*	*9.152*	0.000	*0.000*	0.000	0.000	0.000	0.000	0.000	0.000
Total Available to Transfer	1,843.524	*(7.081)*	*10.529*	1,969.879	*8.151*	2,145.337	35.099	2,282.232	35.683	2,439.030	46.084
ECONOMIC DEVELOPMENT FUND											
Beginning Balance	84.396	*0.000*	*0.000*	0.000	*0.000*	0.000	0.000	0.000	0.000	0.000	0.000
Transfers from Lottery	1,843.524	*(7.081)*	*10.529*	1,969.879	*8.151*	2,145.337	35.099	2,282.232	35.683	2,439.030	46.084
Other Resources[2]	7.685	*5.685*	*5.685*	2.000	*0.000*	2.000	0.000	2.000	0.000	2.000	0.000
Total Available Resources	1,935.605	*(1.396)*	*16.215*	1,971.879	*8.151*	2,147.337	35.099	2,284.232	35.683	2,441.030	46.084
ALLOCATION OF RESOURCES											
Constitutional Distributions											
Education Stability Fund[3]	331.834	*0.180*	*1.895*	174.411	43.602	386.161	5.031	254.662	(99.022)	380.008	3.334
Oregon Capital Matching Fund[3]	0.000	*0.000*	*0.000*	150.139	(35.929)	0.000	0.000	130.117	86.752	0.000	0.000
Parks and Natural Resources Fund[4]	276.529	*(1.062)*	*1.579*	295.482	1.223	321.801	5.265	342.335	5.352	365.854	6.913
Veterans' Services Fund[5]	27.653	*(0.106)*	*0.158*	29.548	0.122	32.180	0.526	34.233	0.535	36.585	0.691
Other Distributions											
Outdoor School Education Fund[6]	56.406	*0.000*	*0.000*	59.736	(0.798)	62.608	(2.397)	65.627	(4.180)	68.730	(6.233)
County Economic Development	59.982	*0.000*	*0.000*	66.841	(0.150)	73.361	0.760	78.555	0.814	84.484	1.221
HECC Collegiate Athletic & Scholarships[7]	18.330	*0.000*	*0.000*	19.699	0.082	21.453	0.351	22.822	0.357	24.390	0.461
Gambling Addiction [7]	18.330	*0.000*	*0.000*	19.699	0.082	21.453	0.351	22.822	0.357	24.390	0.461
County Fairs	3.828	*0.000*	*0.000*	3.828	0.000	3.828	0.000	3.828	0.000	3.828	0.000
Other Legislatively Adopted Allocations[8]	1,061.945	*0.000*	*0.000*	322.982	88.682	266.266	31.966	215.497	(18.803)	165.921	(68.379)
Employer Incentive Fund (PERS)[1]	28.186	*(2.375)*	*0.000*	40.259	7.276	42.024	8.377	44.540	9.197	47.268	9.279
Total Distributions	1,883.023	*(3.364)*	*3.633*	1,182.624	104.191	1,231.136	50.230	1,215.038	(18.642)	1,201.459	(52.252)
Ending Balance/Discretionary Resources	52.582	*1.968*	*12.582*	789.255	(96.040)	916.202	(15.130)	1,069.195	54.324	1,239.571	98.336

Note: Some totals may not foot due to rounding.

1. Sports Betting revenues are transferred to Economic Development Fund making them subject to the constitutional distributions, after which the remainder is transferred to the Employer Incentive Fund
2. Includes reversions (unspent allocations from previous biennium) and interest earnings on Economic Development Fund.
3. Eighteen percent of proceeds accrue to the Ed. Stability Fund, until the balance equals 5% of GF Revenues. Thereafter, 15% of proceeds accrue to the School Capital Matching Fund.
4. The Parks and Natural Resources Fund Constitutional amendment requires 15% of net proceeds be transferred to this fund.
5. Per Ballot Measure 96 (2016), 1.5% of net lottery proceeds are dedicated to the Veterans' Services Fund
6. Per Ballot Measure 99 (2016), the lesser of 4% of Lottery transfers or $22 million per year is transferred to the Outdoor Education Account. Adjusted annually for inflation.
7. Approximately one percent of net lottery proceeds are dedicated to each program. Certain limits are imposed by the Legislature.
8. Includes Debt Service Allocations, Allocations to State School Fund and Other Agency Allocations

Table B.10 –Budgetary Reserve Summary

Table B.10: Budgetary Reserve Summary and Outlook **Mar 2024**

Rainy Day Fund

(Millions)	2021-23	2023-25	2025-27	2027-29	2029-31	2031-33
Beginning Balance	$962.2	$1,353.5	$1,859.5	$2,413.9	$3,037.4	$3,335.9
Interest Earnings	$44.1	$142.4	$125.7	$152.5	$174.0	$191.1
Deposits[1]	$347.2	$363.6	$428.7	$471.0	$124.5	$0.0
Triggered Withdrawals	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Ending Balance[2]	**$1,353.4**	**$1,859.5**	**$2,413.9**	**$3,037.4**	**$3,335.9**	**$3,526.9**

Education Stability Fund[3]

(Millions)	2021-23	2023-25	2025-27	2027-29	2029-31	2031-33
Beginning Balance	$414.6	$710.8	$1,007.0	$1,164.0	$1,511.6	$1,740.8
Interest Earnings[4]	$21.9	$81.0	$67.1	$75.6	$94.4	$105.6
Deposits[5]	$294.0	$298.7	$157.0	$347.5	$229.2	$342.0
Distributions	$19.8	$83.4	$67.1	$75.6	$94.4	$210.7
Oregon Education Fund	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Oregon Opportunity Grant	$19.8	$83.4	$67.1	$75.6	$94.4	$210.7
Withdrawals	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Ending Balance	**$710.8**	**$1,007.0**	**$1,164.0**	**$1,511.6**	**$1,740.8**	**$1,977.7**

Total Reserves

(Millions)	2021-23	2023-25	2025-27	2027-29	2029-31	2031-33
Ending Balances	**$2,064.2**	**$2,866.5**	**$3,577.9**	**$4,548.9**	**$5,076.6**	**$5,504.6**
Percent of General Fund Revenues	6.7%	11.2%	10.4%	11.7%	11.6%	11.1%

Footnotes:

1. Includes transfer of ending General Fund balances up to 1% of budgeted appropriations as well as private donations. Assumes future appropriations equal to 98.75 percent of available resources. Includes forecast for corporate income taxes above rate of 6.6% for the biennium are deposited on or before Jun 30 of each odd-numbered year.
2. Available funds in a given biennium equal 2/3rds of the beginning balance under current law.
3. Excludes funds in the Oregon Growth and the Oregon Resource and Technology Development subaccounts.
4. Interest earnings are distributed to the Oregon Education Funds (75%) and the State Scholarship Fund (25%), provided there remains debt outstanding. In the event that debt is paid off, all interest earnings distributed to the State Scholarship Fund.
5. Contributions to the ESF are capped at 5% of the prior biennium's General Fund revenue total. Quarterly contributions are made until the balance exceeds the cap.

Table B.11 – Recreational Marijuana Forecast

TABLE B.11 **Mar 2024**

Summary of Marijuana Resources

(in millions of dollars)	2023-25 Current Forecast	2023-25 *Change from Dec-23*	2023-25 *Change from COS 2023*	2025-27 Current Forecast	2025-27 *Change from Dec-23*	2027-29 Current Forecast	2027-29 *Change from Dec-23*	2029-31 Current Forecast	2029-31 *Change from Dec-23*	20231-33 Current Forecast	20231-33 *Change from Dec-23*
MARIJUANA EARNINGS											
+ Tax Revenue [1]	311.075	*(6.997)*	*(5.786)*	349.667	*(6.332)*	404.491	(6.362)	460.488	(7.333)	508.867	(8.671)
+ Medical Marijuana Tax Revenue [2]	0.000	*0.000*	*0.000*	0.000	*0.000*	31.817	0.000	43.625	0.000	45.041	0.000
- Administrative Costs [3]	18.374	*0.000*	*0.000*	18.746	*0.000*	19.144	0.000	19.571	0.000	20.027	0.000
Net Available to Transfer	292.701	*(6.997)*	*(5.786)*	330.921	*(6.332)*	385.347	*(6.362)*	484.543	*(7.333)*	533.881	*(8.671)*
OREGON MARIJUANA ACCOUNT											
Beginning Balance	0.000	*0.000*	*0.000*	0.000	*0.000*	0.000	0.000	0.000	0.000	0.000	0.000
Revenue Transfers	292.701	*(6.997)*	*(5.786)*	330.921	*(6.332)*	417.164	(6.362)	484.543	(7.333)	533.881	(8.671)
Other Resources	0.000	*0.000*	*0.000*	0.000	*0.000*	0.000	0.000	0.000	0.000	0.000	0.000
Total Available Resources	292.701	*(6.997)*	*(5.786)*	330.921	*(6.332)*	417.164	*(6.362)*	484.543	*(7.333)*	533.881	*(8.671)*
ALLOCATION OF RESOURCES [4]											
Drug Treatment & Recovery	190.824	*(6.997)*	*(5.786)*	222.774	*(6.332)*	304.223	(6.362)	366.562	(7.333)	410.659	(8.671)
State School Fund	40.751	*0.000*	*0.000*	43.259	*0.000*	45.176	0.000	47.192	0.000	49.289	0.000
Mental Health, Alcoholism, & Drug Services	20.375	*0.000*	*0.000*	21.629	*0.000*	22.588	0.000	23.596	0.000	24.644	0.000
State Police	15.281	*0.000*	*0.000*	16.222	*0.000*	16.941	0.000	17.697	0.000	18.483	0.000
Cities	10.188	*0.000*	*0.000*	10.815	*0.000*	11.294	0.000	11.798	0.000	12.322	0.000
Counties	10.188	*0.000*	*0.000*	10.815	*0.000*	11.294	0.000	11.798	0.000	12.322	0.000
Alcohol & Drug Abuse Prevention, Intervention & Treatment	5.094	*0.000*	*0.000*	5.407	*0.000*	5.647	0.000	5.899	0.000	6.161	0.000
Total Distributions	292.701	*(6.997)*	*(5.786)*	330.921	*(6.332)*	417.164	*(6.362)*	484.543	*(7.333)*	533.881	*(8.671)*
Ending Balance	0.000	*0.000*	*0.000*	0.000	*0.000*	0.000	0.000	0.000	0.000	0.000	0.000

Note: Some totals may not foot due to rounding.

1. Retailers pay taxes monthly, however taxes are not available for distribution to recepient programs until the Department of Revenue receives and processes retailers' quarterly tax returns. As such, there is a one to two quarter lag between when the initial monthly payments are made and when monies be come available to distribute.

2. Medical marijuana being exempt from tax is an explicit tax expenditure per HB 2433 (2021). Tax expenditures sunset after 6 years, although they may be renewed at that time. Current law is that medical marijuana sales will be taxed beginning January 1, 2028.

3. Administrative Costs reflect monthly collection costs for the Department of Revenue in addition to distributions to the Criminal Justice Commission and OLCC per SB 1544 (2018)

4. The first $11.25 million per quarter ($45m per year) is distributed via forumula to the initial recipient programs. These distributions are adjusted for inflation. All additional revenues go to the Drug Treatment & Recovery Fund.

Table B.12 – Fund for Student Success (Corporate Activity Tax)

TABLE B.12 **March 2024**

Summary of Corporate Activity Tax Resources

(in millions of dollars)	2023-25 Current Forecast	2023-25 *Change from Dec-23*	2023-25 *Change from COS 2023*	2025-27 Current Forecast	2025-27 *Change from Dec-23*	2027-29 Current Forecast	2027-29 *Change from Dec-23*	2029-31 Current Forecast	2029-31 *Change from Dec-23*	2031-33 Current Forecast	2031-33 *Change from Dec-23*
Corporate Activity Tax											
+ Tax Revenue	2,814.622	43.445	*35.525*	3,211.118	102.465	3,592.901	*115.421*	4,007.320	*128.780*	4,465.852	*143.498*
- Administrative Costs	21.312	0.000	*0.000*	23.656	0.000	26.259	*0.000*	28.689	*0.000*	31.234	*0.000*
Net Available to Transfer	2,793.310	43.445	35.525	3,187.462	102.465	3,566.643	115.421	3,978.632	128.780	4,434.619	143.498
Fund for Student Success											
Beginning Balance	326.038	(18.967)	*7.511*	161.719	(35.553)	0.000	*0.000*	0.000	*0.000*	0.000	*0.000*
Revenue Transfers	2,793.310	43.445	*35.525*	3,187.462	102.465	3,566.643	*115.421*	3,978.632	*128.780*	4,434.619	*143.498*
Other Resources	0.000	0.000	*0.000*	0.000	0.000	0.000	*0.000*	0.000	*0.000*	0.000	*0.000*
Total Available Resources	3,119.349	24.477	43.036	3,349.181	66.912	3,566.643	115.421	3,978.632	128.780	4,434.619	143.498
ALLOCATION OF RESOURCES											
State School Fund	783.271	60.030	*81.317*	822.032	16.166	896.732	*(14.628)*	977.466	*(48.597)*	1,063.727	*(89.094)*
Student Investment Account	1,087.179	0.000	*0.000*	1,263.574	25.373	1,334.955	*65.024*	1,500.583	*88.688*	1,685.446	*116.296*
Statewide Education Initiative Account	557.396	0.000	*0.000*	758.145	15.224	800.973	*39.015*	900.350	*53.213*	1,011.268	*69.777*
Early Learning Account	529.783	0.000	*0.000*	505.430	10.149	533.982	*26.010*	600.233	*35.475*	674.178	*46.518*
Total Distributions	2,957.629	60.030	81.317	3,349.181	66.912	3,566.643	115.421	3,978.632	128.780	4,434.619	143.498
Ending Balance	161.719	(35.553)	(38.281)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: The State School Fund distribution equals an estimate of the lost General Fund due to the Personal and Corporate Income Tax changes enacted in HB 3427. In addition, each biennium includes an additional $40 million dedicated to the High Cost Disabilities Account. The 2021-23 distribution equals the Legislatively Adopted Budget Other Fund limitation. The 2023-25 distribution includes a $30.46 million reconciling adjustment for the prior biennium.
Some totals may not foot due to rounding.

Table B.13 – Fund for Student Success Quarterly Revenues

Table B.13 **Corporate Activity Tax Collections By Quarter** **Mar-24**

(thousands)	2019:3	2019:4	2020:1	2020:2	FY 2020	2020:3	2020:4	2021:1	2021:2	FY 2021
Estimated Payments	0	0	4,023	222,495	226,518	224,973	254,387	223,550	270,784	973,693
Final Payments	0	0	0	0	0	0	0	26,911	163,436	190,348
Refunds	0	0	0	0	0	0	0	-997	-14,657	-15,654
Total	0	0	4,023	222,495	226,518	224,973	254,387	249,464	419,563	1,148,387

	2021:3	2021:4	2022:1	2022:2	FY 2022	2022:3	2022:4	2023:1	2023:2	FY 2023
Estimated Payments	271,858	389,810	230,942	279,349	1,171,959	292,325	391,140	251,283	285,645	1,220,391
Final Payments	15,153	41,892	41,950	168,644	267,640	59,490	75,201	65,187	173,094	372,971
Refunds	-16,356	-141,389	-15,151	-50,166	-223,062	-41,565	-170,978	-21,976	-20,314	-254,833
Total	270,656	290,314	257,741	397,828	1,216,538	310,249	295,362	294,493	438,425	1,338,529

	2023:3	2023:4	2024:1	2024:2	FY 2024	2024:3	2024:4	2025:1	2025:2	FY 2025
Estimated Payments	288,689	316,988	260,110	303,757	1,169,545	294,946	402,636	270,049	321,593	1,289,224
Final Payments	41,981	53,324	53,406	177,703	326,414	40,449	48,123	56,802	190,458	335,833
Refunds	-29,313	-56,912	-29,551	-24,343	-140,120	-33,865	-79,564	-28,569	-24,275	-166,273
Total	301,356	313,400	283,966	457,117	1,355,839	301,530	371,195	298,282	487,777	1,458,783

	2025:3	2025:4	2026:1	2026:2	FY 2026	2026:3	2026:4	2027:1	2027:2	FY 2027
Estimated Payments	313,004	428,145	287,318	341,142	1,369,610	332,143	454,070	304,687	361,132	1,452,032
Final Payments	43,279	51,590	60,663	202,799	358,331	46,114	54,928	64,394	214,967	380,403
Refunds	-33,930	-80,842	-29,251	-25,456	-169,479	-35,707	-85,954	-31,107	-27,012	-179,780
Total	322,353	398,894	318,731	518,485	1,558,462	342,550	423,044	337,974	549,088	1,652,656

	2027:3	2027:4	2028:1	2028:2	FY 2028	2028:3	2028:4	2029:1	2029:2	FY 2029
Estimated Payments	351,243	480,104	322,101	381,598	1,535,046	371,144	507,280	340,299	402,979	1,621,704
Final Payments	48,896	58,221	68,147	227,317	402,581	51,714	61,564	72,022	240,189	425,489
Refunds	-37,876	-91,091	-32,953	-28,579	-190,499	-40,067	-96,312	-34,837	-30,203	-201,419
Total	362,263	447,234	357,294	580,336	1,747,127	382,791	472,533	377,484	612,966	1,845,774

	2029:3	2029:4	2030:1	2030:2	FY 2030	2030:3	2030:4	2031:1	2031:2	FY 2031
Estimated Payments	391,924	535,656	359,326	425,503	1,712,409	413,891	565,654	379,489	449,484	1,808,518
Final Payments	54,645	65,050	76,068	253,629	449,391	57,705	68,689	80,319	267,802	474,516
Refunds	-42,341	-101,762	-36,804	-31,898	-212,804	-44,715	-107,452	-38,861	-33,680	-224,709
Total	404,228	498,944	398,590	647,234	1,948,996	426,882	526,891	420,947	683,605	2,058,325

	2031:3	2031:4	2032:1	2032:2	FY 2032	2032:3	2032:4	2033:1	2033:2	FY 2033
Estimated Payments	437,165	597,478	400,781	474,290	1,909,713	461,252	630,339	422,711	499,618	2,013,920
Final Payments	60,930	72,527	84,826	282,864	501,148	64,355	76,607	89,534	298,436	528,933
Refunds	-47,214	-113,456	-41,035	-35,571	-237,277	-49,866	-119,840	-43,336	-37,541	-250,584
Total	450,881	556,549	444,572	721,582	2,173,584	475,741	587,106	468,908	760,513	2,292,268

Appendix C: Population Forecast Detail

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Table C.1 Oregon's Population Forecasts and Component of Change 1990-2033

Year (July 1)	Population	Population Change Number	Percent	Births Number	Rate/1000	Deaths Number	Rate/1000	Natural Increase	Net Migration Number	Rate/1000
1989-1990	2,860,400	69,800	2.50	42,008	14.87	24,763	8.76	17,245	52,555	18.60
1985-1990		**187,800**		**199,810**		**121,318**		**78,492**	**109,308**	
1990-1991	2,928,500	68,100	2.38	42,682	14.75	24,944	8.62	17,738	50,362	17.40
1991-1992	2,991,800	63,300	2.16	42,427	14.33	25,166	8.50	17,261	46,039	15.55
1992-1993	3,060,400	68,600	2.29	41,442	13.69	26,543	8.77	14,899	53,701	17.75
1993-1994	3,121,300	60,900	1.99	41,487	13.42	27,564	8.92	13,923	46,977	15.20
1994-1995	3,184,400	63,100	2.02	42,426	13.46	27,552	8.74	14,874	48,226	15.30
1990-1995		**324,000**		**210,464**		**131,769**		**78,695**	**245,305**	
1995-1996	3,247,100	62,700	1.97	43,196	13.43	28,768	8.95	14,428	48,272	15.01
1996-1997	3,304,300	57,200	1.76	43,625	13.32	29,201	8.91	14,424	42,776	13.06
1997-1998	3,352,400	48,100	1.46	44,696	13.43	28,705	8.62	15,991	32,109	9.65
1998-1999	3,393,900	41,500	1.24	45,188	13.40	29,848	8.85	15,340	26,160	7.76
1999-2000	3,431,100	37,200	1.10	45,534	13.34	28,909	8.47	16,625	20,575	6.03
1995-2000		**246,700**		**222,239**		**145,431**		**76,808**	**169,892**	
2000-2001	3,470,400	39,300	1.15	45,536	13.20	29,934	8.67	15,602	23,698	6.87
2001-2002	3,502,600	32,200	0.93	44,995	12.91	30,828	8.84	14,167	18,033	5.17
2002-2003	3,538,600	36,000	1.03	45,686	12.98	30,604	8.69	15,082	20,918	5.94
2003-2004	3,578,900	40,300	1.14	45,599	12.81	30,721	8.63	14,878	25,422	7.14
2004-2005	3,626,900	48,000	1.34	45,892	12.74	30,717	8.53	15,175	32,825	9.11
1995-2000		**195,800**		**227,708**		**152,804**		**74,904**	**120,896**	
2005-2006	3,685,200	58,300	1.61	46,946	12.84	30,771	8.42	16,175	42,125	11.52
2006-2007	3,739,400	54,200	1.47	49,404	13.31	31,396	8.46	18,008	36,192	9.75
2007-2008	3,784,200	44,800	1.20	49,659	13.20	32,008	8.51	17,651	27,149	7.22
2008-2009	3,815,800	31,600	0.84	47,960	12.62	31,382	8.26	16,578	15,022	3.95
2009-2010	3,837,300	21,500	0.56	46,256	12.09	31,689	8.28	14,567	6,933	1.81
2005-2010		**210,400**		**240,225**		**157,246**		**82,979**	**127,421**	
2010-2011	3,854,500	17,200	0.45	45,381	11.80	32,437	8.43	12,944	4,256	1.11
2011-2012	3,878,200	23,700	0.61	44,897	11.61	32,804	8.48	12,093	11,607	3.00
2012-2013	3,910,900	32,700	0.84	44,969	11.55	33,168	8.52	11,801	20,899	5.37
2013-2014	3,952,000	41,100	1.05	45,447	11.56	33,731	8.58	11,716	29,384	7.47
2014-2015	4,000,400	48,400	1.22	45,660	11.48	35,318	8.88	10,342	38,058	9.57
2010-2015		**163,100**		**226,354**		**167,458**		**58,896**	**104,204**	
2015-2016	4,060,100	59,700	1.49	45,647	11.33	35,339	8.77	10,308	49,392	12.26
2016-2017	4,122,000	61,900	1.52	44,602	10.90	36,773	8.99	7,829	54,071	13.22
2017-2018	4,173,200	51,200	1.24	42,906	10.34	36,268	8.74	6,638	44,562	10.74
2018-2019	4,211,400	38,200	0.92	42,220	10.07	36,622	8.74	5,598	32,602	7.78
2019-2020	4,243,959	32,559	0.77	40,920	9.68	37,821	8.95	3,099	29,460	6.97
2015-2020		**243,559**		**216,295**		**182,823**		**33,472**	**210,087**	
2020-2021	4,263,581	19,622	0.46	39,654	9.32	41,893	9.85	-2,239	21,861	5.14
2021-2022	4,269,529	5,948	0.14	40,446	9.48	46,351	10.86	-5,905	11,853	2.78
2022-2023	4,291,525	21,996	0.52	40,157	9.38	44,782	10.46	-4,624	26,621	6.22
2023-2024	4,310,400	18,875	0.44	39,815	9.26	45,083	10.48	-5,268	24,143	5.61
2024-2025	4,333,600	23,200	0.54	40,163	9.29	45,487	10.52	-5,324	28,524	6.60
2020-2025		**89,641**		**200,235**		**223,595**		**-23,360**	**113,002**	
2025-2026	4,357,700	24,100	0.56	40,581	9.34	45,994	10.58	-5,413	29,513	6.79
2026-2027	4,382,500	24,800	0.57	40,989	9.38	46,604	10.66	-5,615	30,415	6.96
2027-2028	4,408,000	25,500	0.58	41,428	9.43	47,298	10.76	-5,870	31,370	7.14
2028-2029	4,434,200	26,200	0.59	41,882	9.47	47,949	10.85	-6,067	32,267	7.30
2029-2030	4,461,400	27,200	0.61	42,384	9.53	48,465	10.90	-6,081	33,281	7.48
2025-2030		**127,800**		**207,264**		**236,310**		**-29,046**	**156,846**	
2030-2031	4,489,200	27,800	0.62	42,612	9.52	48,999	10.95	-6,386	34,186	7.64
2031-2032	4,517,600	28,400	0.63	42,884	9.52	49,687	11.03	-6,802	35,202	7.82
2032-2033	4,546,600	29,000	0.64	43,189	9.53	50,335	11.11	-7,146	36,146	7.98
2030-2033		**85,200**		**128,686**		**149,021**		**-20,335**	**105,534**	
1990-2000		**570,700**		**432,703**		**277,200**		**155,503**	**415,197**	13.10
2000-2010		**406,200**		**467,933**		**310,050**		**157,883**	**248,317**	6.83
2010-2020		**406,659**		**442,649**		**350,281**		**92,368**	**314,291**	7.81
2020-2030		**217,441**		**407,499**		**459,905**		**-52,406**	**269,848**	6.22
2030-2033		**85,200**		**128,686**		**149,021**		**-20,335**	**105,534**	5.86

Sources: 1990-1999 population - U.S. Census Bureau; 2000-2019 intercensal population estimates by Office of Economic Analysis based on postcensal estimates by Population Research Center, PSU; 2020-2023 population by PRC/PSU; births and deaths 1990-2022: Oregon Center for Health Statistics. Forecaasts of population, births, deaths, and net migration are by the Oregon Office of Economic Analysis.

Table C.2 Population Forecasts by Age and Sex: 2010-2033

	2010			2020			2021			2022			2023		
Age	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	122,302	116,141	238,443	112,011	106,985	218,996	108,666	103,520	212,186	106,366	101,231	207,597	104,785	99,707	204,492
5- 9	121,563	116,455	238,018	124,747	118,498	243,245	123,837	117,750	241,587	121,967	116,154	238,120	120,193	114,276	234,469
10-14	124,611	118,821	243,432	132,309	125,225	257,534	132,412	125,104	257,515	131,313	123,750	255,063	130,206	122,328	252,534
15-19	131,215	124,664	255,879	130,658	125,672	256,330	130,753	124,261	255,015	131,874	124,763	256,636	134,114	126,805	260,919
20-24	128,737	124,919	253,656	135,238	132,221	267,459	135,835	133,971	269,806	135,688	134,067	269,755	135,750	133,709	269,459
25-29	133,819	131,522	265,341	145,729	142,132	287,860	142,728	139,065	281,793	139,632	135,860	275,492	138,769	134,729	273,497
30-34	131,483	128,253	259,736	152,805	149,031	301,836	155,224	150,855	306,079	156,142	151,526	307,667	157,252	151,906	309,158
35-39	128,103	123,715	251,818	150,399	148,210	298,609	151,617	148,909	300,526	152,239	149,068	301,307	153,469	150,001	303,469
40-44	125,961	122,930	248,891	138,274	136,608	274,883	141,917	140,797	282,714	144,707	144,054	288,761	147,168	147,265	294,433
45-49	130,755	132,549	263,304	130,153	127,426	257,579	128,938	126,672	255,610	129,154	127,536	256,690	131,413	130,192	261,605
50-54	135,069	141,566	276,635	125,650	125,882	251,533	128,315	127,999	256,314	129,887	129,116	259,003	130,488	129,574	260,062
55-59	132,995	140,775	273,769	128,444	134,806	263,250	125,645	131,315	256,960	122,656	127,520	250,176	120,798	125,024	245,821
60-64	115,186	121,047	236,233	130,455	143,111	273,566	129,404	142,001	271,406	127,738	140,097	267,835	126,402	138,333	264,735
65-69	81,837	87,957	169,794	125,244	139,324	264,568	126,016	141,153	267,169	125,582	141,432	267,014	124,792	141,140	265,932
70-74	56,945	63,006	119,950	103,012	114,579	217,592	107,556	120,135	227,690	109,550	123,257	232,807	111,078	125,997	237,075
75-79	40,954	50,138	91,091	65,368	75,617	140,985	68,876	79,838	148,713	73,606	85,341	158,946	78,735	91,400	170,136
80-84	30,391	42,761	73,152	38,064	46,702	84,766	39,844	48,938	88,782	41,864	51,646	93,509	44,658	55,173	99,830
85+	26,767	51,389	78,156	31,812	51,557	83,370	32,310	51,405	83,715	32,336	50,814	83,150	32,861	51,037	83,898
Total	1,898,693	1,938,607	3,837,300	2,100,373	2,143,586	4,243,959	2,109,892	2,153,689	4,263,581	2,112,299	2,157,230	4,269,529	2,122,930	2,168,595	4,291,525
Mdn. Age	37.2	39.4	38.3	38.9	40.8	39.8	39.1	41.1	40.1	39.4	41.4	40.4	39.6	41.7	40.6

	2024			2025			2026			2027			2028		
Age	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	103,509	98,363	201,873	103,177	98,100	201,277	103,765	98,637	202,402	104,129	98,966	203,095	104,841	99,631	204,472
5- 9	117,866	111,950	229,816	114,940	108,754	223,694	111,724	105,354	217,078	109,770	103,308	213,079	108,252	101,823	210,076
10-14	129,088	121,153	250,242	128,437	120,546	248,983	127,753	119,925	247,677	126,449	118,619	245,068	124,757	116,784	241,542
15-19	135,601	128,039	263,639	136,748	128,937	265,684	137,203	129,119	266,322	136,759	128,242	265,001	135,802	126,927	262,729
20-24	135,396	132,558	267,954	134,907	130,666	265,573	135,354	129,581	264,935	137,427	130,971	268,398	139,983	133,344	273,327
25-29	138,854	135,051	273,905	139,681	136,868	276,549	140,676	138,997	279,673	141,345	139,940	281,285	141,671	139,778	281,449
30-34	156,495	150,800	307,295	154,509	148,659	303,168	152,108	145,978	298,086	150,324	143,705	294,029	149,835	142,802	292,637
35-39	155,187	151,301	306,488	157,675	153,165	310,840	160,517	155,310	315,827	162,949	156,996	319,946	164,275	157,562	321,837
40-44	149,195	149,602	298,798	151,038	151,163	302,200	152,396	152,155	304,551	153,491	153,003	306,494	154,852	154,142	308,994
45-49	134,557	133,734	268,291	138,281	138,134	276,415	142,102	142,550	284,652	145,385	146,442	291,826	147,990	149,832	297,822
50-54	129,898	128,962	258,859	128,674	127,803	256,477	127,617	127,214	254,831	128,207	128,477	256,684	130,575	131,277	261,852
55-59	120,631	124,312	244,943	122,668	125,883	248,551	125,454	128,242	253,696	127,423	129,897	257,320	128,158	130,532	258,690
60-64	125,014	136,153	261,167	123,088	133,459	256,547	120,584	130,252	250,835	118,208	127,126	245,334	116,612	124,839	241,451
65-69	123,489	140,187	263,676	122,513	139,344	261,857	121,738	138,515	260,253	120,754	137,362	258,116	119,734	135,861	255,595
70-74	112,759	128,980	241,739	114,235	131,674	245,910	115,132	133,561	248,693	115,382	134,442	249,824	114,928	134,389	249,318
75-79	83,269	96,938	180,206	87,979	102,747	190,726	91,934	107,812	199,746	94,197	111,116	205,313	95,829	113,872	209,701
80-84	47,405	58,789	106,193	49,705	61,974	111,680	52,491	65,549	118,040	56,629	70,598	127,227	60,940	75,972	136,912
85+	33,729	51,587	85,316	34,911	52,559	87,470	36,307	54,095	90,402	38,100	56,360	94,461	40,361	59,238	99,598
Total	2,131,942	2,178,458	4,310,400	2,143,163	2,190,437	4,333,600	2,154,856	2,202,845	4,357,700	2,166,931	2,215,569	4,382,500	2,179,394	2,228,607	4,408,000
Mdn. Age	39.8	42.0	40.9	40.0	42.3	41.1	40.3	42.6	41.4	40.5	42.8	41.7	40.7	43.1	41.9

	2029			2030			2031			2032			2033		
Age	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
0-4	105,961	100,686	206,647	107,156	101,813	208,969	108,255	102,847	211,102	109,285	103,816	213,102	110,246	104,720	214,967
5- 9	107,108	100,570	207,677	106,867	100,367	207,234	107,580	100,979	208,560	108,058	101,380	209,438	108,897	102,125	211,022
10-14	122,597	114,542	237,140	119,691	111,347	231,038	116,470	107,935	224,406	114,562	105,906	220,468	113,102	104,448	217,550
15-19	134,934	125,931	260,864	134,430	125,435	259,865	133,886	124,924	258,811	132,698	123,710	256,409	131,096	121,942	253,038
20-24	141,928	135,024	276,952	143,340	136,187	279,527	144,018	136,586	280,603	143,759	135,865	279,625	142,961	134,675	277,636
25-29	141,667	138,942	280,609	141,363	137,157	278,519	142,028	136,197	278,225	144,416	137,847	282,263	147,324	140,535	287,859
30-34	150,579	143,608	294,187	151,867	145,816	297,684	153,355	148,363	301,718	154,508	149,657	304,165	155,268	149,751	305,019
35-39	164,034	156,809	320,843	162,263	154,794	317,057	160,047	152,205	312,252	158,454	150,035	308,489	158,221	149,298	307,519
40-44	156,802	155,781	312,583	159,449	157,882	317,331	162,447	160,270	322,717	165,036	162,191	327,227	166,513	162,953	329,467
45-49	150,255	152,466	302,721	152,263	154,209	306,472	153,780	155,367	309,148	155,025	156,375	311,401	156,537	157,683	314,220
50-54	133,886	135,040	268,926	137,729	139,612	277,341	141,670	144,204	285,874	145,076	148,276	293,352	147,811	151,848	299,659
55-59	127,792	130,167	257,959	126,762	129,167	255,929	125,897	128,739	254,636	126,651	130,187	256,838	129,161	133,195	262,356
60-64	116,719	124,434	241,153	118,908	126,224	245,131	121,814	128,793	250,608	123,916	130,649	254,565	124,815	131,473	256,288
65-69	118,718	134,047	252,765	117,128	131,619	248,747	114,979	128,673	243,651	112,949	125,801	238,750	111,663	123,759	235,422
70-74	114,076	133,804	247,880	113,468	133,250	246,717	113,043	132,701	245,744	112,419	131,836	244,255	111,755	130,633	242,387
75-79	97,637	116,889	214,526	99,229	119,602	218,831	100,316	121,579	221,896	100,854	122,658	223,512	100,791	122,910	223,702
80-84	64,779	80,900	145,679	68,690	85,976	154,665	72,036	90,448	162,484	74,175	93,575	167,750	75,890	96,324	172,214
85+	42,780	62,309	105,088	45,070	65,273	110,343	47,846	68,920	116,766	51,821	74,172	125,994	56,215	80,061	136,276
Total	2,192,251	2,241,949	4,434,200	2,205,671	2,255,730	4,461,400	2,219,467	2,269,733	4,489,200	2,233,663	2,283,937	4,517,600	2,248,267	2,298,333	4,546,600
Mdn. Age	40.8	43.4	42.1	41.1	43.6	42.3	41.3	43.9	42.5	41.5	44.1	42.8	41.7	44.3	43.0

Table C.3 Population of Oregon: 1990-2033

Year (July 1)	Total Population	Change from previous year Number	Percent
1990	2,860,400	-	-
1991	2,928,500	68,100	2.38%
1992	2,991,800	63,300	2.16%
1993	3,060,400	68,600	2.29%
1994	3,121,300	60,900	1.99%
1995	3,184,400	63,100	2.02%
1996	3,247,100	62,700	1.97%
1997	3,304,300	57,200	1.76%
1998	3,352,400	48,100	1.46%
1999	3,393,900	41,500	1.24%
2000	3,431,100	37,200	1.10%
2001	3,470,400	39,300	1.15%
2002	3,502,600	32,200	0.93%
2003	3,538,600	36,000	1.03%
2004	3,578,900	40,300	1.14%
2005	3,626,900	48,000	1.34%
2006	3,685,200	58,300	1.61%
2007	3,739,400	54,200	1.47%
2008	3,784,200	44,800	1.20%
2009	3,815,800	31,600	0.84%
2010	3,837,300	21,500	0.56%
2011	3,854,500	17,200	0.45%
2012	3,878,200	23,700	0.61%
2013	3,910,900	32,700	0.84%
2014	3,952,000	41,100	1.05%
2015	4,000,400	48,400	1.22%
2016	4,060,100	59,700	1.49%
2017	4,122,000	61,900	1.52%
2018	4,173,200	51,200	1.24%
2019	4,211,400	38,200	0.92%
2020	4,243,959	32,559	0.77%
2021	4,263,581	19,622	0.46%
2022	4,269,529	5,948	0.14%
2023	4,291,525	21,996	0.52%
2024	4,310,400	18,875	0.44%
2025	4,333,600	23,200	0.54%
2026	4,357,700	24,100	0.56%
2027	4,382,500	24,800	0.57%
2028	4,408,000	25,500	0.58%
2029	4,434,200	26,200	0.59%
2030	4,461,400	27,200	0.61%
2031	4,489,200	27,800	0.62%
2032	4,517,600	28,401	0.63%
2033	4,546,600	28,999	0.64%

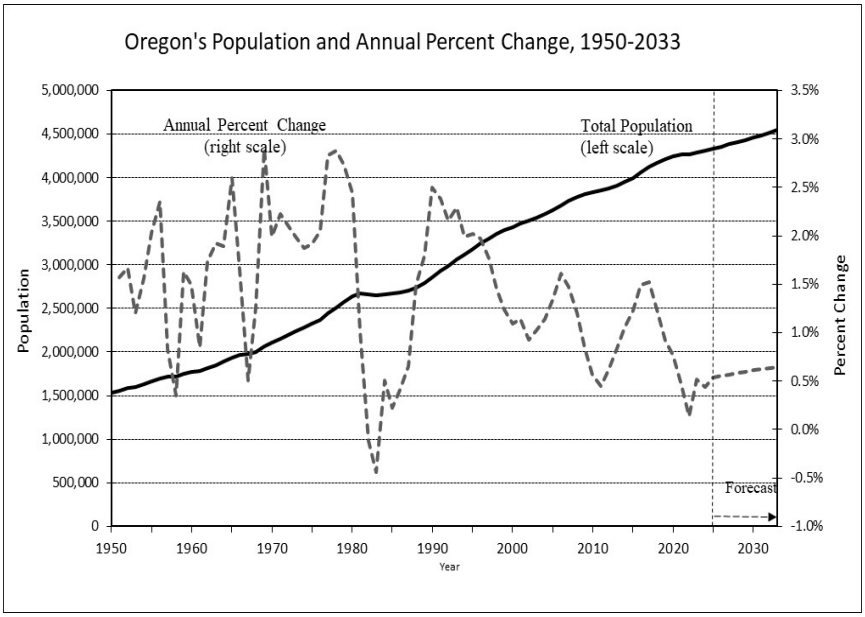

Table C.4 Children: Ages 0-4

Table C.5 School Age Population: Ages 5-17

Table C.6 Young Adult Population: Ages 18-24

Year (July 1)	Table C.4 Children: Ages 0-4 Population	% Change from previous decade/yr. Number	Percent	Table C.5 School Age Population: Ages 5-17 Population	% Change from previous decade/yr. Number	Percent	Table C.6 Young Adult Population: Ages 18-24 Population	% Change from previous decade/yr. Number	Percent
1980	199,525	---	---	524,446	---	---	329,407	---	---
1990	209,638	10,113	5.07%	532,727	8,281	1.58%	268,134	-61,273	-18.60%
2000	223,207	13,569	6.47%	624,316	91,589	17.19%	330,328	62,194	23.20%
2010	238,443	15,236	6.83%	631,132	6,815	1.09%	359,854	29,526	8.94%
2011	235,911	-2,532	-1.06%	629,794	-1,337	-0.21%	360,835	982	0.27%
2012	232,406	-3,506	-1.49%	631,284	1,489	0.24%	362,832	1,997	0.55%
2013	229,470	-2,936	-1.26%	633,903	2,619	0.41%	366,162	3,330	0.92%
2014	228,491	-979	-0.43%	636,663	2,760	0.44%	368,698	2,535	0.69%
2015	228,530	38	0.02%	639,405	2,741	0.43%	370,335	1,638	0.44%
2016	229,939	1,409	0.62%	642,777	3,373	0.53%	371,121	786	0.21%
2017	230,713	774	0.34%	646,608	3,831	0.60%	373,452	2,331	0.63%
2018	228,576	-2,137	-0.93%	647,996	1,387	0.21%	375,357	1,905	0.51%
2019	224,371	-4,206	-1.84%	649,539	1,543	0.24%	374,840	-517	-0.14%
2020	218,996	-5,374	-2.40%	651,951	2,412	0.37%	372,617	-2,222	-0.59%
2021	212,186	-6,810	-3.11%	652,057	106	0.02%	371,866	-751	-0.20%
2022	207,597	-4,589	-2.16%	648,028	-4,028	-0.62%	371,546	-320	-0.09%
2023	204,492	-3,105	-1.50%	644,785	-3,244	-0.50%	372,597	1,051	0.28%
2024	201,873	-2,620	-1.28%	639,467	-5,318	-0.82%	372,184	-413	-0.11%
2025	201,277	-596	-0.30%	631,727	-7,740	-1.21%	372,207	24	0.01%
2026	202,402	1,125	0.56%	622,091	-9,636	-1.53%	373,921	1,714	0.46%
2027	203,095	692	0.34%	613,780	-8,311	-1.34%	377,766	3,845	1.03%
2028	204,472	1,378	0.68%	605,971	-7,810	-1.27%	381,702	3,936	1.04%
2029	206,647	2,175	1.06%	598,574	-7,396	-1.22%	384,058	2,356	0.62%
2030	208,969	2,322	1.12%	592,027	-6,548	-1.09%	385,637	1,579	0.41%
2031	211,102	2,133	1.02%	586,215	-5,812	-0.98%	386,165	527	0.14%
2032	213,102	2,000	0.95%	580,888	-5,327	-0.91%	385,052	-1,113	-0.29%
2033	214,967	1,865	0.88%	575,870	-5,017	-0.86%	383,376	-1,676	-0.44%

Table C.7 Criminally At Risk Population (males): Ages 15-39

Table C.8 Prime Wage Earners: Ages 25-44

Table C.9 Older Wage Earners: Ages 45-64

Year (July 1)	Population	% Change from previous decade/yr. Number	Percent	Population	% Change from previous decade/yr. Number	Percent	Population	% Change from previous decade/yr. Number	Percent
1980	561,931	---	---	790,750	---	---	491,249	---	---
1990	544,738	-17,193	-3.06%	926,326	135,576	17.15%	531,181	39,932	8.13%
2000	616,988	72,250	13.26%	996,500	70,174	7.58%	817,510	286,329	53.90%
2010	653,357	36,370	5.89%	1,025,787	29,287	2.94%	1,049,941	232,431	28.43%
2011	651,180	-2,178	-0.33%	1,027,906	2,120	0.21%	1,055,385	5,444	0.52%
2012	652,390	1,211	0.19%	1,032,603	4,697	0.46%	1,049,595	-5,790	-0.55%
2013	657,293	4,903	0.75%	1,040,709	8,106	0.78%	1,045,648	-3,947	-0.38%
2014	664,759	7,466	1.14%	1,051,331	10,622	1.02%	1,047,081	1,433	0.14%
2015	673,701	8,941	1.35%	1,063,996	12,664	1.20%	1,051,826	4,745	0.45%
2016	685,321	11,621	1.72%	1,083,602	19,607	1.84%	1,058,830	7,003	0.67%
2017	697,303	11,981	1.75%	1,107,682	24,080	2.22%	1,060,299	1,469	0.14%
2018	705,507	8,204	1.18%	1,129,825	22,143	2.00%	1,056,891	-3,407	-0.32%
2019	711,574	6,068	0.86%	1,147,437	17,612	1.56%	1,050,482	-6,409	-0.61%
2020	714,828	3,253	0.46%	1,163,188	15,750	1.37%	1,045,927	-4,555	-0.43%
2021	716,157	1,330	0.19%	1,171,112	7,924	0.68%	1,040,290	-5,637	-0.54%
2022	715,574	-584	-0.08%	1,173,227	2,115	0.18%	1,033,703	-6,586	-0.63%
2023	719,353	3,779	0.53%	1,180,558	7,330	0.62%	1,032,223	-1,480	-0.14%
2024	721,533	2,180	0.30%	1,186,486	5,928	0.50%	1,033,260	1,037	0.10%
2025	723,518	1,985	0.28%	1,192,757	6,271	0.53%	1,037,989	4,729	0.46%
2026	725,858	2,339	0.32%	1,198,137	5,380	0.45%	1,044,015	6,025	0.58%
2027	728,805	2,948	0.41%	1,201,755	3,618	0.30%	1,051,164	7,150	0.68%
2028	731,566	2,760	0.38%	1,204,917	3,163	0.26%	1,059,814	8,650	0.82%
2029	733,141	1,576	0.22%	1,208,222	3,305	0.27%	1,070,759	10,945	1.03%
2030	733,263	121	0.02%	1,210,591	2,369	0.20%	1,084,874	14,115	1.32%
2031	733,333	71	0.01%	1,214,912	4,322	0.36%	1,100,265	15,391	1.42%
2032	733,836	502	0.07%	1,222,143	7,231	0.60%	1,116,155	15,890	1.44%
2033	734,870	1,034	0.14%	1,229,864	7,721	0.63%	1,132,522	16,367	1.47%

Table C.10 Elderly Population by Age Group

Year (July 1)	Ages 65+	%Change from previous decade/yr.	Ages 65-74	%Change from previous decade/yr.	Ages 75-84	%Change from previous decade/yr.	Ages 85+	%Change from previous decade/yr.
1980	305,841	---	185,863	---	91,137	---	28,841	---
1990	392,369	28.29%	224,772	20.93%	128,813	41.34%	38,784	34.48%
2000	439,239	11.95%	218,997	-2.57%	162,187	25.91%	58,055	49.69%
2010	532,145	21.15%	289,744	32.31%	164,244	1.27%	78,156	34.62%
2011	544,668	2.35%	300,679	3.77%	164,699	0.28%	79,290	1.45%
2012	569,480	4.56%	323,020	7.43%	166,250	0.94%	80,210	1.16%
2013	595,007	4.48%	344,941	6.79%	169,092	1.71%	80,974	0.95%
2014	619,735	4.16%	364,915	5.79%	173,464	2.59%	81,356	0.47%
2015	646,309	4.29%	386,254	5.85%	178,545	2.93%	81,510	0.19%
2016	673,830	4.26%	406,961	5.36%	184,772	3.49%	82,098	0.72%
2017	703,246	4.37%	428,081	5.19%	192,909	4.40%	82,256	0.19%
2018	734,554	4.45%	447,292	4.49%	204,711	6.12%	82,552	0.36%
2019	764,731	4.11%	465,467	4.06%	216,593	5.80%	82,671	0.14%
2020	791,279	3.47%	482,160	3.59%	225,750	4.23%	83,370	0.84%
2021	816,070	3.13%	494,859	2.63%	237,495	5.20%	83,715	0.41%
2022	835,426	2.37%	499,821	1.00%	252,456	6.30%	83,150	-0.67%
2023	856,870	2.57%	503,007	0.64%	269,966	6.94%	83,898	0.90%
2024	877,131	2.36%	505,415	0.48%	286,400	6.09%	85,316	1.69%
2025	897,643	2.34%	507,767	0.47%	302,406	5.59%	87,470	2.52%
2026	917,134	2.17%	508,946	0.23%	317,786	5.09%	90,402	3.35%
2027	934,940	1.94%	507,940	-0.20%	332,540	4.64%	94,461	4.49%
2028	951,124	1.73%	504,912	-0.60%	346,613	4.23%	99,598	5.44%
2029	965,940	1.56%	500,646	-0.85%	360,206	3.92%	105,088	5.51%
2030	979,303	1.38%	495,464	-1.04%	373,496	3.69%	110,343	5.00%
2031	990,541	1.15%	489,396	-1.22%	384,380	2.91%	116,766	5.82%
2032	1,000,261	0.98%	483,005	-1.31%	391,262	1.79%	125,994	7.90%
2033	1,010,001	0.97%	477,810	-1.08%	395,916	1.19%	136,276	8.16%

APRIL 2021

To work from home or not to work from home? That is the question

Maya B. Brandon

The coronavirus disease 2019 (COVID-19) era has ushered in a new look and feel for the workplace. With the fear of infection, of self or loved ones, many people are breathing a sigh of relief with the expansion of permissions to work from home, whereas others are holding their breath in the aftermath of widespread lockdowns and economic uncertainty. In "Who should work from home during a pandemic? The wage-infection trade-off" (National Bureau of Economic Research, Working Paper 27908, October 2020), authors Sangmin Aum, Sang Yoon (Tim) Lee, and Yongseok Shin explore an optimal policy: "the economic costs of containing a pandemic can be minimized by only sending home those jobs that are highly exposed but easy to perform from home."

How we think about interacting with others, avoiding illness, and establishing a new normal are top subjects today. In many cases, people must weigh the risks of exposure and infection against the benefits of wages. We assume that with these widespread health disparities, the workplace is a breeding ground of infection and shutting it down will reduce infection. Actions to contain pandemic-level contagions often require the cooperation of people at multiple levels, but these actions come at a cost, especially to low-wage workers who are "bearing the brunt of the pandemic economically and in terms of infection risks." Businesses and workers have difficult choices to make, and these choices come with a laundry list of economic, social, and health tradeoffs.

Many workers are safely able to work from home during the pandemic, but many are not. Aum, Lee, and Shin have constructed two indexes—one of occupational exposure risk and another of time spent working from home. Their indexes use data from O*NET (the Occupational Information Network that is the primary source of occupational information for the United States), the American Time Use Survey, and the American Community Survey to find that jobs with workers who have less ability to work from home and higher exposure to infection are not tightly correlated. "Infection risks vary widely even among jobs with the same WFH [working from home]: for example, neither medical therapists nor experimental physicists can work from home, but the latter pose almost no risk of contagion." The authors argue that the ability to work from home is not the be-all and end-all for who should work from home, because the nature of the work and possibility of exposure should also be considered. Jobs have been classified as essential or nonessential. These classifications, however, are too broad because the scope of work and the exposure risk better indicate who should be allowed to work from home on the basis of need. The authors report that closing and locking down all businesses are more harmful economically at micro- and macrolevels than operating under the optimal policy of sending home workers who have jobs that are highly exposed but easy to perform from home.

In the face of widespread business closures, high levels of exposure to the COVID-19, and uncertainty of employment, low-wage workers have been greatly affected globally by the lockdowns. High-wage workers have been less affected by the lockdowns and continued to work with modifications and increased options to telework. Aum, Lee, and Shin's optimal policy provides a realistic view of the job world during the COVID-19 pandemic but uses a conceptual view of the real world. Their goal is to provide a blueprint for pandemic lockdowns that is simple, implementable, and optimal for workers, employers, and the overall economy.

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BLS

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Measuring industry employment, 1990–2018: a look at the auxiliary-unit concept

The North American Industry Classification System (NAICS) replaced the Standard Industrial Classification (SIC) system in 1997. Since the change, some analysts have expressed concerns about the elimination in NAICS of the concept of auxiliary units, which are now classified with other worksites that perform similar functions. This article examines how employment trends by broad industry groups would have differed over the past few decades if the auxiliary-unit concept had been used to estimate employment in those units as it was in the SIC system.

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In the United States, Canada, and Mexico, businesses (and hence business employment) are classified and reported in industries according to the North American Industry Classification System (NAICS).[1] NAICS was implemented in the United States in 1997, replacing its predecessor, the Standard Industrial Classification (SIC) system. A major criticism of this change, over time, has involved the treatment of auxiliary units. In the SIC system, an auxiliary unit was defined as a worksite that was part of a firm and provided management or support services for other worksites within the firm. At the U.S. Bureau of Labor Statistics (BLS), in practice, this meant that an auxiliary unit was a worksite reported with other worksites as part of a multiworksite unemployment insurance account. Typical examples of auxiliary units include headquarters and warehouses associated with a manufacturing plant. Under NAICS, the auxiliary-unit concept was eliminated, and these units are now classified with other worksites performing similar functions.[2]

In this article, I use data from the BLS Quarterly Census of Employment and Wages (QCEW) to look at how employment trends over the past few decades would differ if we were to approximate the auxiliary-unit concept. Would making this change lead to different trends in certain industries over that period?

Background

In 2018, there were about 10 million business establishments in the United States. Each of these establishments produces a good or provides a service. The product or service that a company produces or provides leads to its classification in a specific industry in which similar businesses are also classified. This grouping of businesses by industry allows for a consistent definition to be used across statistical agencies for the collection and publication of economic statistics. It also allows economists, academics, and businesses to compare features of similar and dissimilar businesses, and it allows federal, state, and local governments to develop policies targeted at businesses within specific industries.

Prior to 1997, businesses were classified into industries on the basis of the 1987 SIC system. A notable feature of the SIC system was the inclusion of special rules for coding “auxiliary” establishments, which the SIC manual defined as follows:

> Auxiliary establishments are distinguished from operating establishments that primarily produce goods and from those that primarily provide services for personal or household use or for other enterprises. Some examples of activities commonly performed by auxiliaries are management and other general administrative functions, such as accounting, data processing, and legal services; research, development, and testing; and warehousing.[3]

The 1987 SIC manual further clarified how auxiliary establishments were assigned industry codes: “Auxiliary establishments are assigned four-digit industry codes on the basis of the primary activity of the operating establishments they serve.”[4] Since 1997, businesses have been classified into industry groups using NAICS. The NAICS 2017 manual includes the following explanation in its preface:

> The North American Industry Classification System is unique among industry classifications in that it is constructed within a single conceptual framework. Economic units that have similar production processes are classified in the same industry, and the lines drawn between industries demarcate, to the extent practicable, differences in production processes. This supply-based, or production-oriented, economic concept was adopted for NAICS because an industry classification system is a framework for collecting and publishing information on both inputs and outputs, for statistical uses that require that inputs and outputs be used together and be classified consistently.[5]

The NAICS 2017 manual also describes auxiliary establishments, as follows:

> Although all establishments have output, they may or may not have receipts. In large enterprises, it is not unusual for establishments to exist to solely serve other establishments of the same enterprise (auxiliary, or enterprise support, establishments). In such cases, these units often do not collect receipts from the establishments they serve. This type of support (captive) activity is found throughout the economy and involves goods-producing activities as well as services. Units that carry out support activities for the enterprise to which they belong are classified, to the extent feasible, according to the NAICS code related to their own activity. This means that warehouses providing storage facilities for their own enterprise are classified as warehouses.[6]

Businesses evolve; they grow, change, and decline. A company may start with only one or two workers, and over time it may grow to have thousands of employees, with worksites located in multiple states and industries. Some of the worksites in other industries may partially or fully support the main company activity. A company may change vendors for the inputs it needs to develop and sell its product or service, and over time it may decide to outsource

part of its product development or service delivery to other companies—sometimes even in other countries. This decision process also applies to worksites that would have been classified as auxiliary establishments under the SIC system.

With a few assumptions about the auxiliary relationship, we can explore how important this concept might be in measuring employment change, particularly by industry. This article focuses on exploring employment trends by various industry groups in order to identify how these trends would have differed if an auxiliary-unit concept was used in the estimation process. (See the box that follows for basic definitions of some of the relevant terms used in this article.)

Definitions

Industry. BLS and other federal statistical agencies classify industries according to the North American Industry Classification System (NAICS). NAICS is hierarchical, with broad industry groups comprising more and more detailed groups.

Worksite. BLS defines a worksite as a single physical location of work. A worksite is also frequently referred to as an establishment. If there is more than one economic activity at the site, the economic activity that generates the most revenue is typically used to determine its primary industry for classification under NAICS.

Unemployment insurance (UI) account. Virtually all employers in the United States are required to register with the appropriate agency in the state in which they are located in order to receive a UI account number. State agencies assign this number to employers to track their mandatory participation in state and federal UI programs. Employers can have multiple worksites within one UI account but are limited to only those within the same state. The employer can choose to have more than one UI account, but a single worksite can only have one UI account.

Employer identification number (EIN). The EIN is a unique nine-digit number issued by the Internal Revenue Service (IRS) to identify a business entity. An EIN can identify a single worksite, or it can identify a group of worksites within one state or across states. (See exhibit 1 for a basic relationship structure.) In this article, the EIN is also referred to as a firm identifier. A firm is an establishment or a combination of establishments that sells goods or services for a profit. Firms can operate in one industry or in multiple industries.*

Quarterly Census of Employment and Wages (QCEW). Data from the BLS QCEW are the product of a federal–state cooperative program. The data are derived from summaries of the employment and total pay of workers covered by state and federal UI legislation and are provided to BLS by state workforce agencies. In addition, employers who operate multiple establishments within a state complete a questionnaire called the “Multiple Worksite Report,” which provides detailed information on employment, wages, and industry for each of their establishments.

QCEW data cover about 97 percent of business employment in the United States, and data are published by county, metropolitan area, state, and the nation for detailed industry groups. The QCEW also collects the UI account number and the federal EIN for each of these employers. Major exclusions from UI coverage include self-employed workers, most agricultural workers on small farms, all members of the Armed Forces, elected officials in most states, most student workers at schools, employees of certain small nonprofit organizations, and railroad workers covered by the railroad unemployment insurance system.

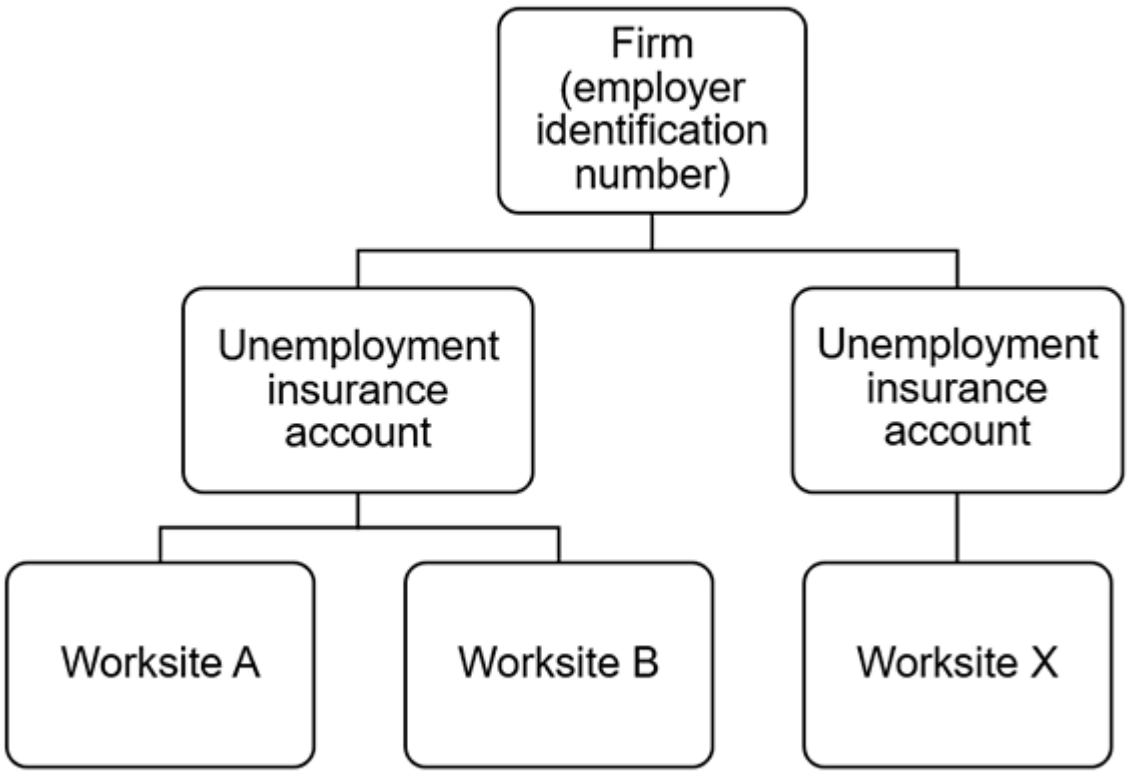
* For more on the "firm" concept, see Akbar Sadeghi, David M. Talan, and Richard L. Clayton, "Establishment, firm, or enterprise: does the unit of analysis matter?" Monthly Labor Review, November 2016, https://www.bls.gov/opub/mlr/2016/article/establishment-firm-or-enterprise.htm.

A methodology to account for auxiliary units

BLS no longer collects data in such a way as to identify auxiliary units. However, we can classify all worksites within an unemployment insurance (UI) account or a federal employer identification number (EIN) on the basis of the dominant industry of the account. Note that this approach serves as a proxy for the auxiliary-unit concept, but it will not capture exactly what a direct coding would.

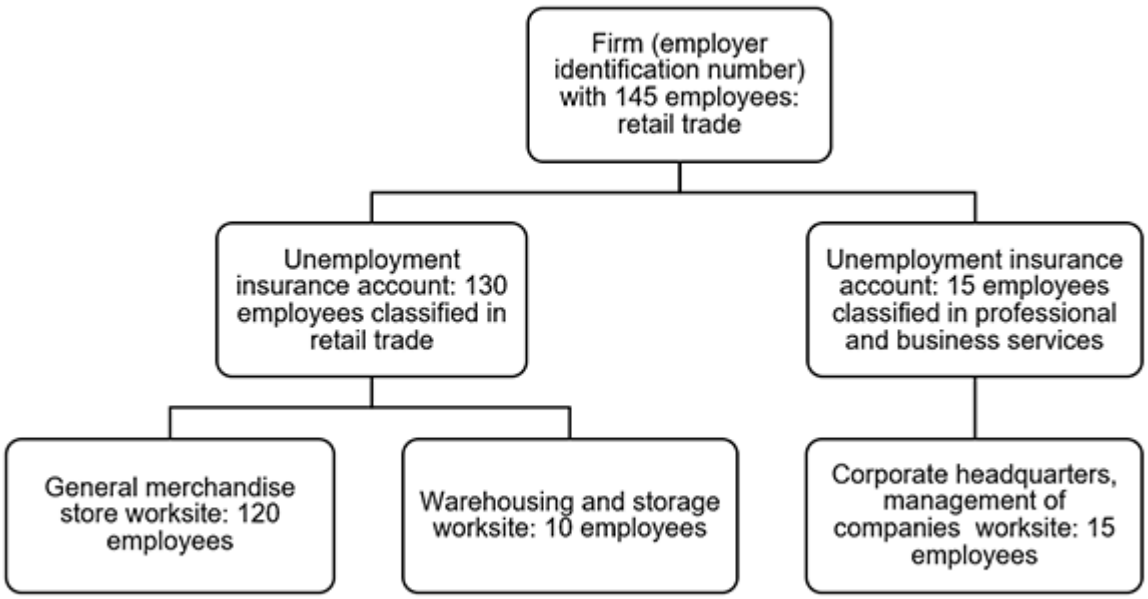
The QCEW program collects data each quarter for all business worksites in the United States, including the number of employees and the total quarterly wages paid.[7] The QCEW also collects information on the worksite location, its UI account number, its federal EIN, and the industry in which it is classified (according to NAICS). With some straightforward assumptions, I assigned the dominant economic activity at the UI account level and at the firm level (i.e., for each group of establishments with the same EIN). The assumptions are that all activity at each worksite is associated with its assigned NAICS code and that the aggregate revenue of the UI account or firm is proportional to the employment at each worksite. With these assumptions, I identified the industry sector that has the most employment within a UI account or within a firm for the third month of each quarter and assigned that industry sector to the entire UI account or firm (for that quarter). (See exhibit 1 for a basic relationship diagram and exhibit 2 for an example.)

Exhibit 1. The basic relationship between a firm and its worksites



Source: U.S. Bureau of Labor Statistics.

Exhibit 2. Example of auxiliary units in a retail trade firm classified according to the primary worksite activity



Source: U.S. Bureau of Labor Statistics.

The analysis presented in this article shows data for employment change classified by industry at the worksite level, by UI account, and by EIN. Clearly, assigning industry classification at a more aggregate company level will produce an employment level that differs from the employment level produced by industry classification at the worksite level. My main interest here is to see if the long-run industry employment story is changed by the reclassification. Therefore, I indexed these data to 1990. (Appendix table A-1 provides the employment levels for the first quarter of 1990, and table A-2 shows index data for all of the industry groups analyzed in this article for the worksite, UI account, and EIN assignment of industry for the 1990–2018 period.) This analysis should help data users identify industries in which the more aggregate trends have deviated substantially from those given by the official worksite-classified statistics.

Note that this analysis allows us to see if aggregate economic trends would have been different if employment in company- and firm-owned worksites in other industries had been included in the primary industry. Total employment, as measured by the QCEW, is not changed by this reassignment, which simply moves selected establishments and their employment from their officially assigned industry group into another one. Therefore, this analysis provides a specific view of employment changes at a broad industry level and examines whether the inclusion of an auxiliary-unit proxy concept changes the economic story in each industry group. Different trends over time could result from several factors outside the scope of this analysis. Principally, this analysis does not determine whether changes in trends are due to aggregate changes in ownership of auxiliary-like worksites or changes in employment in the auxiliary-like industries. What this analysis explores is how much employment is directly attributable to firms whose aggregate primary activity is within a specific industry group, plus the employment associated with worksites owned by those firms that are classified outside of that industry group.

Potential errors associated with reclassification

There are a number of potential errors associated with this reclassification methodology. Among them are the following:

- NAICS codes are rarely in error at the two-digit level. However, when errors are identified during QCEW processing, they are corrected for the current and future quarters, but no historical corrections are made. This analysis accepts the QCEW NAICS six-digit codes as reported each quarter.
- Worksites with multiple economic activities are instructed to select the primary activity in order to assign a NAICS code. The activity associated with the highest revenue stream is usually selected as the primary activity. This analysis assumes that the aggregate revenue of the UI account or firm is associated with its worksites proportional to the employment at each worksite. This assumption is reasonable, and it generally will provide reasonable results; however, there are certainly isolated cases in which it will not. For example, when examining a firm that has an e-commerce worksite and a fulfillment center (i.e., a warehouse) worksite, the highest revenue is likely to be associated with the e-commerce site, whereas the highest employment may be associated with the warehouse site. This analysis does not attempt to make any corrections for such situations.
- This reclassification is based on ownership of worksites and does not include a detailed examination to determine relevance. Therefore, this reclassification may assign relevant worksites outside of the core industry (e.g., it could move a small retail worksite out of retail trade and into wholesale trade), and it could assign to the industry worksites that are completely unrelated to the primary industry.
- Although an EIN usually identifies all of the worksites within a business organization, a single business can obtain multiple EINs. For the purposes of this article, each EIN is treated as an independent firm.

These errors are expected to be small enough not to change the broad results contained in this analysis.

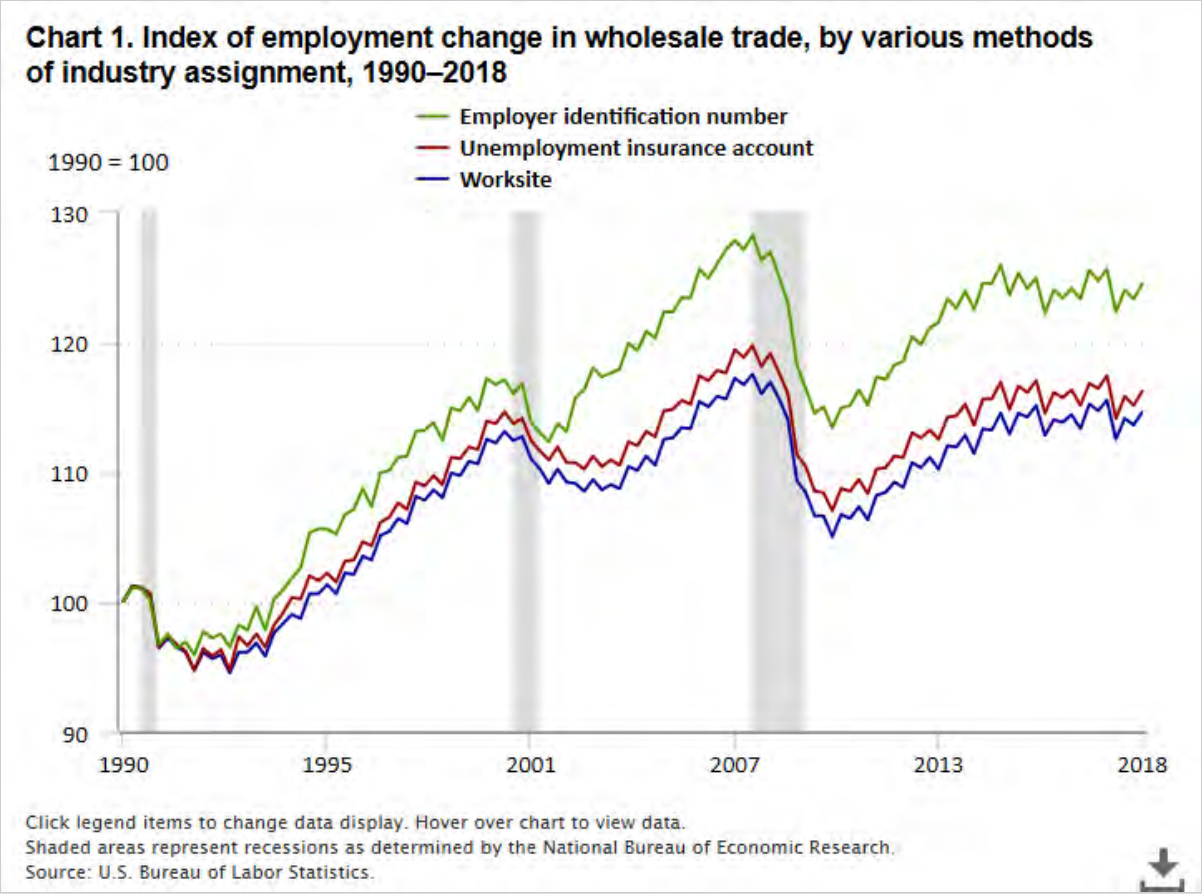
BLS organizes NAICS sectors into broader groupings for some publications. These groupings are natural resources and mining; construction; manufacturing; trade, transportation, and utilities; information; financial activities; professional and business services; education and health services; leisure and hospitality; other services, except public administration; public administration; and an “unclassified” category. The analysis in this article uses these broader industry groupings, with two exceptions—natural resources and mining; and trade, transportation, and utilities are analyzed at the more detailed NAICS-sector level. The analysis omits the unclassified category. Therefore, this article examines the following industry groups: agriculture, forestry, fishing, and hunting; mining, quarrying, and oil and gas extraction; construction; manufacturing; wholesale trade; retail trade; transportation and warehousing; utilities; information; financial activities; professional and business services; education and health services; leisure and hospitality; other services, except public administration; and public administration.

Results

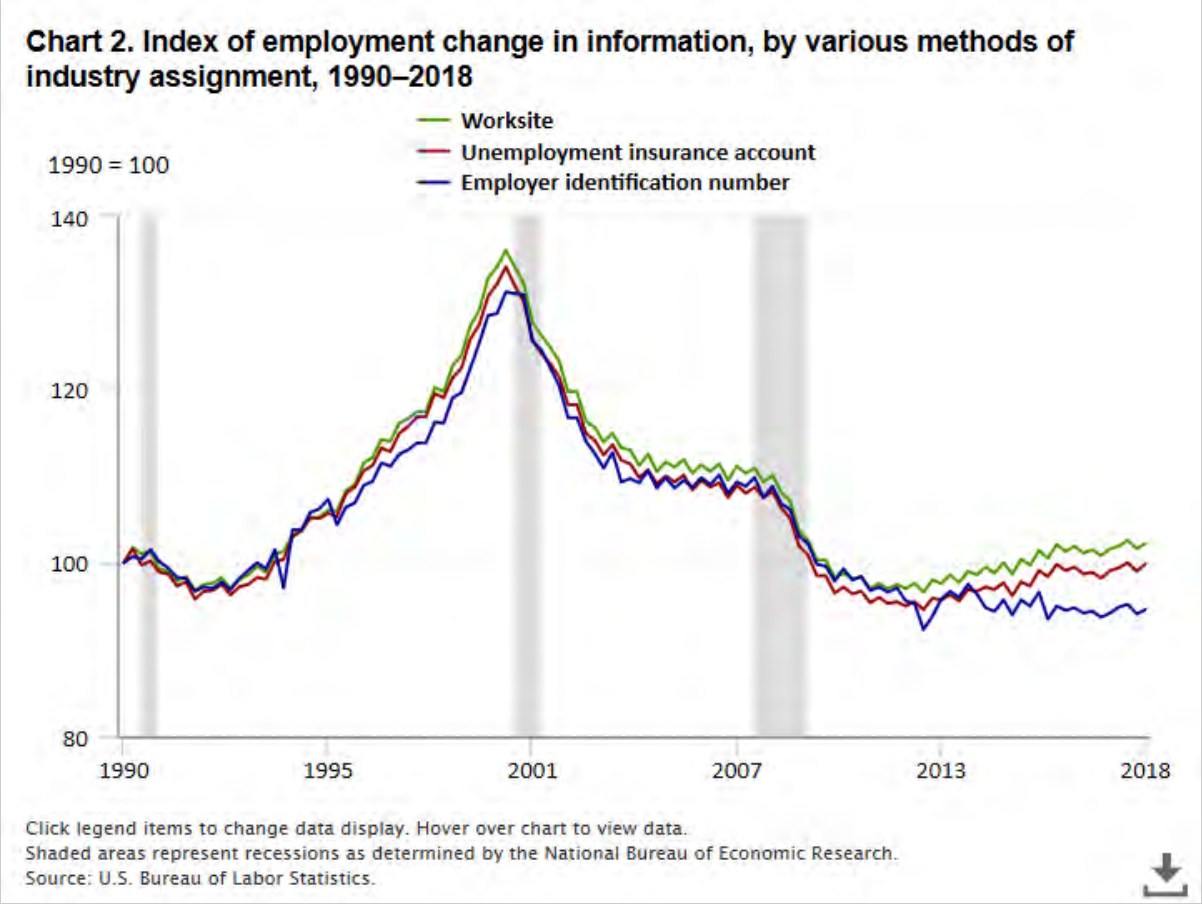
The analysis in this article includes a reassignment of industry at both the UI account level and the EIN (firm) level. As expected, the assignment of industry at the UI account level results in employment trends that are closer to the trends seen at the worksite-assigned level, because the aggregation of worksites is on a smaller scale. For this reason, this analysis focuses on comparing data with an assignment of industry at the EIN or firm level by using data that have been categorized with the official worksite industry assignment. The analysis focuses mostly on the

end points of the various indexes that were created for this purpose, in order to identify industry sectors in which the economic story would be most similar and most different under this proxy auxiliary assignment procedure.

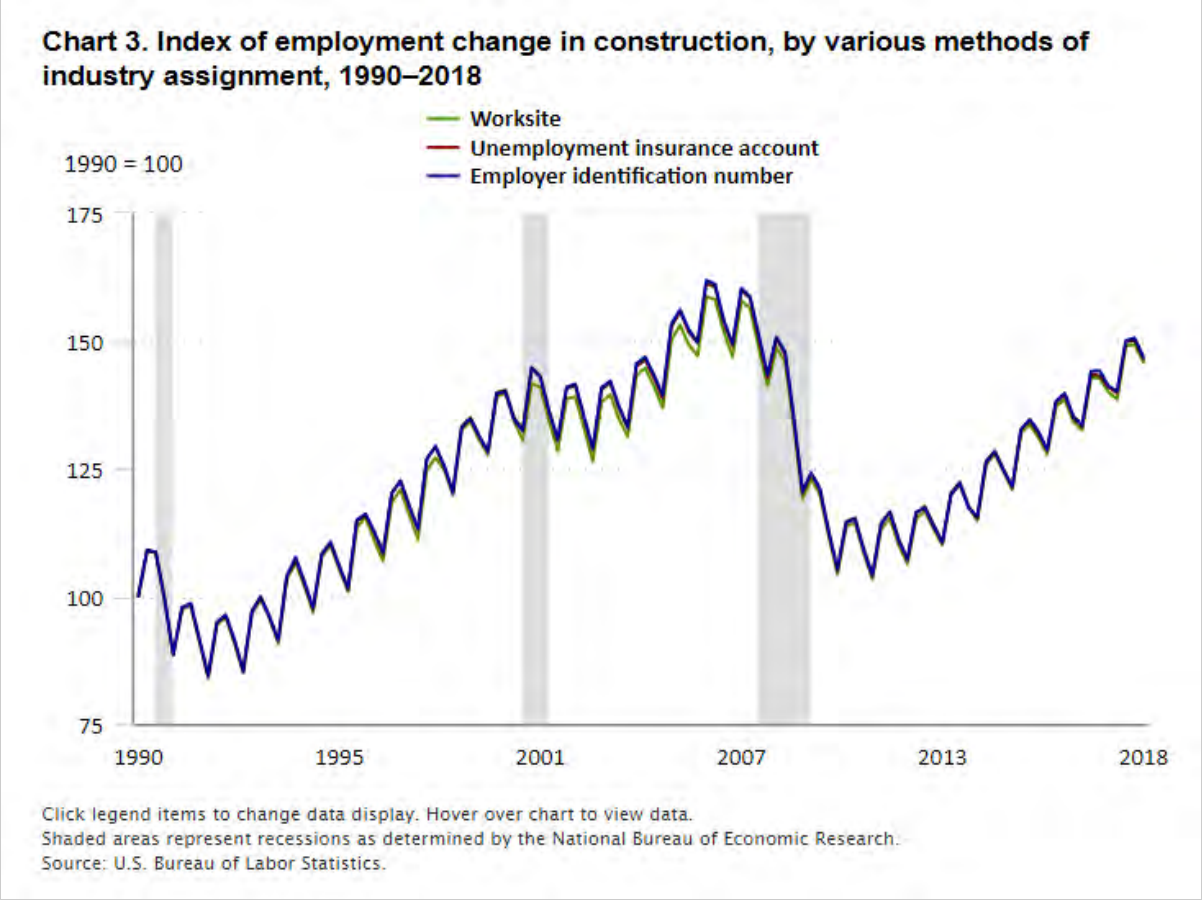
The industry with the largest positive percent difference between the EIN index and the worksite index over the 1990–2018 period is wholesale trade. Chart 1 shows a continually stronger trend in the EIN index, except around recessions. The data show that the EIN index grew 8.6 percent more than the worksite index over the period. This finding indicates that firms in the wholesale trade industry expanded their ownership of (and employment in) worksites outside of the wholesale trade industry during the study period.



The industry with the largest negative percent difference between the EIN index and the worksite index over the 1990–2018 period is information. (See chart 2.) There was some limited deviation early in the period, but it moderated in early 2000. The deviation returned in early 2014 and mostly widened each quarter until the end of the period. The result is an EIN index that was 7.5 percent lower than the worksite index in 2018. This finding indicates that firms in the information industry reduced their ownership of (and employment in) worksites outside of the information industry over the 1990–2018 period.



By contrast, as shown in table 1, the industries with the least deviation between the EIN index and the worksite index over the period are other services (+0.4 percent), utilities (−0.6 percent), and construction (+0.7 percent). Among these three industries, construction had the most employment. The index of employment change for construction is shown in chart 3. Visually, we see very little deviation between the EIN index and the worksite index for the construction industry over the entire 1990–2018 period.



Charts 1, 2, and 3 show, respectively, positive, negative, and “no change” deviations between worksite and EIN industry coding. Table 1 provides information on the relative percent difference in the index values (at the end of the period) between the EIN NAICS reassignment and the original worksite NAICS code assignment, the difference in employment change, and the relative percent employment change (taking the difference in employment change divided by the final employment level of the worksite NAICS assignment).[8]

Table 1. Measures of employment change, by industry, between EIN-assigned industry and worksite-assigned industry

Industry	Relative percent difference in **index values: (EIN – WS) / WS**	Difference in employment **change (EINΔ – WSΔ)**	Relative percent employment **change, (EINΔ – WSΔ) / WS**
Agriculture, forestry, fishing and hunting	2.2	16,885	1.5
Mining, quarrying, and oil and gas extraction	–5.1	–34,787	–5.1
Construction	0.7	37,409	0.5
Manufacturing	–1.8	–684,757	–5.4
Wholesale trade	8.6	316,505	5.4
Retail trade	3.0	521,647	3.2
Transportation and warehousing	–3.0	–278,485	–5.0

See footnotes at end of table.

Table 1. Measures of employment change, by industry, between EIN-assigned industry and worksite-assigned industry

Industry	Relative percent difference in **index values: (EIN – WS) / WS**	Difference in employment **change (EINΔ – WSΔ)**	Relative percent employment **change, (EINΔ – WSΔ) / WS**
Utilities	–0.6	–11,768	–2.1
Information	–7.5	–219,373	–7.8
Financial activities	1.1	99,178	1.2
Professional and business services	5.3	–6,448	0.0
Education and health services	2.4	379,854	1.7
Leisure and hospitality	1.1	189,686	1.2
Other services, except public administration	0.4	–25,979	–0.6
Public administration	–1.6	–271,911	–1.2

Note: EIN = employer identification number; WS = worksite.

Source: U.S. Bureau of Labor Statistics.

Table 1 shows that the industries with the largest positive difference in employment change between the worksite- and EIN-based industry assignments over the 1990–2018 period are retail trade (+521,647), education and health services (+379,854), and wholesale trade (+316,505). The industries with the largest negative difference in employment change in this reassignment are manufacturing (−684,757), transportation and warehousing (−278,485), public administration (−271,911), and information (−219,373). The industries in which employment change was the least affected by this reassignment are professional and business services (−6,448), utilities (−11,768), and agriculture, forestry, fishing and hunting (+16,885)

The analysis presented in this article identifies industries whose firms changed their pattern of other-industry worksite ownership and employment over the 1990–2018 period. For example, as classified by the official worksite industry assignment, employment in retail trade grew by about 3.3 million over the period. However, when the data are reclassified at the firm level, employment growth in retail trade during this period increases to about 3.8 million. Therefore, a firm-level industry classification strategy shows somewhat stronger growth for retail trade plus retail-owned firms than the growth shown by the original worksite industry assignment. Based on this strategy of identifying deviations in employment change between worksite and EIN industry assignment, the following industries changed the most over the period from the first quarter of 1990 to the fourth quarter of 2018: manufacturing, wholesale trade, information, retail trade, and transportation and warehousing. (See appendix table A-2 for index data for all of the industry groups examined in this article at the worksite, UI account, and firm level.)

A deeper look at the two industries that changed the most over the 1990–2018 period after reclassification

This section takes a deeper look at some of the most substantial compositional changes identified in the earlier analysis of broad industry employment trends. Recall that, under NAICS, industry assignment is determined by the worksite's dominant economic activity. Hence, the majority of employment in a firm with multiple worksites

generally will be in the industry originally assigned to the firm in the QCEW.[9] In this article, this employment is referred to as core industry employment. The firm may also own establishments and have employment in other industries, and this is referred to as noncore employment. In this section, I briefly explore the distribution of noncore employment in wholesale trade and retail trade, the two industries that showed the most difference between worksite and EIN industry assignment in the earlier analysis.

Wholesale trade

In the fourth quarter of 2018, core wholesale trade employment (i.e., employment in worksites and firms that shared the same industry classification) represented 87.2 percent of total employment in the industry. The noncore employment in firms connected to wholesale trade was most concentrated in management of companies and enterprises (1.8 percent), professional and technical services (1.5 percent), and warehousing and storage (1.0 percent), computer and electronic products manufacturing (0.8 percent), chemical manufacturing (0.7 percent), and building material and garden supply stores (0.6 percent). An additional 6.4 percent of noncore employment was spread among many other three-digit industries. (See table 2.)

Table 2. Noncore employment as a percentage of total firm employment in wholesale trade, by three-digit NAICS subsector, fourth quarter 2018

Industry	Percent
Total	12.8
Management of companies and enterprises	1.8
Professional and technical services	1.5
Warehousing and storage	1.0
Computer and electronic products manufacturing	0.8
Chemical manufacturing	0.7
Building material and garden supply stores	0.6
Remaining	6.4

Note: The “remaining” category consists of smaller shares of employment spread among many other three-digit industries. NAICS = North American Industry Classification System.

Source: U.S. Bureau of Labor Statistics.

In wholesale trade, the noncore industries in which employment increased the most over the 1990–2018 period when they were reclassified at the EIN level included auxiliary worksites in professional and business services (+2.5 percent),[10] manufacturing (+0.9 percent),[11] and transportation and warehousing

(+0.9 percent).[12] In total, firms in the wholesale trade industry reduced the employment share of the core industry by 4.7 percent. At the three-digit level, these firms mainly added additional worksites and employment in management of companies and enterprises (+1.1 percent), professional and technical services (+1.0 percent), and warehousing and storage (+0.8 percent). (See table 3.)

Table 3. Largest noncore industry employment changes in wholesale trade when industries are **reclassified at the EIN level, 1990–2018**

Noncore industry	Percent change in employment share

See footnotes at end of table.

Table 3. Largest noncore industry employment changes in wholesale trade when industries are **reclassified at the EIN level, 1990–2018**

Noncore industry	Percent change in employment share
Management of companies and enterprises	1.1
Professional and technical services	1.0
Warehousing and storage	0.8

Note: Changes measured from fourth quarter 1990 to fourth quarter 2018. EIN = employer identification number.

Source: U.S. Bureau of Labor Statistics.

Retail trade

In the fourth quarter of 2018, core employment in retail trade represented 93.3 percent of total employment for the industry. The noncore employment in firms connected to retail trade was primarily found in warehousing and storage (2.3 percent) and management of companies and enterprises (1.9 percent). (See table 4.)

Table 4. Noncore employment as a percentage of total firm employment in retail trade, by three-digit NAICS subsector, fourth quarter 2018

Industry	Percent
Total	6.7
Warehousing and storage	2.3
Management of companies and enterprises	1.9
Merchant wholesalers, nondurable goods	0.3
Merchant wholesalers, durable goods	0.3
Telecommunications	0.3
Administrative and support services	0.3
Remaining	1.3

Note: The “remaining” category consists of smaller shares of employment spread among many other three-digit industries. NAICS = North American Industry Classification System.

Source: U.S. Bureau of Labor Statistics.

In retail trade, the noncore industries in which employment increased the most over the 1990–2018 period when they were reclassified at the EIN level included auxiliary worksites in transportation and warehousing (+1.7 percent), professional and business services (+1.1 percent), and information (+0.3 percent). The noncore industry with the largest decrease in employment over this period was worksites in manufacturing (−0.4 percent). In total, firms in the retail trade industry reduced the employment share of the core industry by 2.4 percent over these years. At the three-digit level, these firms mainly added more worksites and employment in warehousing and storage (+1.6 percent), management of companies and enterprises (+1.1 percent), and telecommunications (+0.3 percent). Although these changes do not fully encompass the e-commerce-related changes in and outside of this industry, they seem to support the e-commerce changes in retail trade that are well known—that is, a greater reliance on warehousing and storage, management of companies and enterprises, and telecommunications. (See table 5.)

Table 5. Largest noncore industry employment changes in retail trade when industries are reclassified at **the EIN level, 1990–2018**

Noncore industry	Percent change in employment share
Warehousing and storage	1.6
Management of companies and enterprises	1.1
Telecommunications	0.3

Note: Changes measured from fourth quarter 1990 to fourth quarter 2018. EIN = employer identification number.

Source: U.S. Bureau of Labor Statistics.

Conclusion

Several economic statistics can be used to measure industry change. BLS statistics used for this purpose include employment, hours, wages, turnover, industry productivity, and producer prices. This suite of statistics tells us much about the growth and decline of industries and about changes in prices, industry hires and separations, industry productivity, and average hourly, weekly, and annual wages paid to employees. These statistics can be supplemented by looking at employer size class, business age, the employment associated with expanding and contracting businesses, and other statistics readily available from BLS. Each of these statistics is mostly focused on telling us how industries are doing today, with some historical context to aid in understanding their contribution to the overall economy.

The statistics I have examined in this article are not focused on how much employment is in an industry or how much its employees are paid. Rather, the article examines data to identify industries in which employment trends would have been different if an auxiliary-like industry coding practice had been used, and then briefly explores the composition of industries in which those trends were most changed when the auxiliary-unit concept was used.

This article shows that, over the study period, several industries changed compositionally with respect to the noncore worksites that businesses own. Among the industries that changed the most over the period are wholesale trade and retail trade. The article also confirms that the worksite assignment of industry typically yields similar employment trend results to industry assignment made at the level of a UI account or an EIN, with some moderate deviations.

Appendix: recode data and index data

Table A-1. Recode data: levels for first quarter 1990 for data coded to NAICS by worksite, UI account, and EIN (in thousands)

Table A-2. Index data for all industries, worksite, UI account, and EIN assignment of industry, 1990–2018

SUGGESTED CITATION

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NOTES

1 For more information on the North American Industry Classification System (NAICS), see https://www.census.gov/naics/. The use of NAICS as an industry classification system is mandated for federal statistical agencies by the Office of Management and Budget. Having a common classification system allows data users to compare data from various federal statistical agencies, knowing that each agency defines industries in the same way. NAICS also facilitates efficient sampling and estimation, because within detailed industry and size-class cells, the business activities, employment, and wages across worksites are relatively homogenous.

2 The former concept of the auxiliary unit from the Standard Industrial Classification (SIC) system was not ideal. The concept was based on ownership as well as function, which tended to reduce the clarity of economic reports. For example, consider a large retail firm that operates its own warehouse, and suppose that the warehouse was classified as part of a retail-owned business (as it would be under the SIC system). Now suppose that the retailer decides to make the warehouse part of a separate company, with the retailer purchasing warehousing services from it. In this scenario, employment would have declined in retail trade and increased in warehousing and storage. But the employment decline really had nothing to do with retail trade; rather, it was about a company's decision about which support services to own and which to purchase. By contrast, under NAICS, the warehouse would be assigned to the warehousing and storage industry, regardless of ownership. As a result, NAICS makes economic trends for warehousing and storage about that industry and its functions, rather than about who owns the warehouse. Nevertheless, note that this increased clarity of reporting about what is happening in individual industries can also obscure broader changes in businesses, especially in the longer term. Over the past few decades, for example, growth in e-commerce (retailers that do not operate in a traditional brick-and-mortar site) has led to that industry taking over a substantial portion of retail sales. This transformation of the retail sector affects employment in a number of industries that support e-commerce, including warehouses, and couriers and messengers.

3 See Standard Industrial Classification Manual, 1987 (Executive Office of the President, Office of Management and Budget, 1987), p. 13, https://www.naics.com/wp-content/uploads/2017/05/SIC-Full-1987-Manual.pdf.

4 Ibid., p. 16.

5 See North American Industry Classification System: United States, 2017 (Executive Office of the President, Office of Management and Budget, 2017), p. 3, https://www.census.gov/eos/www/naics/2017NAICS/2017_NAICS_Manual.pdf.

6 Ibid., pp. 19–20.

7 For more information, see the U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages page at https://www.bls.gov/cew/.

8 Note that some worksites enter the unemployment insurance system without having a NAICS industry code and are labeled "unclassified" until an industry code is assigned. Table 1 excludes a row for these records; therefore, the sum of the differences shown do not sum to zero.

9 In this article, the NAICS code is assigned as the two-digit industry with the single largest employment value among all two-digit industry employment values from worksites owned by the firm.

10 The professional and business services industry group includes the NAICS two-digit industries 54, 55, and 56.

11 The manufacturing industry includes the NAICS two-digit industries 31, 32, and 33.

12 The transportation and warehousing industry includes the NAICS two-digit industries 48 and 49.

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The U.S. productivity slowdown: an economy-wide and industry-level analysis

Labor productivity—defined as output per labor hour—has grown at a below-average rate since 2005, representing a dramatic reversal of the above-average growth of the late 1990s and early 2000s. The productivity slowdown during these years has left many economic observers wondering why this situation has occurred and what factors may have contributed. To clarify potential sources of the productivity slowdown, this article presents an analysis of labor *productivity and its component series—multifactor* productivity, contribution of capital intensity, and *contribution of labor composition—at both the economy-*wide and industry levels, complemented with a survey of the contemporary productivity literature.

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The figure—$10.9 trillion—represents the cumulative loss in output in the U.S. nonfarm business sector due to the labor productivity slowdown since 2005, also corresponding to a loss of $95,000 in output per worker.[1]

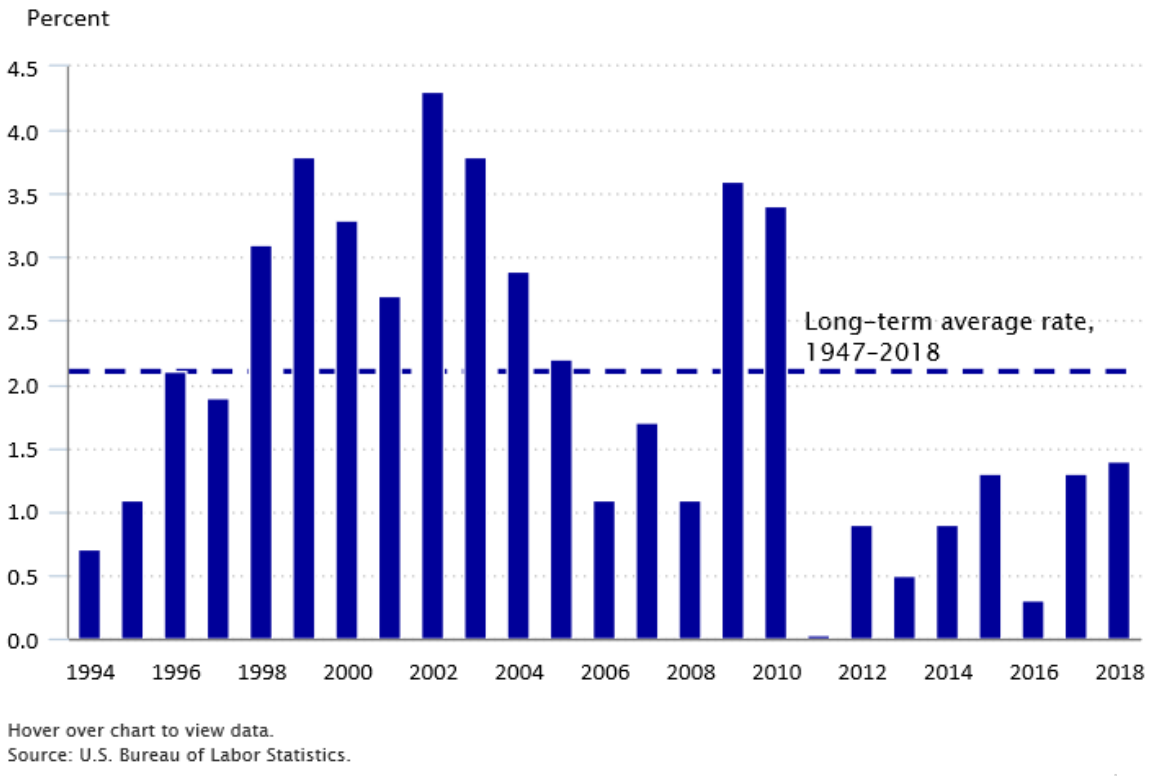
These figures show that, when there is consistently below-average productivity growth, year after year, a substantial effect can result over an extended period. How could this situation have occurred, in a modern and technically advanced economy such as in the United States? Well, not only has the productivity slowdown been one of the most consequential economic phenomena of the last two decades, but it also represents the most profound economic mystery during this time, and though many economists have grappled with the issue for over a decade and even created some innovative research approaches to address the question, we still cannot fully explain what brought on this situation.

One of the more perplexing aspects of the current slowdown is its genesis: that it came immediately following a historic productivity boom in the United States, and represented a swift rebuke of the popular idea of that time that we had entered a new era of heightened technological progress. The suddenness and size of the reversal were difficult to comprehend. For some background, in the late 1990s, when that much-cited productivity boom had begun, U.S. labor productivity growth had accelerated to rates of change that had not been seen since the late 1960s and early 1970s. This late 1990s surge surprised many economic observers, who had become accustomed to the below-average productivity growth rates of the mid-to-late 1970s through the early 1990s. In addition, the

situation in the United States was even more startling due to the fact that the rest of the more-developed economies of the world were not similarly experiencing a speedup in growth rates.[2]

A debate ensued among economists: Was the tremendous productivity growth of the late 1990s here to stay—a fundamental change generated by the computing and internet-related innovations that were all around us—or was it a temporary phenomenon that would pass? The fact that the productivity speedup persisted through the recession of 2001, and then became even more pronounced in 2002, convinced many observers that perhaps something had changed.[3] The acceleration of U.S. productivity growth is shown in figure 1, illustrated by the growth rates during 1998 through 2005, which rise above the long-term average rate since 1947, denoted by the dashed blue line. Over these high-growth years, U.S. labor productivity grew at an average rate of 3.3 percent,[4] which is markedly higher than the cumulative 2.1-percent average rate from 1947 to 2018.

Figure 1. Labor productivity growth: annual percent changes, nonfarm business sector, 1994–2018



Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

This high-growth period came to an end during the mid-2000s, when U.S. labor productivity growth rates began to stumble, and in 2006 receded below the long-term average trend line for the first time in a decade. And, notwithstanding 2 years of high growth in 2009 and 2010 following the Great Recession, productivity growth rates have remained stubbornly low in subsequent years. Many economic observers were yet again surprised, in this case at just how drastically growth rates slowed, given the recently observed high rates of growth and the continued technological innovations that were proliferating throughout the economy. In the years since 2005, labor productivity has grown at an average annual rate of just 1.3 percent, which is lower than the 2.1-percent long-term

average rate from 1947 to 2018. The slow growth observed since 2010 has been even more striking: labor productivity grew just 0.8 percent from 2010 to 2018.

As the slowdown in labor productivity growth has steadily held on throughout the past decade, economic observers have been trying to understand this phenomenon, which has the effect of placing downward pressure on economic growth, worker compensation gains, profits growth, and gains in living standards of Americans. Many observers began to wonder: Why has U.S. labor productivity growth been so consistently low in recent years, and why is it so markedly different from the strong growth observed relatively recently? This article presents two approaches to address these questions, with each approach including an analysis of the U.S. Bureau of Labor Statistics (BLS) productivity data and a review of the contemporary productivity literature. First, the economy-wide slowdown in labor productivity growth is analyzed by breaking out the series into its three component series: multifactor productivity (MFP) growth, the contribution of capital intensity, and the contribution of labor composition. Second, industry-level productivity data are used to identify the industries that made notable contributions to the economy-wide labor productivity slowdown.

Economy-wide analysis of the U.S. labor productivity slowdown

This section presents an analysis of the economy-wide slowdown in labor productivity growth that decomposes the series into its three component series: multifactor productivity growth, the contribution of capital intensity, and the contribution of labor composition. This section also presents a dollar and time cost analysis of the slowdown, and an analysis of how U.S. regions impacted the economy-wide slowdown.

Decomposition of labor productivity growth

Labor productivity is a measure of economic performance that compares the amount of goods and services produced (output) with the number of labor hours used in producing those goods and services. It is defined mathematically as output per hour of work, and growth occurs when output increases faster than labor hours. For example, if output is rising by 3 percent and hours are rising by 2 percent, then labor productivity is growing by 1 percent.

Labor productivity growth is vitally important to present and future prospects for economic growth, because it represents the only path by which economic growth can rise above what would be possible by simply increasing labor hours (as, by definition, economic growth can only come from either hours growth or labor productivity growth). The economic gains brought about by labor productivity growth make it possible for an economy to achieve higher growth in labor income,[5] profits and capital gains of businesses, and public sector revenue; these economic gains also hold the potential to lead to improved living standards for those participating in an economy, in the form of higher income, greater leisure time, or a mixture of both. In addition, as labor productivity rises, all of these factors may increase simultaneously, without gains in one coming at the cost of one of the others.

Given the importance of labor productivity growth, it is worth delving into the measure in more detail to see what underlying factors are making this growth possible. As such, in addition to labor productivity growth being defined as a residual—the difference between output growth and hours growth—we can also analyze it as a sum, built up from the contributions of its three component series.

Components of labor productivity growth

The following equation allows us to quantify the sources of labor productivity growth and helps us better understand the measure by looking into its three component series:

labor productivity growth = multifactor productivity growth + contribution of capital intensity + contribution of labor composition

Multifactor productivity (MFP) growth represents the portion of output growth that is not accounted for by the growth of capital and labor inputs and is due to contributions of other inputs, such as technological advances in production, the introduction of a more streamlined industrial organization, relative shifts of inputs from low to high productivity industries, increased efforts of the workforce, and improvements in managerial efficiency. Similar to labor productivity growth, MFP growth can also be defined as a residual—output growth minus the growth of the combined inputs of labor and capital.

The contribution of capital intensity is defined as the capital-weighted change in the capital-labor ratio. The measure is computed as capital's share of current dollar costs multiplied by the growth in capital services per labor hour. The contribution of capital intensity—also called capital deepening—reflects businesses' decision-making process between hiring more workers and purchasing more or higher-quality equipment, or of substituting equipment for workers or vice versa.* In cases in which firms increase their usage of capital relative to labor, or where capital costs rise relative to labor costs, there will be an increase in the contribution of capital intensity to labor productivity growth.

The contribution of labor composition is defined as the labor-weighted change in a measure—labor composition—which reflects shifts in the level of skills and experience of the workforce. It is computed as labor's share of current dollar costs multiplied by labor composition.** The contribution of labor composition helps us gauge the productive capacity of the workforce at a given point in time. When firms hire more workers with higher skills and more experience or lay off workers with lower skills or less experience, or when labor costs rise relative to capital costs, the contribution of labor composition to labor productivity growth increases.

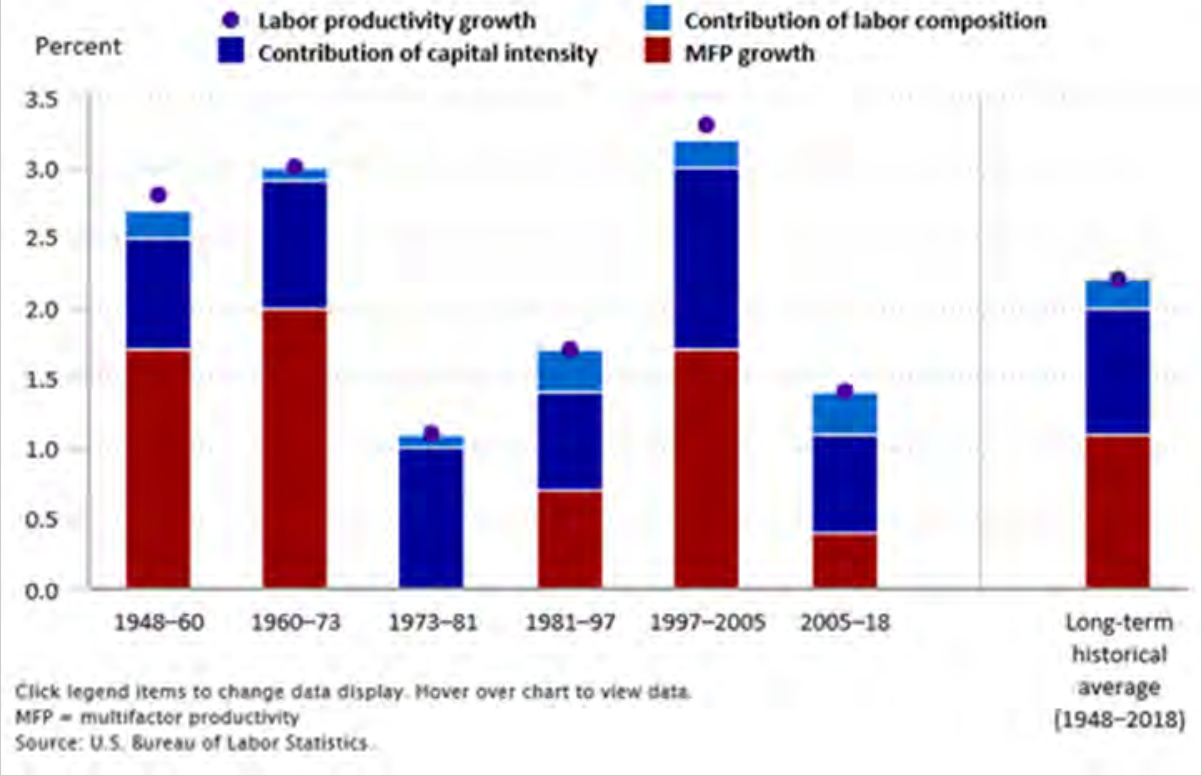
* Specifically, the contribution of capital intensity is defined as $w_k \left[\left(\ln\frac{K_t}{K_{t-1}}\right) - \left(\ln\frac{L_t}{L_{t-1}}\right)\right]$, where w_k is the 2-year average cost share of capital and K_t and L_t are capital services and labor hours at a given time t.

** The BLS labor composition methodology can be found at https://www.bls.gov/mfp/mprlabor.htm.

The three components of labor productivity growth are displayed in figure 2 for the slowdown period (2005–18), the speedup period (1997–2005), as well as other selected post-World War II (WWII) periods and the long-term historical average.[6] Labor productivity growth, corresponding to the purple dots, represents the sum of the three stacked bars of MFP growth,[7] contribution of capital intensity, and contribution of labor composition. It is apparent that the labor productivity growth rate (1.4 percent) of the slowdown period has slackened relative to the rate of the

speedup period and is also below the long-term historical average. Furthermore, we can see from the diminished red and dark-blue stacked bars of the slowdown period relative to the bars of the speedup period that MFP growth and the contribution of capital intensity are the sources of the U.S. labor productivity slowdown. (The contribution of labor composition was approximately the same as that of the speedup period and did not contribute to the slowdown.[8]) MFP grew 0.4 percent during the slowdown period, which is less than one-fourth the growth of the speedup period and is also well below the long-term historical average. In addition, the contribution of capital intensity in the slowdown period, 0.7 percent, is around half that of the speedup period and is also below the long-term historical average.

Figure 2. Contributions to labor productivity growth: MFP growth, contribution of capital intensity, contribution of labor composition, average annual growth rates for selected periods, private nonfarm business sector, 1948–2018



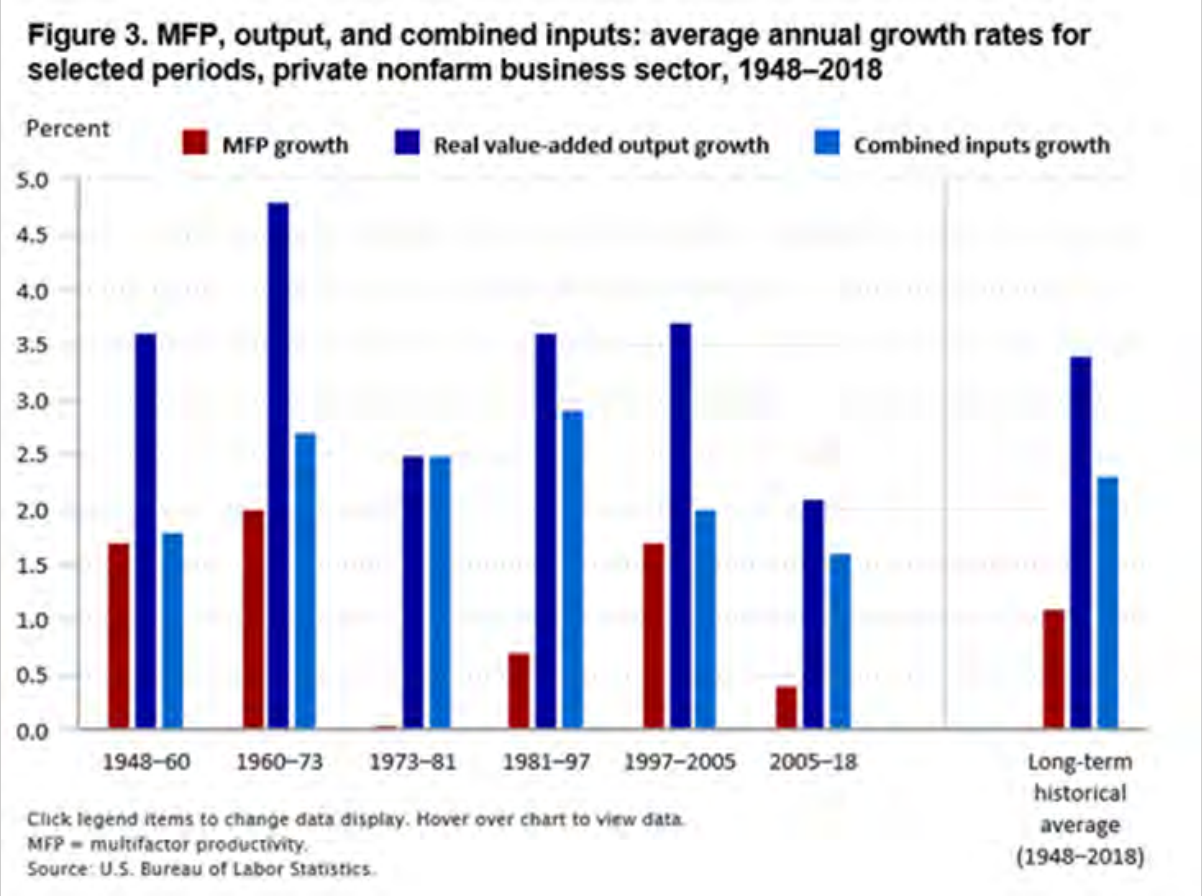
The deceleration in MFP growth—the largest contributor to the slowdown—explains 65 percent of the slowdown relative to the speedup period; it also explains 79 percent of the sluggishness relative to the long-term historical average rate. The massive deceleration in MFP growth is also emblematic of a broader phenomenon shown in figure 2. We can see that throughout the historical period since WWII, the majority of the variation in labor productivity growth from one period to the next was from underlying variation in MFP growth, rather than from the other two components. While the contribution of labor composition varied only between a range of 0.1 percent to 0.3 percent during the entire post-WWII era and the contribution of capital intensity varied between 0.7 percent and 1.3 percent, MFP growth varied within a wider range, between 0.0 percent and 2.0 percent.[9]

At the same time, in addition to the notable variation in MFP growth during the recent periods, something unprecedented about these recent periods was the additional contribution from variation in the contribution of capital intensity. The contribution of capital intensity had previously remained within a relatively small range (0.7 percent to 1.0 percent) during the first five decades of post-WWII periods, but then in the 1997–2005 period, the measure nearly doubled, from 0.7 percent up to 1.3 percent, followed by nearly halving to 0.7 percent in the 2005–18 period. This unprecedented variation in the contribution of capital intensity was the factor that combined with the variation in MFP growth to bring about such historic speedup and slowdown periods in recent years, increasing the size of the overall labor productivity slowdown to rival the widely noted 1970s slowdown. The contribution of capital intensity accounts for 34 percent of the labor productivity slowdown relative to the speedup period and explains 25 percent of the sluggishness relative to the long-term historical average rate.

The slowdown in MFP growth

Now let us take a deeper look into the two contributors to the labor productivity slowdown. For MFP growth, let us start out by noting the inherent difficulty in attempting to quantify the sources, components, or causes of MFP growth or lack thereof. This difficulty arises because MFP growth itself cannot be measured or identified on its own but can only be ascertained as the leftover output growth that remains after all measurable inputs to production—in this case, labor and capital[10]—have already been taken into account. With MFP growth, we are actually measuring something that is unidentifiable, similar to how cosmologists can measure the extent of dark matter and its influence on the universe even as they do not know what this matter comprises.[11] This is the reason that the question of what is driving the slowdown in MFP growth has puzzled so many economic observers in recent years and still remains incompletely explained following more than a decade of work on the issue.

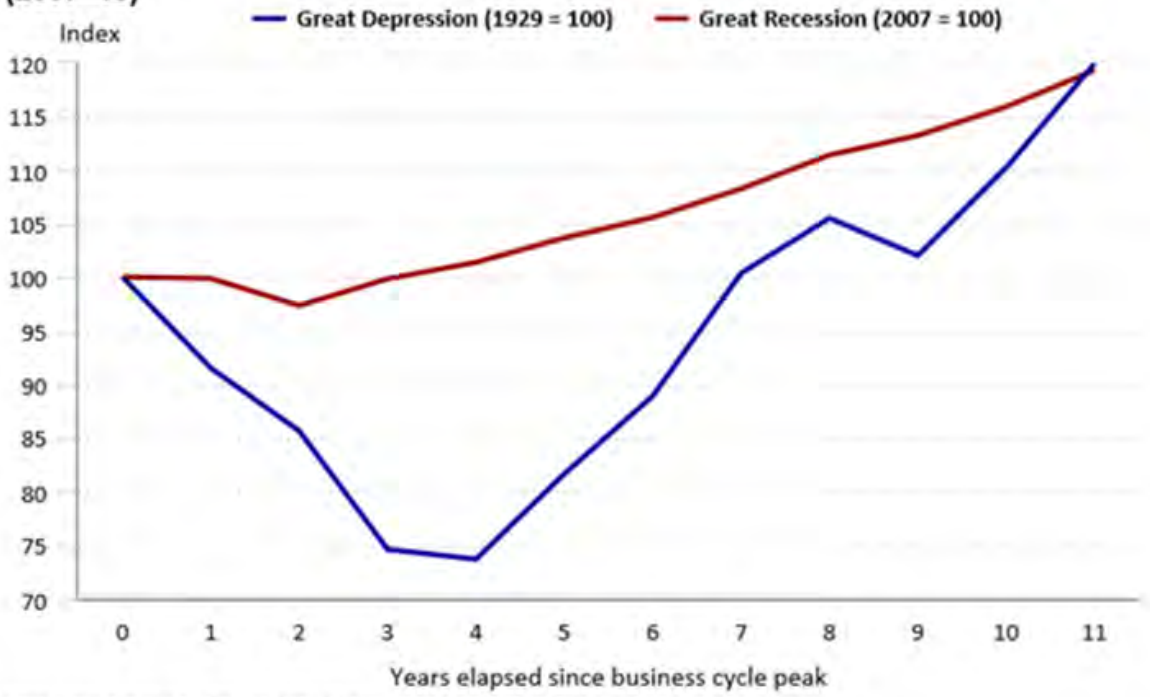
However, there are a few approaches that can be taken to help us gain a foothold on what might be happening to MFP growth, both by using BLS data as well as by looking at some clever approaches of the numerous researchers working on this issue. As a first step in our analysis, let us look at the BLS series used in calculating MFP growth, in order to provide some background and context on the economy in which the MFP slowdown took place. As just noted, MFP growth is a residual: output growth minus the growth of the combined inputs of capital and labor. Figure 3 reveals that, although both output growth and combined input growth atrophied in the slowdown period relative to their higher rates of the speedup period, output growth succumbed to a much more serious retrenchment. Namely, while combined input growth slowed by 0.4 percentage point, output growth slowed 4 times as much, by 1.6 percentage points. The fact that output growth retreated so much further than combined inputs during the slowdown period is reflected in the notably low MFP growth rate of 0.4 percent during this period, and is a key fact connected with the productivity slowdown. For this reason, as we begin our investigation of the MFP slowdown, we will first be looking closely at the historically weak output growth and getting a sense of the state of the economy during this period.



Historically weak output growth of the post-2005 slowdown period

The rate of output growth during the 2005–18 slowdown period (2.1 percent) is a historically weak growth rate. Not only does this rate pale in comparison to the 3.7-percent growth of the speedup period, but it also represents a historically slow rate for the entire post-WWII period, well below the historical average growth rate of 3.4 percent (see figure 3). Of course, a large portion of the below-average output growth in the slowdown period reflects the fact that this period encompasses the global financial crisis and Great Recession of 2007–09 and the subsequent recovery. It might surprise some to discover that the post-2007 business cycle, which contains this historic downturn, not only had slower cyclical growth than all previous business cycles since WWII, but it even recorded a slower overall growth rate than the Great Depression of the 1930s (see figure 4). In the case of the Great Depression, output plummeted by 26 percent—a much more severe decline than the 3-percent decline during the Great Recession.[12] However, the recent cycle exhibited a much weaker recovery than that of the Great Depression, with output growth from 2009 to 2018 being less than one-third of the 7.2-percent rate posted during the peacetime recovery from 1933 to 1940.[13] Because of this extended weak recovery, as of 2018, the post-2007 cycle's growth rate came in slightly below what had occurred during the 1930s—even more striking when one considers that the population growth rate was the same in these two periods.[14]

Figure 4. Output during declines and recoveries, relative to business cycle peak: real GDP index of Great Depression (1929–40) and Great Recession (2007–18)



Click legend items to change data display. Hover over chart to view data.
GDP = gross domestic product.
Source: U.S. Bureau of Labor Statistics.

The historically low output growth of the post-2007 business cycle—and particularly the anemic recovery—was not wholly unexpected. Valerie Cerra and Sweta Chaman Saxena, Carmen M. Reinhart and Kenneth S. Rogoff, and Carmen M. Reinhart and Vincent R. Reinhart show that a permanent loss of output and a lack of rebound to the long-term growth trend often follow financial crises such as the one the United States experienced in 2008.[15] Similarly, the International Monetary Fund (IMF) asserts that output losses arising from banking crises are usually substantial, stating that "typically, output does not recover to its precrisis trend. On average, output falls steadily below its precrisis trend until the third year after the crisis and does not rebound thereafter," although the IMF also clarifies that following this permanent output loss, "medium-term growth rates tend to eventually return to the precrisis rate."[16] Daisuke Ikeda and Takushi Kurozumi offer a story that may underlie this phenomenon, suggesting that an "adverse financial shock tightens firms' financing and thereby dampens their activities, which in turn has a significant negative impact on the economy as a whole by decreasing activities not only on the demand side but also on the supply side of the economy. The effect on the supply side, such as the sectors of research and development (R&D) and technology adoption, induces a persistent decline in [MFP] and thus can cause a permanent decline in output relative to a pre-shock balanced growth path."[17]

James H. Stock and Mark W. Watson look even further back in time, to before the financial crisis, claiming that more than half of the weakness of the recovery is from slower long-term trend growth—due to changing demographics—that was already apparent before the Great Recession.[18] However, they also note that particularly slow government spending (specifically from the phaseout of the American Recovery and

Reinvestment Act and the budget sequestration of 2013, as well as from slow state and local government hiring during the entire recovery) and faltering international demand following the recession also played a role. Ray C. Fair also cites sluggish government spending following the Great Recession, asserting that it was the central factor underlying the weak recovery.[19]

In addition to researchers citing weak fiscal stimulus, other researchers have pointed to limitations on monetary stimulus. Robert E. Hall offers that the zero lower bound on interest rates following the financial crisis presented a limiting factor that had not been operative in prior U.S. recessions.[20] Robert J. Barro also claims that monetary stimulus was insufficient to spur a vigorous recovery.[21]

The drag on MFP growth from the Great Recession

Now that we have an understanding of the recent trends in the measures used to compute MFP growth (in particular the unusually slow output growth of recent years), our first task is to attempt to use this basic information to help us better understand the slowdown in MFP growth. Specifically, we may ask: Could the state of the economy during the slowdown period, as indicated by the atypically low output growth, especially with it running below its potential and capacity during and following the Great Recession, have helped to cause the low MFP growth?

Yes, according to several authors, the weakened state of the economy during much of the 2005–18 slowdown period could be one factor underlying the low MFP growth. As noted earlier, Ikeda and Kurozumi argue that when an economy is operating below its potential, firms may pull back on investment in R&D and new technology.[22] David M. Byrne, Stephen D. Oliner, and Daniel E. Sichel concur, noting that one possible explanation for the productivity slowdown is that "the economy has taken a long time to recover from the financial crisis and Great Recession, as the repair of balance sheets has proceeded slowly and as uncertainty about the pace of the recovery has held back investment."[23] Romain Duval, Gee Hee Hong, and Yannick Timmer agree, postulating that "the combination of pre-existing firm-level financial fragilities and tightening credit conditions made an important contribution to the post-crisis productivity slowdown,"[24] and also that "while most forms of physical capital can be pledged as collateral to get a loan, intangible assets such as R&D or workforce training cannot. Furthermore, investments in intangible assets tend to translate more slowly into sales and to be riskier. Therefore, [their] hypothesis is that credit-constrained firms cut their investment in intangible assets, contributing in part to a sharper productivity slowdown after the crisis."[25]

Waning dynamism: reduced responsiveness to productivity gains at the firm level

At the same time, although the Great Recession and its aftermath have substantially affected recent economic trends, the data clearly show that the productivity slowdown started before the global financial crisis and Great Recession.[26] Looking back at figure 1, we can see that labor productivity grew at a successively lower rate in each consecutive year from 2002 through 2006, descending to well below the long-term average trend by 2006. So, a second question emerges: What might have led to this initial slowing and commencement of the slowdown period, or, more broadly, what factors might have contributed to the productivity slowdown of the entire 2005–18 period, other than the Great Recession and its deficient recovery?

One major finding is that the businesses that have been spurring recent innovations are having difficulty expanding, and thus, their innovations are failing to make a bigger impact on the economy as a whole than would otherwise be the case. Ryan A. Decker, John C. Haltiwanger, Ron S. Jarmin, and Javier Miranda show that, despite the broad slowdown in productivity growth, many firms are actually still seeing strong productivity gains, with innovation having continued to occur at the "productivity frontier" during the slowdown period since the early 2000s, among the firms that are the productivity leaders in their respective industries.[27] The authors reveal this indirectly, by observing that productivity dispersion in the United States has expanded in recent years, which means that a wider gap exists between these leading firms and the laggards. The authors claim that, within the framework of Michael Gort and Steven Klepper, this increased productivity dispersion implies that there has not been a declining pace of innovation.[28]

So then, why are the innovations that have been sparking at these higher-productivity firms not translating into solid economy-wide productivity gains? The answer has to do with how these firms have responded to their productivity windfall. Namely, Decker et al. observe decreased responsiveness to these firm-level productivity bursts as a potential source of the aggregate productivity slowdown, as evidenced by falling rates of job reallocation among these firms.[29] In other words, many of the firms that have been innovating have not similarly been able to scale up and hire more employees commensurate with their improved productivity.

This slump in firm-level reallocation coincides with the timeline of the aggregate productivity slowdown, with Decker et al. finding that "reallocation has declined in all sectors—particularly the high-tech sector—since the early 2000s."[30] In terms of quantifying the impact of this phenomenon, the authors observe that "counterfactual exercises imply that the decline in responsiveness yields a significant drag on aggregate (industry-level) productivity, as much as 2 log points in high-tech manufacturing and more than 5 log points economy-wide in recent years."[31] (Note that we will further explore in depth the slowdown in high-tech manufacturing in the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article, particularly the dramatic slowdown in the computer and electronic products industry.) As for the underlying sources, which may be resulting in these lower rates of reallocation, Decker et al. cite several potential factors: rising adjustment costs, globalization, increased regulation, and declining competition.

The factor of declining competition—as potentially having a stultifying effect upon productivity-enhancing job reallocation—has been of particular interest in the literature, with Jan De Loecker, Jan Eeckhout, and Gabriel Unger outlining this phenomenon in the United States, offering as evidence that average markup costs have nearly tripled—from 21 percent as of 1980 to a level of 61 percent in 2016—in addition to the rate of profits expanding by 8 times its size, from 1 percent to 8 percent.[32] The authors claim that "because passthrough [of cost savings from productivity growth to lower prices for consumers] is lower in the presence of higher market power, the rise in market power will give rise to [a] lower degree of adjustment of the variable inputs, including labor, for the same [productivity] shock process. The rise in market power thus can rationalize the decrease in labor reallocation across firms, even if the observed shocks to firm productivity [have] remained constant."[33]

Gustavo Grullon, Yelena Larkin, and Roni Michaely echo De Loecker et al.'s data and analysis on increasing market power, stating that such findings "are robust to the inclusion of private firms and factors that account for foreign competition, as well as the use of alternative measures of concentration. Overall, [their] findings suggest that the nature of US product markets has undergone a structural shift that has weakened competition."[34]

Furthermore, undergirding these findings regarding expanded market power are findings of not only rising concentration across firms but also rising concentration in ownership across firms, with a few large shareholders in multiple companies in a given industry.[35] Other related findings include relaxed antitrust enforcement, increased mergers and acquisitions, and other restraints on competition, including increases in occupational licensing by states, the growth of land use restrictions, a greater scope of intellectual property law, and increases in lobbying and political rent seeking.[36]

Additionally, it might be of interest that, in a slightly different analysis of the widening productivity dispersion of high-growth and low-growth firms found by Decker et al., Dan Andrews, Chiara Criscuolo, and Peter N. Gal have proposed that "stalling technological diffusion" may be a possible source of this widening productivity dispersion, theorizing that low-growth firms may be having a difficult time integrating new technologies.[37] However, Decker et al. caution and clarify that "while the diffusion hypothesis could play a role, [their] estimates of [MFP] persistence suggest that the group of 'frontier firms' is sufficiently fluid to somewhat limit the diffusion story's explanatory power. Increased adjustment frictions is an alternative, but not mutually exclusive, explanation."[38]

Income inequality

Escalating income inequality may also be a factor underlying the productivity slowdown, according to Jason Furman and Peter Orszag.[39] Namely, though low productivity growth may be leading to rising inequality, it may also be that rising inequality is reducing productivity growth, by stifling "the ability to harness the talents of potential innovators across the income spectrum." The authors caution, however, that "any plausible magnitude for such an effect would fall well short of explaining the 1.0- to 1.5-percentage-point drop in productivity growth."[40] Furman and Orszag further qualify that rising income inequality and low productivity growth may both "have a common cause, namely that reduced competition and reduced dynamism—in part caused by specific policy changes—have contributed to both issues."[41] Some empirical support for Furman and Orszag's hypothesis that income inequality may be a potential factor in sluggish productivity growth has been offered by Ruchir Agarwal and Patrick Gaulé, who examine income disparities on a global scale and observe that "talented individuals born in low- or middle-income countries are systematically less likely to become knowledge producers."[42]

The debate over innovation possibilities in the 21st century

At this point, it should be noted that a weighty qualifier exists with regard to all the foregoing material regarding the MFP slowdown, on the basis of a notably different perspective on the recent data taken by several economists, such as Robert J. Gordon and John G. Fernald.[43] These authors have hypothesized that a productivity slowdown has not occurred per se in recent years. Rather, they contend that a productivity reversion to the "new normal" of lower productivity growth, established in the early 1970s, has occurred.

More specifically, these economists assert that the information technology (IT)-based innovations of recent decades are no match for the world-changing impacts of widespread electricity, the internal combustion engine, and indoor plumbing that emerged in the late 1800s and early 1900s. They claim that productivity growth cannot be expected to sustainably continue on the same high-growth trend that previously had been seen as of the mid-20th century. Furthermore, they regard the productivity speedup of the late 1990s and early 2000s as the true

outlier and the subsequent low productivity growth as merely the expected case in this relatively lower innovation era.

One underlying rationale for this potential story is provided by Joseph A. Tainter.[44] This author offers that, in general, as complexity in a society increases following initial waves of innovation, further innovations become increasingly costly because of diminishing returns. As a result, productivity growth eventually succumbs and recedes below its once torrid pace: “As easier questions are resolved, science moves inevitably to more complex research areas and to larger, costlier organizations,” clarifying that “exponential growth in the size and costliness of science, in fact, is necessary simply to maintain a constant rate of progress.” Nicholas Bloom, Charles I. Jones, John Van Reenen, and Michael Webb offer supporting evidence for this view regarding the United States, asserting that given that the number of researchers has risen exponentially over the last century—increasing by 23 times since 1930—it is apparent that producing innovations has become substantially more costly during this period.[45]

However, at the same time, some other economists have a few qualifiers of their own regarding the hypothesis that we have long been in an essentially low-productivity era. Chad Syverson reminds us that productivity slowdowns did occur between the waves of innovation during the late 1800s and early 1900s, as seminal technologies such as electricity and the internal combustion engine emerged.[46] Ana Paula Cusolito and William F. Maloney add that “while this prior diffusion hardly implies that a second IT wave is imminent, it does show that productivity accelerations from general-purpose technologies do not have to be one-off events. Just because their resultant productivity growth sped up in the late 1990s and early 2000s does not mean it cannot speed up again.”[47]

To sum up this section, from an economy-wide perspective, we can identify several plausible explanations for the slowdown in MFP growth, including

- declining rates of productivity-enhancing job reallocation,
- rising market power and industry concentration,
- greater restraints on competition,
- growing income inequality,
- the drag from the global financial crisis and Great Recession and its weak recovery,
- diminishing returns to innovation relative to that of the late-19th and early to mid-20th centuries, and
- a historically wavelike tendency of innovations.

It appears likely that the MFP slowdown is coalescing from a combination of these factors, though it may not be possible to place them into an integrated framework or decomposition, given that they address the issue of the MFP slowdown from widely different perspectives—some cyclical, some noncyclical, and some more qualitative in nature than quantitative—and as there may be other factors, which have not yet been discovered. However, these factors do provide us with an overall sense of what may be undergirding the slowdown.

It should also be noted that the story of the MFP slowdown does not end here. In the “Industry-level analysis of the U.S. labor productivity slowdown” section of this article, we will analyze the slowdown from an industry-level perspective, investigating the

- large negative contribution from the computer and electronic products industry,

- large negative contributions from the retail and wholesale trade industries, and

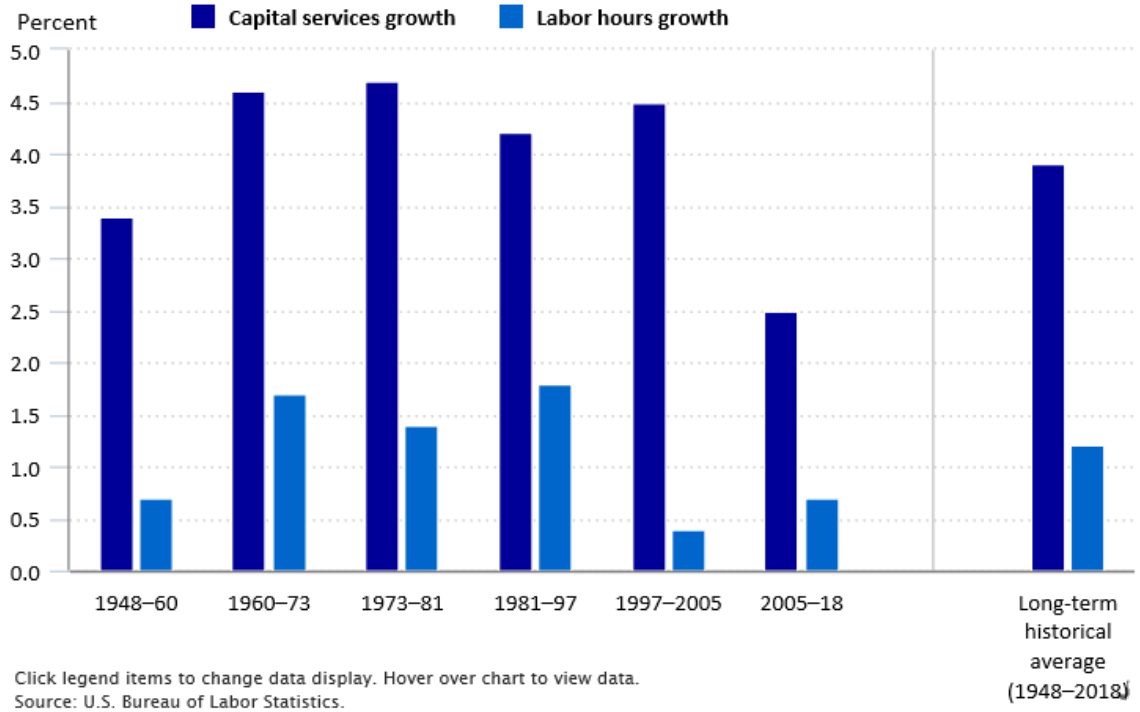
- small negative contributions from most other industries.

The slowdown in the contribution of capital intensity

Alongside the slowdown in MFP growth is the other contributor to the labor productivity slowdown: the contribution of capital intensity. This measure has exhibited an unprecedented variation and, from 2005 to 2018, was cut by nearly half relative to the 1997–2005 speedup period. As noted previously, the contribution of capital intensity grew just 0.7 percent during the 2005–18 slowdown period, which is lower than the 1997–2005 speedup period (1.3 percent) and the historical average rate (0.9 percent). As was also noted, the measure accounts for 34 percent of the labor productivity slowdown relative to that of the speedup period, explains 25 percent of the sluggishness relative to the long-term average percentage rate, and had the lowest growth among all the selected post-WWII periods (see figure 2).[48]

Given that the contribution of capital intensity is calculated as the difference in growth rates between capital and labor inputs, multiplied by the capital cost share, we can determine how much each of these three underlying factors contributed to its slowdown. As shown in figure 5, capital services grew during the slowdown period at a rate of 2.5 percent, which is well below both its rate for the speedup period (4.5 percent) and its long-term average (3.9 percent). Labor hours grew at a rate of 0.7 percent, which lies between its rate for the speedup period (0.4 percent) and its long-term average (1.2 percent). Capital's cost share was 38 percent during the slowdown period, which is higher than during the speedup period (33 percent) and the long-term average rate (34 percent).

Figure 5. Capital services and labor hours: average annual growth rates for selected periods, private nonfarm business sector, 1948–2018



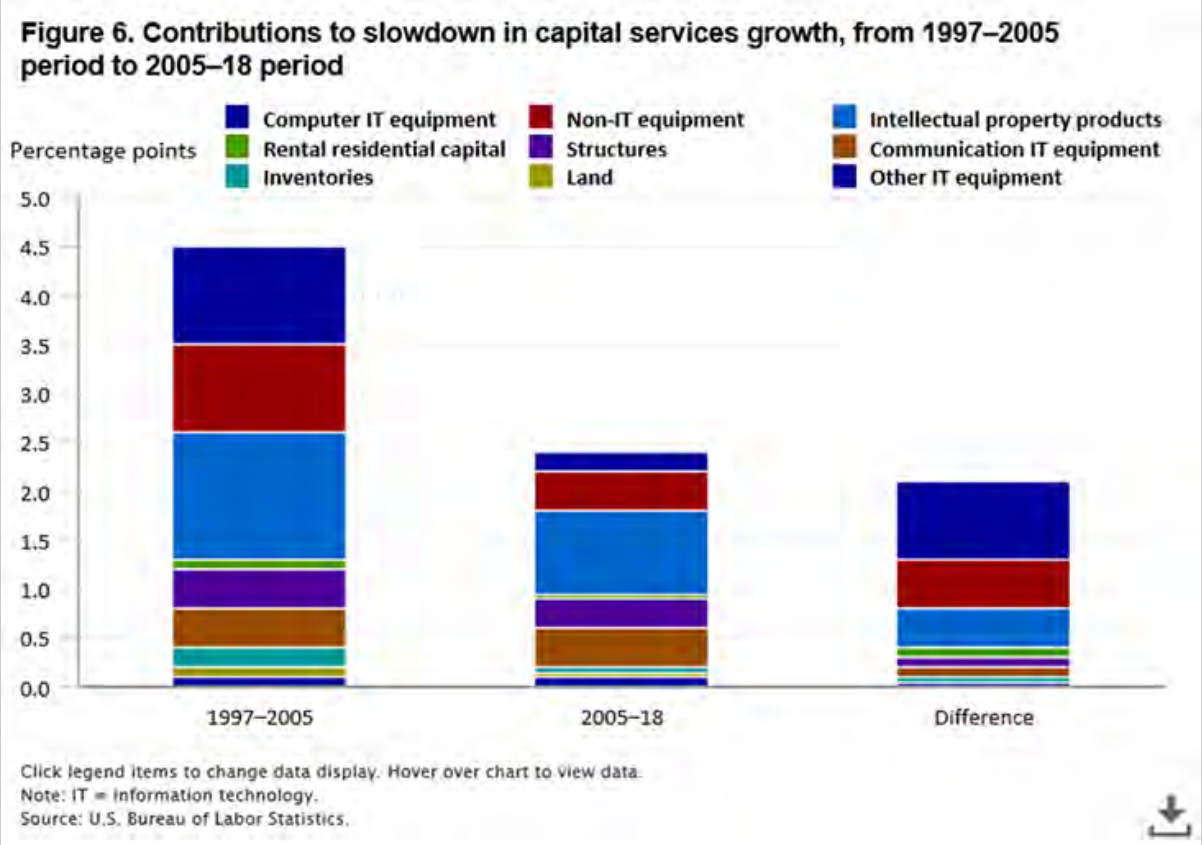
Thus, we can say that it was the combination of a large deceleration in capital services growth with a slight acceleration in labor hours growth that drove down the change in the capital-labor ratio in the slowdown period. This dual effect overwhelmed a slight increase in the capital cost share and diminished the contribution of capital intensity to 0.6 percentage point below what it had been in the speedup period.

At the same time, relative to its long-term trend rate, the sluggishness in the contribution of capital intensity in the slowdown period was comparatively modest—just 0.2 percentage point below its long-term trend rate (see figure 2). Furthermore, the contribution of capital intensity in the slowdown period was not as much of an outlier as it had been during the speedup period, in which it was 0.4 percentage point above the long-term trend during these high-growth years. Nonetheless, both periods exhibited rates that were outside the norm. So, a question arises: What led to such a dramatic acceleration in the contribution of capital intensity and then led to a similarly sized deceleration not just back to normal during the slowdown period, but to slightly below the norm?

To answer the first part of this question, we must look back at the capital and labor components of the contribution of capital intensity during the 1981–97 pre-speedup period (see figure 5). What this reveals is that the vast majority of the acceleration in the contribution of capital intensity from the pre-speedup period to the speedup period was not due to capital services growth expanding but to labor hours growth shrinking. While capital services growth sped up slightly, from 4.2 percent to 4.5 percent, labor hours slowed substantially, from 1.8 percent to 0.4 percent. This drop in labor hours growth is not altogether surprising, given that the speedup period contained both the recession of 2001 and the “jobless recovery” of the early 2000s.

So, it can be said that the change in the capital-to-labor ratio—and thereby the contribution of capital intensity—during the speedup period was boosted up to such a high degree from unusually low labor hours growth, with capital services growth lying not far outside the norm. In contrast, for the slowdown period, it was the inverse: most of the slowing in the measure came from unusually low capital services growth, with labor hours growth not far outside the norm.

We can identify the contributions toward the recent slowdown in capital services growth, which are found in the far right stacked bar in figure 6. As previously noted, capital services growth slowed from 4.5 percent to 2.5 percent during the slowdown period. Of this 2.0-percentage-point deceleration, 0.8 percentage point was from a massive slowdown in computer IT equipment, which shrunk from providing a contribution of 1.0 percentage point in the speedup period to just making a 0.2-percentage-point contribution in the slowdown period. The other two notable contributors to the slowdown were from non-IT equipment (0.5 percentage point) and intellectual property products (0.4 percentage point). In addition, 0.1-percentage-point contributions were from rental residential capital, structures, communication IT equipment, and inventories.



So, what factors may have undergirded such below-average capital services growth during the slowdown period? As noted earlier, Byrne, Oliner, and Sichel assert that the fragile financial condition of the economy following the Great Recession may have hindered investment during the recovery.[49] Robert E. Hall agrees, stating that "at the end of 2013 [the capital stock] was 13.2 percent below its trend path. The crisis and Great Recession, including amplification mechanisms, appear to be responsible for the shortfall."[50] Also, the work of Ravi Bansal, Mariano Max Croce, Wenxi Liao, and Samuel Rosen indicates specifically that uncertainty during and following the Great Recession may have also played a role and, especially, hurt innovative and productivity-driving firms, observing that "volatility shocks are more disruptive for innovation-oriented firms both in terms of market valuation and contraction in their investments. According to the data, when uncertainty increases, there exists a relative reallocation effect that penalizes investments in R&D-intensive firms, that is, investments that are important to sustain long-term growth."[51]

Taking a slightly longer view and analyzing the entire 2005–18 slowdown period, Germán Gutiérrez and Thomas Philippon point out that the U.S. business sector has underinvested relative to "measures of profitability and valuation, particularly Tobin's Q, and that this weakness starts in the early 2000's."[52] In terms of a theoretical underpinning that could explain this phenomenon, the authors specify that although it is possible for firms to underinvest either because of a low Q or despite a high Q, the data do not support the first case. So instead, the authors focus on the latter case, in which they find evidence of three main drivers: "rising intangibles, decreased competition, and changes in corporate governance that encourage payouts instead of investment."[53]

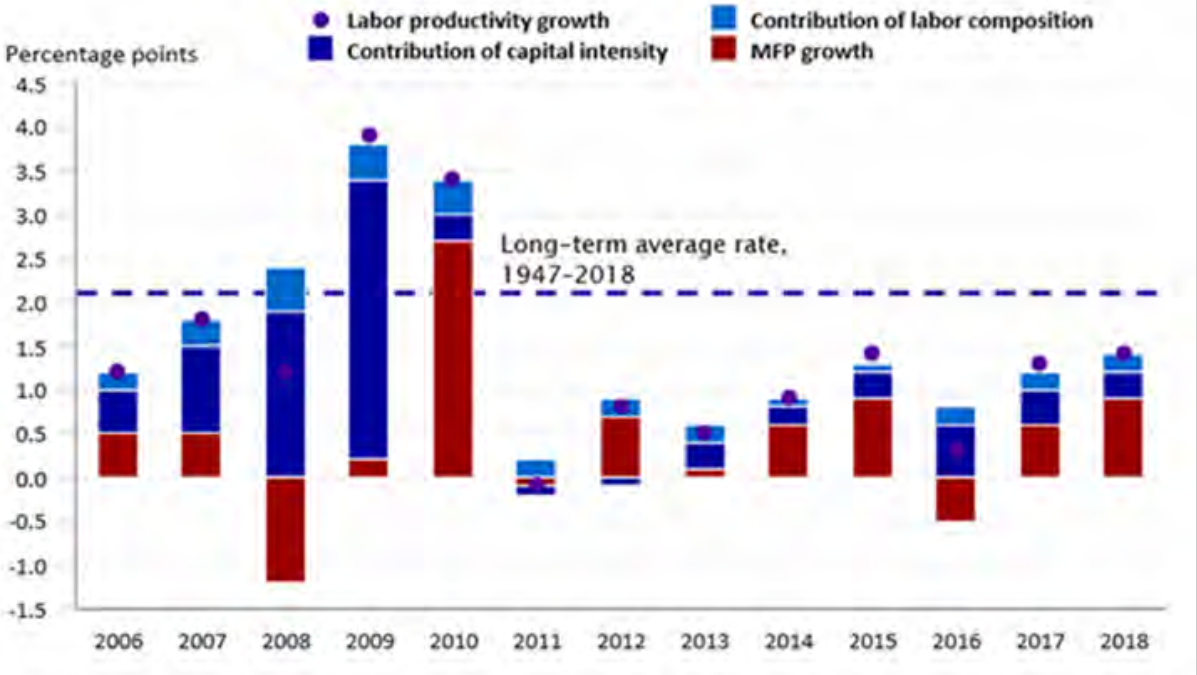
Regarding the rise of intangibles (intellectual property including software, R&D, patents, trademarks, and goodwill) as a share of overall capital investment, Gutiérrez and Philippon estimate that this component "can explain a quarter to a third of the observed investment gap."[54] This is because these assets are both difficult to measure, which may lead to their undercounting, and also "difficult to accumulate, due to higher adjustments costs," leading to "a higher equilibrium value of Q, even if intangibles are correctly measured."[55]

The remainder of the underinvestment likely comes from some combination of decreased competition and changes in corporate governance, according to Gutiérrez and Philippon. Regarding the former, the evidence indicates that "industries with more concentration and more common ownership invest less, even after controlling for current market conditions. Within each industry year, the investment gap is driven by firms that are owned by quasi-indexers and located in industries with more concentration and more common ownership.[56] These firms spend a disproportionate amount of free cash flows buying back their shares."[57] And, in terms of the latter, Gutiérrez and Philippon cite increased shareholder oversight, particularly in guarding against managers' desire to expand capital investments beyond an amount that would be in shareholders' best interests, as well as short-termism, in which "stock-based compensation incentivizes managers to focus on short-term capital gains" via share buybacks rather than making long-term capital investments in their firm.[58]

Annual contributions to the productivity slowdown

In addition to analyzing the labor productivity slowdown from a full-period perspective, as we have done thus far, we can also look at the individual years of the slowdown period itself, to determine how the path of each component developed over time. Figure 7 illustrates how the three series underlying labor productivity growth—MFP growth, the contribution of capital intensity, and the contribution of labor composition—progressed over the course of the slowdown period, from 2005 to 2018.

Figure 7. Contributions to labor productivity growth: MFP growth, contribution of capital intensity, contribution of labor composition, annual growth rates, private nonfarm business sector, 2005–18 period (i.e., annual rates for 2006–18)



Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

In the first year of the slowdown period—2006, which in figure 7 indicates the growth observed from 2005 to 2006, as we are displaying the growth from one year to the next—MFP growth and the contribution of capital intensity not only had the same rate of growth but they were also similarly below their respective long-term rates. A 0.5-percent increase in MFP in 2006 was below its long-term average of 1.1 percent, and a 0.5-percent increase in contribution of capital intensity was below its long-term average of 0.9 percent. However, over the next few years, it is remarkable how each of these measures diverged as the Great Recession began and wore on. In each year from 2006 through 2009, the contribution of capital intensity incrementally expanded, reaching a series-high 3.2 percent in 2009 and composing the majority of the above-trend labor productivity growth in that year. This acceleration in the contribution of capital intensity was due to an outsized decline in underlying labor hours; although capital services growth slowed from 3.7 percent in 2006 to 1.1 percent in 2009, labor hours growth plummeted from 2.3 percent in 2006 to –7.2 percent in 2009. This difference in magnitudes makes sense, given that it is easier for businesses to lay off workers than sell capital equipment during a recession.

At the same time as the contribution of capital intensity was expanding during the Great Recession, MFP growth was stagnating. After posting a below-average value in 2007 (0.5 percent), the measure sank well into negative territory in 2008 and then edged barely back into positive territory in 2009. What may have brought about this below-average MFP growth during the Great Recession? John G. Fernald notes that “Factor utilization . . . ‘explains’ the plunge and rebound in [MFP]. Utilization fell below the range of historical experience in the recession, [and] then recovered rapidly during the recovery.”[59] Nicholas Bloom, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry cite uncertainty, noting that “plant-level [MFP] shocks increased in

variance by 76 percent during the recession" and that "bad times, defined in terms of low growth rates of output, are also uncertain times in terms of increased cross-sectional dispersion of [MFP] shocks."[60] In addition, Lucia Foster, Cheryl Grim, and John Haltiwanger claim that the Great Recession was an atypically detrimental recession in terms of its effect on MFP growth, in that there was not the usual boost from increased reallocation, which most recessions offer; the authors show that "the intensity of reallocation fell rather than rose and the reallocation that did occur was less productivity enhancing than in prior recessions."[61]

Following the end of the Great Recession in 2009, we observe another year of strong labor productivity growth (3.4 percent) in 2010, though with a sudden reversal in the underlying contributions: MFP growth and the contribution of capital intensity were virtually mirror images of one another in those 2 years, with MFP growth accelerating from 0.2 percent in 2009 to 2.7 percent in 2010 and the contribution of capital intensity slowing from 3.2 percent in 2009 to 0.3 percent in 2010. What might have brought about this result? As noted earlier, Fernald cites increased utilization as a potential explanation for the rebound in MFP growth during this early phase of the recovery.[62] Also, it is often the case when emerging from a recession—especially one as severe as the Great Recession—that firms may still remain apprehensive about hiring until the recovery begins in earnest, with a lag in employment recovery relative to output recovery. This was the case with the recovery from the Great Recession, with labor hours falling for an additional quarter more than output, in the third quarter of 2009, and then remaining virtually flat for two additional quarters—while output was simultaneously rising—and hours not beginning to recover in earnest until the second quarter of 2010.[63] This lag in the labor hours recovery contributed to both the dramatic increase of MFP growth in 2010 as well as the diminution of the contribution of capital intensity in that year.[64]

In the years following 2010, labor productivity growth stagnated, with an average rate of just 0.8 percent—well below the 2.1-percent long-term average rate since 1947. These early years of the recovery were particularly weak for the underlying measures, with the contribution of capital intensity receding into slightly negative territory in both 2011 and 2012, and MFP posting a decline in 2011 and a 0.1-percent increase in 2013. More recently, the situation has improved somewhat compared with those early years, with labor productivity rising above 1.0 percent during 3 of the last 4 years, though still remaining below the long-term historical trend and thus extending the productivity slowdown for over a decade.[65]

A noteworthy fact about the growth during the historically weak recovery period—specifically, after 2011—is how consistent and steady the growth rates have been during these years, with labor productivity growth staying within a historically narrow range of between 0.3 percent and 1.4 percent. This phenomenon reflects the combination of a steadily weak output recovery and a consistently moderate labor hours recovery. And, in terms of labor productivity growth's underlying series, MFP growth was below average during these years as weak output growth was paired with moderate combined-input growth from labor and capital. And, the contribution of capital intensity was also low throughout these years, as moderately increasing labor hours were paired with similarly moderate capital services growth.

Also, note that, in contrast to its typical steadiness during the full periods (see figure 2), the contribution of labor composition exhibited some within-period variation during the slowdown period from 2005 to 2018 (see figure 7) and thereby slightly amplified the swings in labor productivity during this period. Specifically, the contribution of labor composition rose at above-average rates during the Great Recession, with a high of 0.5 percent in 2008, and then grew at below-average rates since, of 0.1 or 0.2 percent. These shifts in the contribution of labor composition over the slowdown period—particularly within the post-2007 business cycle—are not surprising, given that lower-

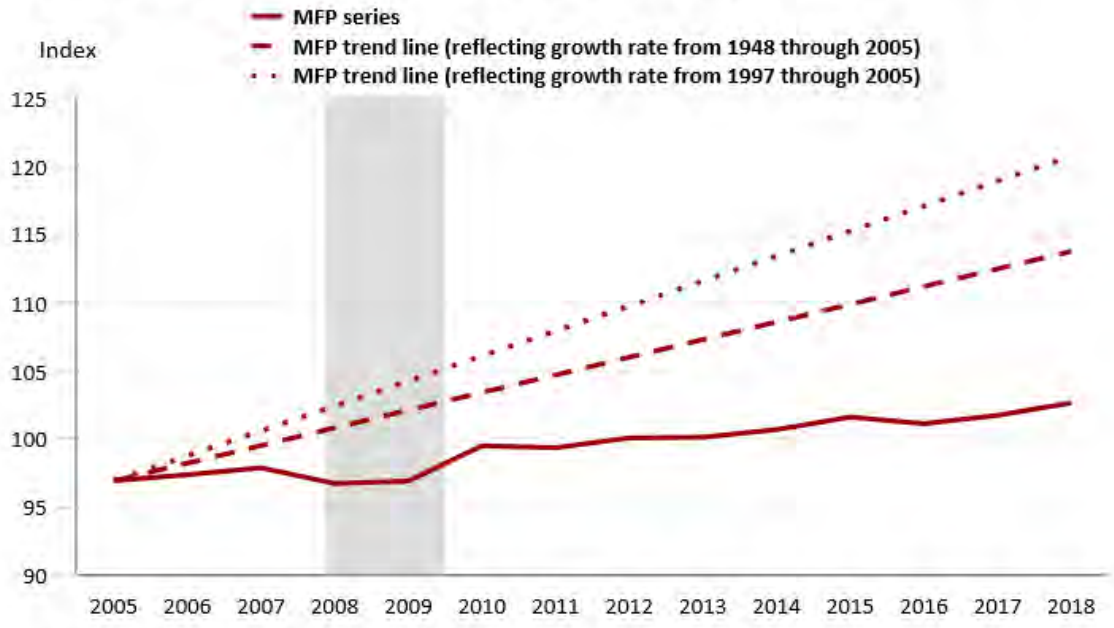
skilled or less-experienced workers are more likely to be laid off during recessions and then may gradually be reintegrated into the workforce as a recovery progresses.[66]

Trend comparisons for MFP and the contribution of capital intensity

In addition to determining the extent to which each component series contributed to labor productivity growth within each year of the slowdown period, we can also determine how each of these component series tracked during these years compared with its own previously observed growth trends, particularly its speedup period trend rate (1997–2005) and its long-term trend rate (1948–2005). This analysis allows us to see how much the movements after 2005 either stayed on course with, or diverged from, the growth trends that had been previously and historically observed for these series. We will do this for the two contributors to the slowdown: MFP growth and the contribution of capital intensity.

The path of the MFP index series over the slowdown period, as well as the long-term trend rate and the speedup period trend rate for this series, is shown in figure 8. We see that in 2006 and 2007, MFP was already falling slightly behind both the speedup period and long-term period trend lines, and this gap widened substantially during the recession. Then, in 2010, 1 year of high MFP growth partially shrank the gap, but subsequently, from 2011 to 2018, below-average MFP growth widened the gap substantially. Strikingly, we can see from the figure that every annual movement from 2005 to 2018 other than the gain in 2010 acted to widen the gap, either with a negative annual change or a positive change that was slower than the historical trend.

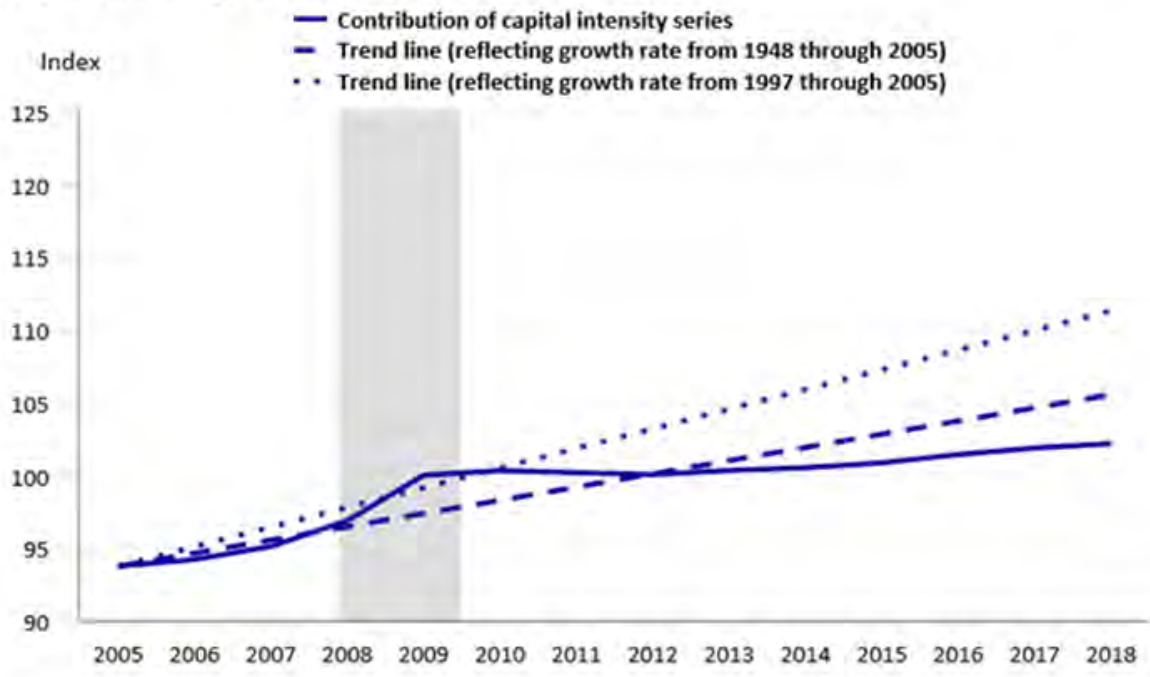
Figure 8. Comparing the MFP series during the slowdown period with past trends: private nonfarm business MFP, 2005 through 2018



Click legend items to change data display. Hover over chart to view data.
Notes: MFP = multifactor productivity. Shaded area represents a recession as determined by the National Bureau of Economic Research.
Source: U.S. Bureau of Labor Statistics.

The contribution of capital intensity index series took a much different path through the slowdown period, as is illustrated by figure 9. As just discussed, the contribution of capital intensity took an inverse path relative to MFP during the Great Recession, with an increase in 2008 and a surge in 2009 that sent the series above both the long-term and speedup period trend lines by 2009. However, the subsequent stagnation in the series, with virtually no growth over the next 4 years, submerged it below both trend lines by 2013 and widened the gap from that point onward. At the same time, note that this cumulative gap in the growth of the contribution of capital intensity was, as of 2018, less than that of MFP, which is cumulatively much further behind its historical trends (see figure 8).

Figure 9. Comparing the contribution of capital intensity series during the slowdown period with past trends: private nonfarm business contribution of capital intensity, 2005 through 2018



Click legend items to change data display. Hover over chart to view data.
Note: Shaded area represents a recession as determined by the National Bureau of Economic Research.
Source: U.S. Bureau of Labor Statistics.

Dollar and time costs of the productivity slowdown

In addition to analyzing the productivity slowdown in terms of percent changes, as we have done up to this point, we may also wonder: how much of a real-world impact did the labor productivity slowdown have in terms of dollars of lower output or hours of lost leisure time, for participants of the U.S. economy? Before undertaking this analysis, we should clarify that it is not possible to know in what combination the additional productivity growth—if growth had continued at average historical rates following 2005, rather than at the low rates we have observed—would have translated into greater output and additional leisure time. However, these calculations give us a sense of the losses that have been incurred by Americans, due to the productivity slowdown.

We will first estimate the loss from the productivity slowdown by assuming that the additional productivity growth (representing the difference between recorded productivity growth and what productivity growth would have been if

rates had continued at average historical rates following 2005) would have all contributed to producing additional output, and we will then make an analysis assuming that the added productivity growth would have all contributed to accumulating additional leisure time.

To estimate the total loss in output, we first ascertain how much total output was produced during the slowdown period. This amount is $175.2 trillion. We can then calculate a hypothetical total output, incorporating a consistent 2.3-percent labor productivity growth rate.[67] This amount is $186.1 trillion. So, the difference in output, representing the loss due to the productivity slowdown, is $10.9 trillion. Furthermore, as there were, on average, 114.6 million workers in the nonfarm business sector during these years, this result translates into a loss of $95,000 in output per worker.[68]

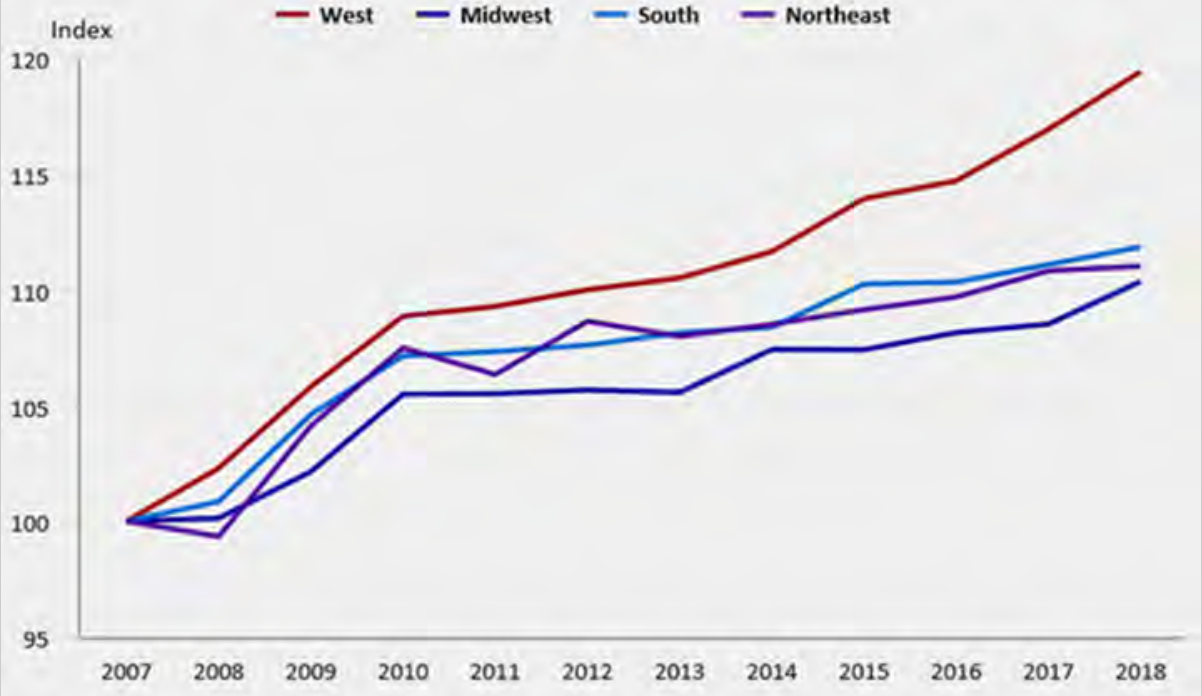
The productivity slowdown can also be framed in terms of lost time, specifically the lost leisure time that could have been available for workers to consume if a slowdown had not occurred.[69] To do this analysis, we first add up all hours worked during the slowdown period, which comes to 2.51 trillion. Then, assuming that labor productivity grew at a consistent rate of 2.3 percent throughout the period and that all of the effect of the added productivity growth contributed to a reduction in hours worked, this calculation would yield a total of 2.37 trillion hypothetical hours worked. Then, subtracting this hypothetical hours figure from the actual hours figure (2.51 trillion) would result in a hypothetical gain of leisure time of 138.5 billion hours, or 1,209 per worker. And, given that the average weekly hours during these years would have been 30.7 in this case,[70] this would result in a total of 39.4 weeks of leave lost because of the slowdown in productivity growth during this period or, correspondingly, 3.0 additional weeks of leave per year.

Did the productivity slowdown progress differently in U.S. regions?

Before we move on to the industry-level analysis, it might be of interest to some readers to know that there was some variation in how the economy-wide productivity slowdown progressed between states and regions of the United States. BLS publishes data on U.S. state and regional labor productivity for 2007 forward, and we can use these data to illustrate how the slowdown progressed in these areas for this portion of the post-2005 slowdown period.*

Box figure 1 tracks the progress of the labor productivity series for the private nonfarm sector in the four U.S. regions during the 2007–18 period. What this figure shows is that the Western United States outperformed the other three regions (Midwest, South, and Northeast) during these years. The West not only outperformed the other regions throughout and following the Great Recession, but its outperformance expanded during the recovery.

Box figure 1. Comparing labor productivity in U.S. regions: output per hour, West, Midwest, South, and Northeast regions, private nonfarm sector, 2007–18

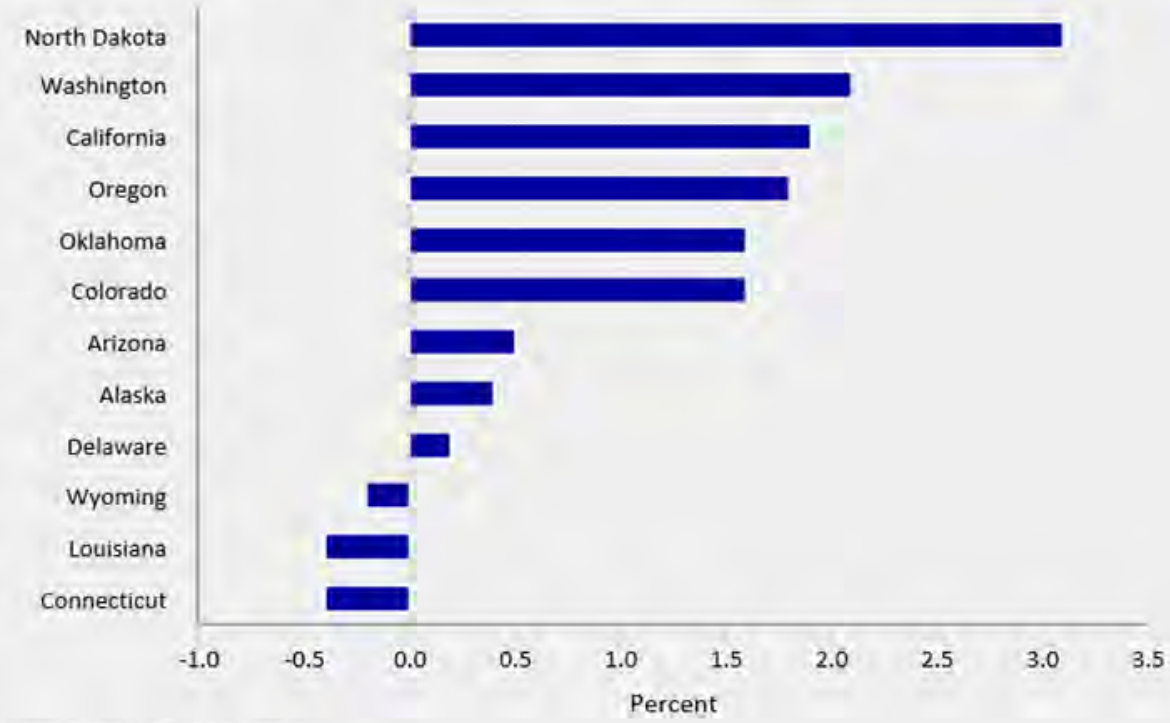


The West realized a 1.6 percent rate of labor productivity growth during these years, whereas the Midwest, South, and Northeast posted rates of 0.9 percent, 1.0 percent, and 1.0 percent, respectively. Given that the national rate for these years is 1.3 percent, we can see that, if not for the faster growth of the West during these years, the overall U.S. slowdown would have been around 0.3 percentage point lower than the already low rate observed during this period. This insight may offer researchers a potential avenue for future research, to look into what potential factors may have contributed to the somewhat higher productivity growth in the Western United States as compared with the rest of the country. At the same time, it is still the case that all four regions posted below-average growth, compared with the national long-term average rate since 1948 of 2.2 percent.

As for the individual states, box figure 2 reveals that, in addition to having the highest overall growth, the Western United States also had the most outliers, both on the high and low end (the figure shows the top six and bottom six state productivity growth rates). Washington, California, Oregon, and Colorado had four of the top six rates, which buoyed the overall growth of the West and more than counterbalanced very low growth in Arizona and Alaska and a decline in Wyoming. North Dakota took the top state rate, at 3.1 percent, and was the only state that had a growth rate that placed above the long-term average U.S. rate of 2.2 percent. As noted by YiLi Chien and Paul Morris, North Dakota underwent an oil boom during these years, “bringing a large influx of capital” to the state, with the authors concluding that the above-average labor productivity growth in this state “is very likely associated with the boom of the oil industry.”** (The turnaround

in this industry, as well as the results of other notable industries, will be discussed in detail in the next section.)

Box figure 2. Labor productivity growth: selected U.S. states, private nonfarm sector, average annual growth rates, 2007–18 period



Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

* For more information on BLS state-level productivity data, see Sabrina Wulff Pabilonia, Michael W. Jadoo, Bhavani Khandrika, Jennifer Price, and James D. Mildenberger, “BLS publishes experimental state-level labor productivity measures,” Monthly Labor Review, June 2019, https://www.bls.gov/opub/mlr/2019/article/pdf/bls-publishes-experimental-state-level-labor-productivity-measures.pdf. In addition, the data can be found at the BLS state productivity home page at https://www.bls.gov/lpc/state-productivity.htm.

** YiLi Chien and Paul Morris, “Slowdown in productivity: state vs. national trend,” The Regional Economist (Federal Reserve Bank of St. Louis, first quarter 2017).

Industry-level analysis of the U.S. labor productivity slowdown

Up to this point, we have analyzed the U.S. labor productivity slowdown from an economy-wide perspective. We can also examine more detailed, industry-level data to extend our analysis and identify the industries that contributed the most to the slowdown in productivity growth from the 1997–2005 period to the 2005–18 period. In

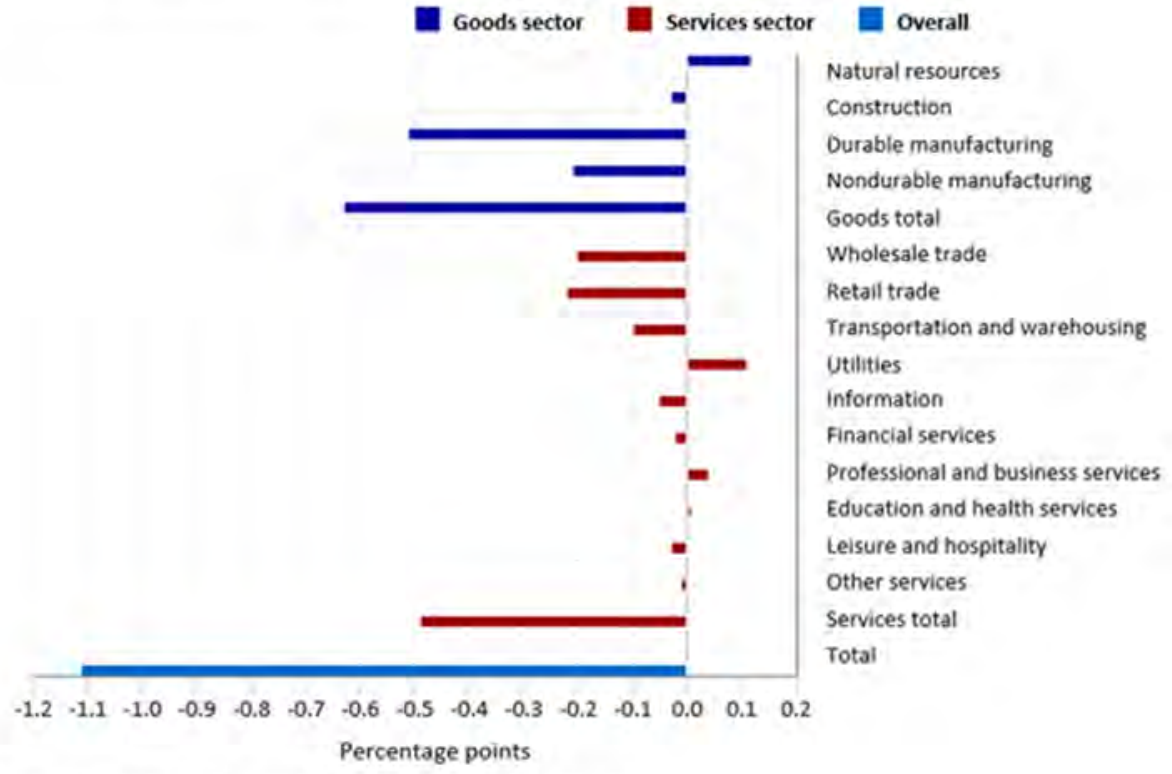
breaking out the U.S. labor productivity slowdown into its industry-level components, we will investigate the two series contributing to the slowdown—MFP growth and the contribution of capital intensity—to determine which industries contributed most to the economy-wide slowdown via these two factors. This can be done by calculating Domar-weighted growth rates of these two factors, for all the industries that make up the private nonfarm business sector.[71] First, we will be looking at the industry contributions to the MFP slowdown, followed by the industry contributions to the slowdown in the contribution of capital intensity.

Industry contributions to the MFP slowdown

When we break out the economy-wide MFP slowdown into its components, it is instructive for us to disaggregate the data into both sectors and industries, because each of these approaches provides a slightly different perspective and can deepen our understanding of the issue. As such, we will first look at contributions at the 14-sector level and then at contributions at the 60-industry level.[72]

The sector-level contributions to the economy-wide MFP slowdown are shown in figure 10, along with the corresponding contributions of the overall goods sector and services sector. First, we notice that the goods sector made a contribution (0.63 percentage point [ppt.]) to the MFP slowdown that is larger than the contribution made by the services sector (0.49 ppt.). The fact that the goods sector made a larger contribution is at first glance somewhat surprising, given that it is much smaller than the services sector and produces just 25 percent of private nonfarm business output. The potency of the contribution from the goods-producing sector can be isolated to the manufacturing sector and, most prominently, durable goods manufacturing, which itself contributed 0.51 ppt., or nearly half the overall contributions to the private nonfarm business sector (1.11 ppt.).[73] When the durable goods sector contribution is combined with the nondurable goods sector contribution, the total manufacturing sector accounted for 65 percent of the private nonfarm business MFP slowdown.

Figure 10. Contributions of sectors to slowdown in MFP growth in private nonfarm business sector, from 1997–2005 period to 2005–18 period



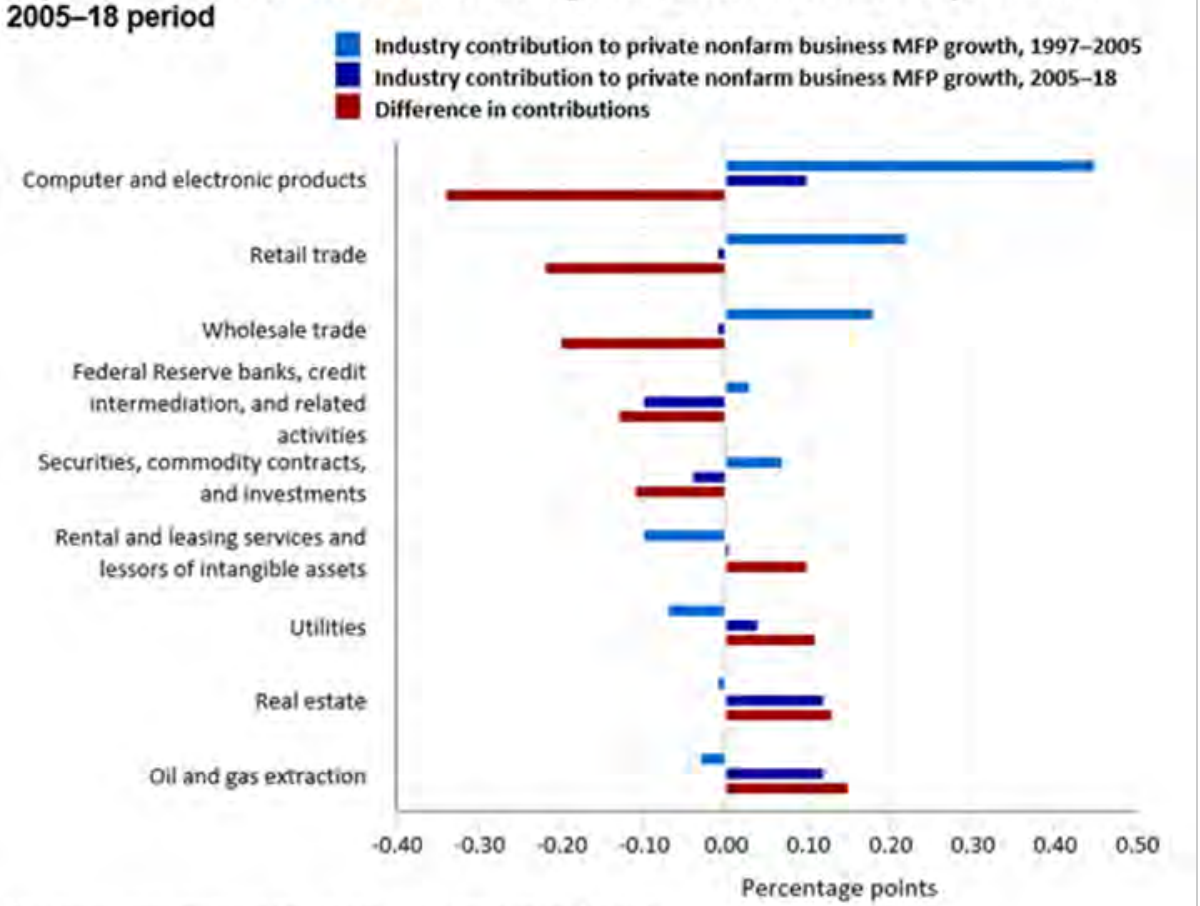
Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

For the services sector, the largest contributors to the slowdown were retail trade (0.22 ppt.), wholesale trade (0.20 ppt.), and transportation and warehousing (0.10 ppt.). These three sectors together more than explain the overall contribution to the MFP slowdown coming from the services sector (0.49 ppt.), as they made a combined contribution of 0.52 ppt. It is also worth pointing out that two sectors had notable productivity speedups, especially considering their small size—natural resources and mining (0.12 ppt.) and utilities (0.11 ppt.); natural resources and mining makes up just 2.7 percent of the private nonfarm business sector, and utilities makes up just 2.3 percent. Also, though the financial services sector and the professional and business services sector made relatively flat contributions to the slowdown, there were a number of industries within those two sectors that made notable contributions to the slowdown (these industries are discussed below). However, when these industry-level slowdowns are summed with speedups in other industries within the same sector, only a small overall contribution to the slowdown remains for these two sectors.

The industry-level contributions to the economy-wide MFP slowdown are shown in figure 11, specifically for a selection of the largest contributions (positive or negative). (Also, see appendix, table 1, for a full list of industry contributions to the MFP slowdown and industry contributions to the slowdown in the contribution of capital intensity, in the private nonfarm business sector.) It is not surprising that the largest industry-level contributor to the slowdown (computer and electronic products) is from within the largest sector-level contributor to the slowdown (durable manufacturing). Computer and electronic products incurred a massive slowdown, with a contribution to

MFP growth of 0.45 ppt. from 1997 to 2005 dwindling to 0.10 ppt. from 2005 to 2018. A startling fact about this industry is that, even after having the largest MFP slowdown among all the industries, computer and electronic products still possessed a positive contribution and, in fact, the third-largest contribution among all 60 industries during the 2005–18 period, behind only real estate (0.12 ppt.) and oil and gas extraction (0.12 ppt.).[74] The MFP slowdown in computer and electronic products represents 66 percent of the slowdown in durable manufacturing and 31 percent of the slowdown in the private nonfarm business sector.

Figure 11. Industries with largest percentage-point differences in contributions to private nonfarm business sector MFP growth, between 1997–2005 period and 2005–18 period



Click legend items to change data display. Hover over chart to view data.
MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

Numerous researchers have focused on the historic acceleration and subsequent moderation in the growth of the computer and electronic products industry as being a major driver of the economy-wide productivity slowdown. Many had been aware of the remarkable growth of computer and electronic products in the late 1990s and early 2000s, with Stephen D. Oliner and Daniel E. Sichel observing that the trend at that time was already apparent and strong. They note that “the multifactor productivity contributions from computer and semiconductor producers moved up sharply during 1996–99, reaching 0.26 and 0.39 percentage point per year, respectively,” and that “the increases largely reflect the faster decline in the relative prices of computers and semiconductors . . . and the rising output shares of computer and semiconductor producers.”[75] David M. Byrne and Carol Corrado also

emphasize the rapidly declining prices during those years: “the greatest computer [price] declines, and the greatest gap, occurs [sic] in the 1994 to 2000 period, when [microprocessor unit] prices were falling especially fast.”[76]

Then, however, during the mid-2000s, the pace of microprocessor unit price declines began to stall.[77] And, more recently, price declines have shrunk in size even more, with Byrne and Corrado citing “extremely small declines of late, after having gradually lost force since 2004.”[78] At the same time, Byrne, Oliner, and Sichel argue that there has not been a slowdown in technological progress that the paltry price declines might indicate, clarifying that “technical progress in the semiconductor industry has continued to proceed at a rapid pace.”[79] So, might there be some mismeasurement occurring with regard to these prices? Yes, there was, argue David M. Byrne, John G. Fernald, and Marshall B. Reinsdorf, who say that in “IT-related hardware and software . . . mismeasurement is sizable.”[80]

However, these authors also caution that this measurement was not a new issue in the mid-2000s and that IT price mismeasurement was evident even before the productivity slowdown, clarifying that they “find no evidence that the biases have gotten worse since the early 2000s.”[81] In fact, they point out that, if one were to consistently adjust for mismeasurement across time, it would actually make the labor productivity slowdown worse, given that “mismeasurement of IT hardware [was] significant prior to the slowdown,” and also given that “the domestic production of these products has fallen, [and thus] the quantitative effect [of mismeasurement] on productivity was larger in the 1995–2004 period than since, despite mismeasurement worsening for some types of IT.”[82]

Chad Syverson concurs with Byrne, Fernald, and Reinsdorf, agreeing that mismeasurement is unlikely to be a driver of the productivity slowdown,[83] and observes that “the productivity slowdown has occurred in dozens of countries, and its size is unrelated to measures of the countries’ consumption or production intensities of information and communication technologies [ICTs],” further contending that “if measurement problems were to account for even a modest share of this missing output, the properly measured output and productivity growth rates of industries that produce and service ICTs would have to have been multiples of their measured growth in the data.”

So, what factors might have led to the slowdown in the productivity growth of IT goods? Decker et al. point out that a dwindling of the “marginal employment growth response of businesses to idiosyncratic productivity draws . . . is especially large in the high-tech sector, with the responsiveness of young firms in the post-2000 period only about half (manufacturing) to two thirds (economy-wide) of the peak responsiveness in the 1990s.” The authors conclude that “the timing of reallocation and responsiveness patterns in high-tech is consistent with the timing of the productivity slowdown, which evidence indicates was driven by ICT-producing and using industries.”[84]

The waning responsiveness of young high-tech firms that is cited by Decker et al. could potentially be explained, at least in part, by the work of Mordecai Kurz, who finds growing market power in the IT sector, which may be stifling the entry and growth of young firms.[85] Kurz reports that “declining or slow growing firms with broadly distributed ownership have been replaced by IT based firms with highly concentrated ownership,” and that “IT innovations enable and accelerate the erection of barriers to entry and once erected, IT facilitates maintenance of restraints on competition.”[86] Foster, Grim, Haltiwanger, and Wolf also reference the concentration within high-tech industries, noting that, in contrast to the late 1990s, when “the productivity surge in the high-tech sectors [had] a high contribution of increased within-industry covariance between market share and productivity . . . the productivity slowdown in the post-2000 period in high tech is due to both a decrease in within-firm productivity growth but also

a decrease in this covariance."[87] Titan Alon, David Berger, Robert Dent, and Benjamin Pugsley offer further evidence to support this finding, noting that "over the last three decades, the U.S. business sector has experienced a collapse in the rate of new startups alongside an enormous reallocation of economic activity from entrants and young firms to older incumbents."[88] Alon et al. clarify that this finding is not just particular to high-tech industries but is "widespread across industries and geographic markets,"[89] so that while this could be relevant in high-tech industries, it could also help explain the productivity slowdowns in other industries. And, more generally, Grullon et al. observe that "more than 75% of U.S. industries have experienced an increase in concentration levels over the last two decades."[90]

Beyond the concentration argument, David Autor, David Dorn, Gordon H. Hanson, Gary Pisano, and Pian Shu propose another potential contributor to the productivity slowdown in IT, particularly in IT-intensive manufacturing industries, which is a reduction in U.S. innovation caused by increased foreign competition from China.[91] The authors observe that "despite accounting for less than one-tenth of U.S. private non-farm employment, U.S. manufacturing still generates more than two-thirds of U.S. R&D spending and corporate patents," and claim that "increased imports from China ramped up competitive pressure on publicly listed U.S. firms" and that "this increase in competitive pressure caused U.S. firms to decrease their output of innovations as measured by patent grants."[92] However, this phenomenon is more long-term and may not apply only or specifically to the 2005–18 slowdown period, although it could potentially be a contributor.

Now, shifting gears a bit, let us look beyond the large slowdown in the computer and electronic products industry and examine some other sizable contributors, located in the trade sector. Specifically, retail trade and wholesale trade contributed 0.22 ppt. and 0.20 ppt., respectively, to the MFP slowdown, and when combined, they actually exceed the size of the slowdown in computer and electronic products. These trade sectors transitioned from making sizeable positive contributions to MFP growth during the speedup period to being virtually flat during the slowdown period.

Might the size and coincidence of these slowdowns in the trade sectors and those in the IT-related industries be related? The answer is likely yes, according to several researchers, at least regarding the retail trade sector. Lucia Foster, John Haltiwanger, and C. J. Krizan assert that "the retail trade sector underwent a massive restructuring and reallocation of economic activity in the 1990s. Retail businesses changed their ways of doing business with intensive adoption of advanced information technology, including everything from improvements in inventory control to the introduction and widespread use of scanners and rapid credit card processing technologies. Structural changes occurred with entering establishments from large multiunit national firms displacing single-establishment firms."[93]

These changes were widely seen in the economy, with the proliferation of "big box" stores such as Wal-Mart, Home Depot, and Best Buy that swept the country and displaced many small businesses that could not compete with the advanced IT that these corporations were using.[94] Emek Basker argues that the effect was particularly powerful regarding Wal-Mart, "because Wal-Mart competes with retailers across many categories, including general merchandise stores, drugstores, apparel stores, and grocery stores."[95]

Moreover, Foster et al. contend that, in their firm-level analysis of the dispersion and reallocation dynamics within the retail trade sector, "virtually all of the productivity growth in the retail trade sector over the 1990s is accounted for by more productive entering establishments displacing much less productive exiting establishments," which

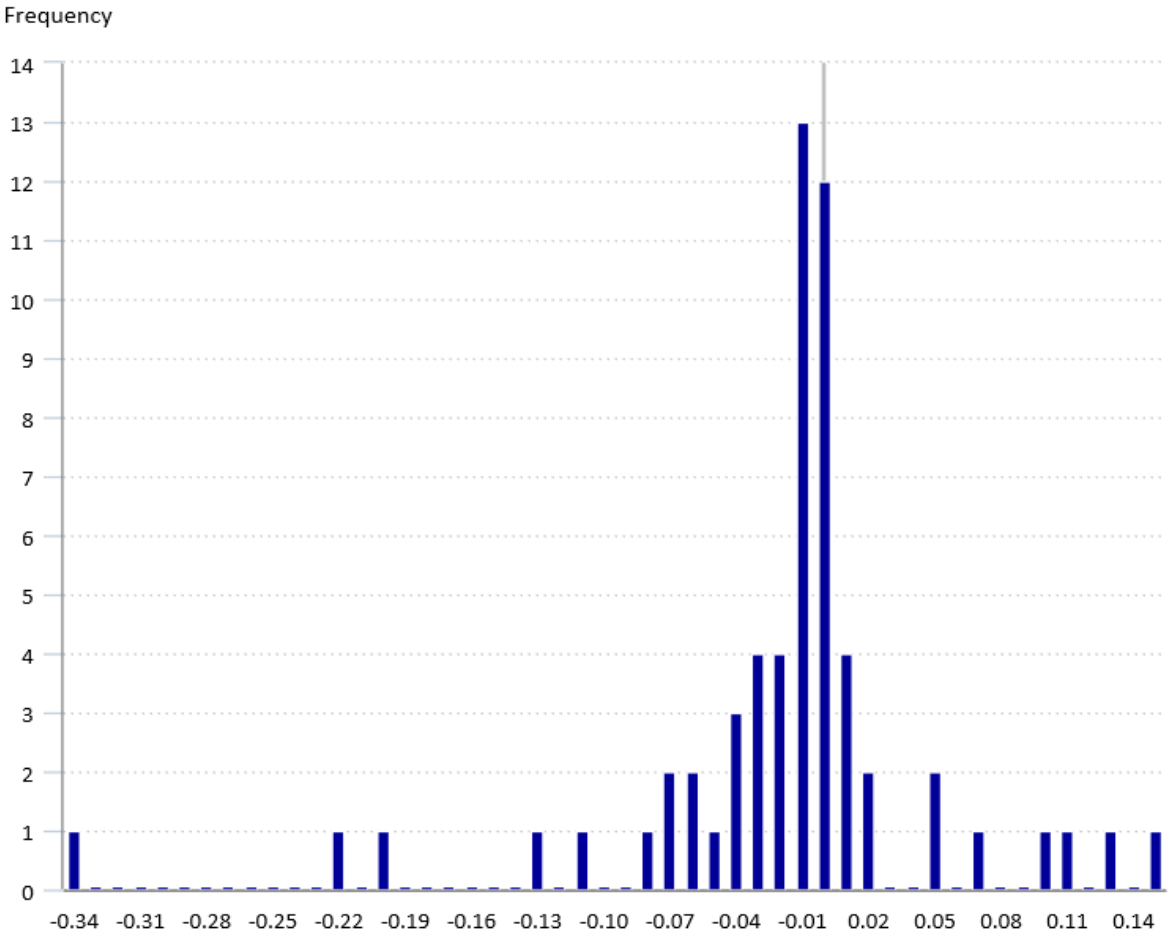
they clarify is due to a combination of “selection effects and post-entry learning effects. That is, establishments that enter might be immediately more productive than the establishments they are displacing, or it may take time for the productivity gap to widen or emerge.”[96]

Also, looking beyond the trade sectors and the computer and electronic products industry, we see several other notable downward contributors to the slowdown in MFP growth: Federal Reserve banks and credit intermediation (0.13 ppt.), securities, commodity contracts, and investments (0.11 ppt.), and broadcasting and telecommunications (0.08 ppt.).

In addition, a few industries worked in the opposite direction of the overall slowdown and posted accelerations in MFP growth during this period: oil and gas extraction (0.15 ppt.), real estate (0.13 ppt.), utilities (0.11 ppt.), and rental and leasing services and lessors of intangible assets (0.10 ppt.). The increase for the oil and gas extraction industry during the slowdown period catapulted it from being the 56th ranked industry among all 60 industries as of the speedup period, to a rank of 2 as of the slowdown period. This astounding turnaround, note David Popp, Jacquelyn Pless, Ivan Haščič, and Nick Johnstone, may reflect technological innovations in this industry, in which the “rise of hydrofracturing lowered fossil fuel prices so much that natural gas is now the primary fuel for electricity generation in the U.S.”[97] The real estate industry had a similarly extraordinary turnaround in its MFP growth contribution, rising from a rank of 51 to 1.

Given that there were both negative and positive contributors to the MFP slowdown, with sizable contributors on both sides, it may be of interest to look at the distribution of these industry-level data (see figure 12). The first item to note is that there were more large negative contributors (those slowing by 0.05 ppt or more) than large positive contributors (those expediting by 0.05 ppt. or more). The net slowdown of the large-contributing industries was 0.74 ppt., with 1.39 ppts. of the large contributors on the negative side and 0.66 ppt. on the positive side. The second item worth noting is that the remaining 0.38 ppt. of the slowdown comes from the small contributors—specifically, many more small negative contributors existed than small positive contributors. While just 6 industries contributed between 0.01 and 0.04 ppt., 24 contributed between –0.01 and –0.04 ppt. These negative small contributors had a combined slowdown of 0.44 ppt., greatly outweighing the positive small contributors, which had a combined speedup of just 0.08 ppt. So, we can say that, although there were numerous large contributors to the overall slowdown on the negative side (particularly computer and electronic products and the trade industries), there was also a widespread, generalized negative slide among the vast majority of the industries, which also helped bring about the historic decline in MFP growth.

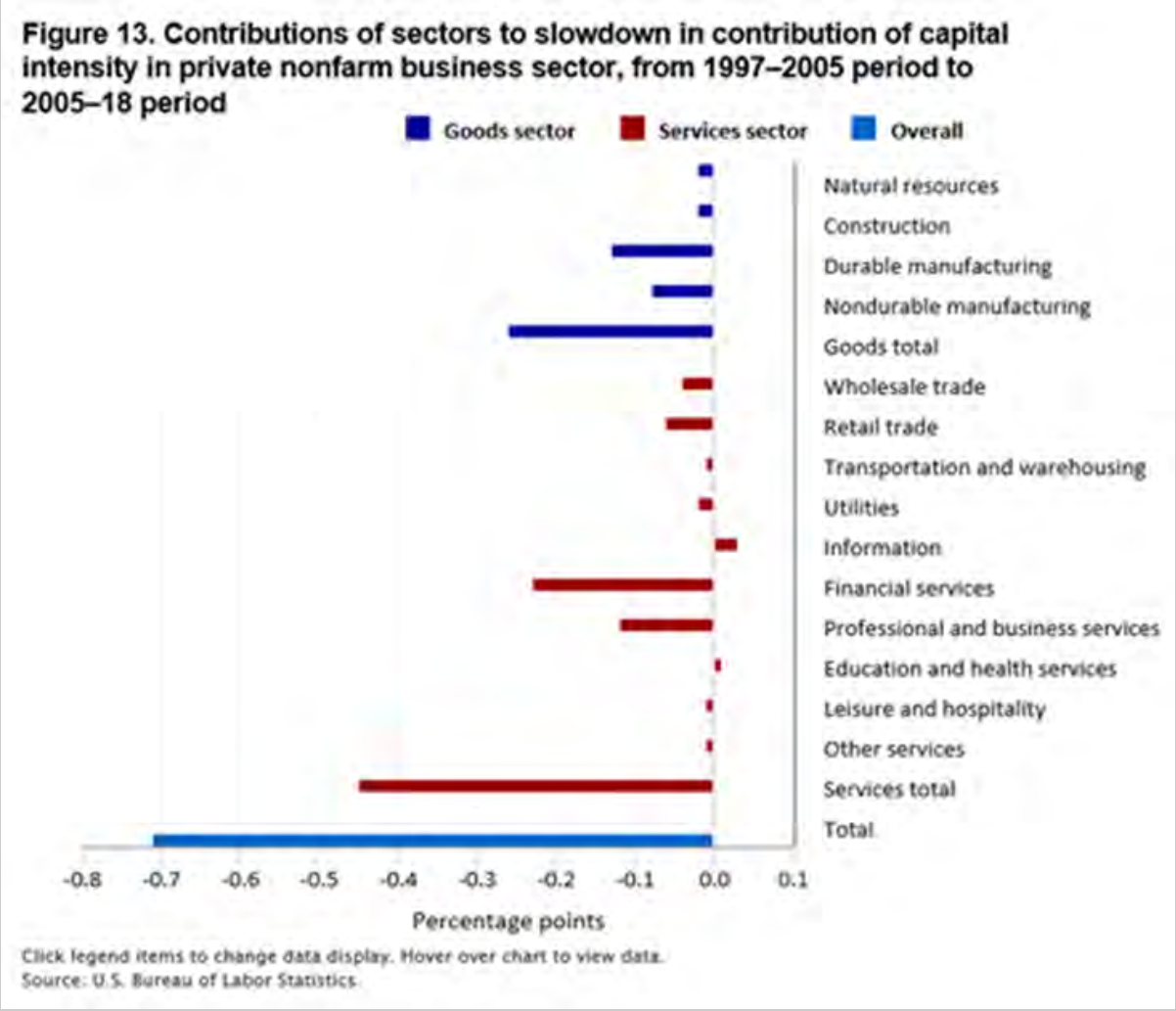
Figure 12. Distribution of percentage-point industry contributions to slowdown in MFP growth, private nonfarm business sector, from 1997–2005 period to 2005–18 period



Hover over chart to view data.
Note: MFP = multifactor productivity.
Source: U.S. Bureau of Labor Statistics.

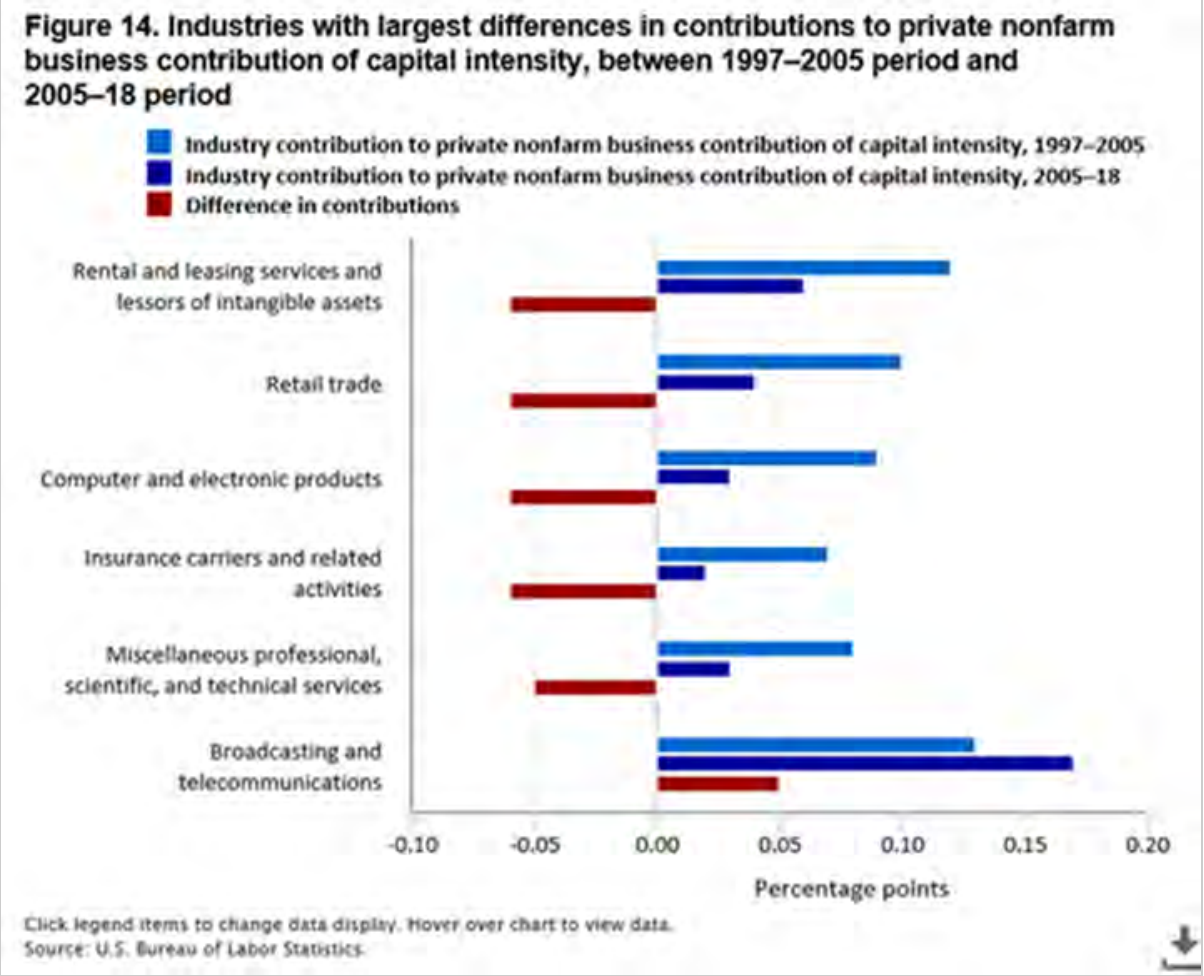
Industry contributions to the slowdown of the contribution of capital intensity

The slowdown in the contribution of capital intensity came more from the services sector than the goods sector. This finding can be seen in figure 13, which shows the sector-level contributions to the overall slowdown in the contribution of capital intensity. The services sector accounted for 0.45 ppt. of the overall slowdown in this measure, with the goods sector contributing 0.26 ppt.



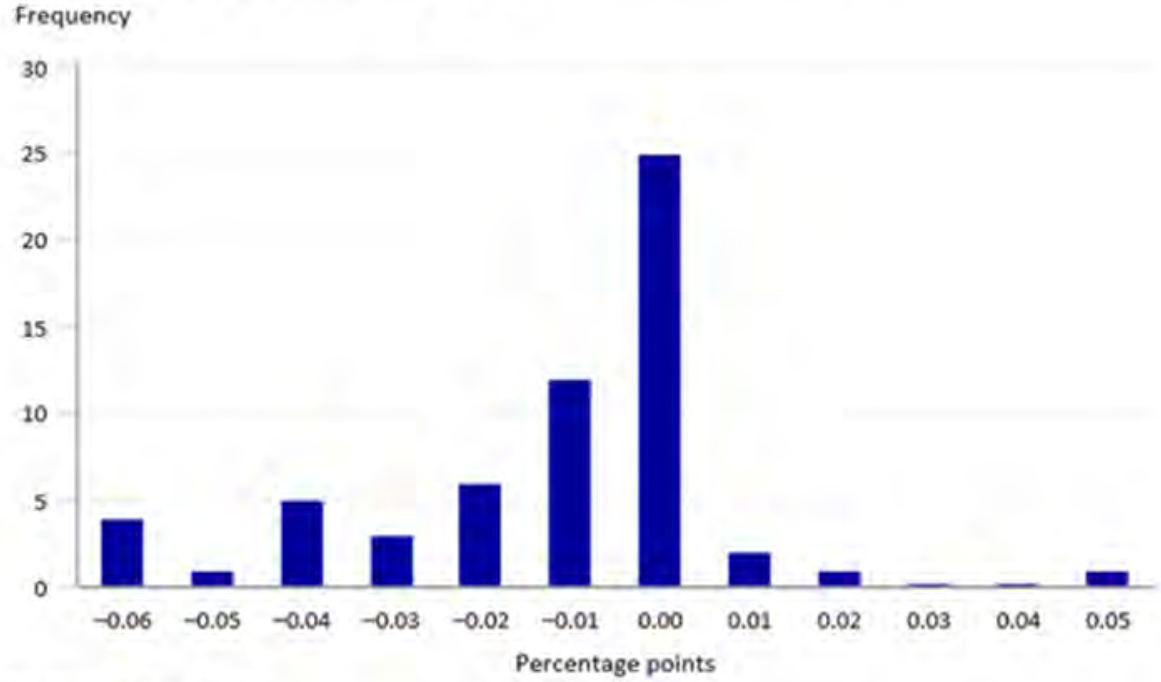
The largest sector contribution to the slowdown was from the financial services sector, with a contribution of 0.23 ppt. There were also noteworthy contributions from professional and business services (0.12 ppt.), durable manufacturing (0.13 ppt.), and nondurable manufacturing (0.08 ppt.).

Figure 14 shows the large industry-level contributions to the slowdown in the contribution of capital intensity, including those with contributions of 0.05 or greater in either direction, positive or negative. Five of the six large contributors were negative and were of similar sizes. The four largest outliers each had slowdowns of 0.06 ppt.; these were rental and leasing services and lessors of intangible assets, retail trade, computer and electronic products, and insurance carriers and related activities. Miscellaneous professional, scientific, and technical services slowed by 0.05 ppt. The broadcasting and telecommunications industry had a speedup of 0.05 ppt.



The distribution of industry contributions to the economy-wide slowdown in the contribution of capital intensity skews heavily negative (see figure 15), with 31 negative contributors and just 4 positive contributors. At the same time, the net contribution to the slowdown from the large contributors (0.24 ppt.) was lower than the net contribution from the small contributors (0.46 ppt.), indicating that there were relatively few outliers with regard to the slowdown in the contribution of capital intensity, especially when compared with the case of the MFP slowdown, which had some substantial outliers. To summarize this section, the bulk of the slowdown in the economy-wide contribution of capital intensity came from relatively small slowdowns in this measure that occurred in a substantial number of industries.

Figure 15. Distribution of percentage-point industry contributions to slowdown in contribution of capital intensity, private nonfarm business sector, from 1997–2005 period to 2005–18 period



Conclusion

At this point, we have a general understanding of the many factors—at both the economy-wide and industry levels—which may underlie the productivity slowdown since the mid-2000s. However, some questions remain, perhaps the most central one being: Is the U.S. economy now, as some researchers have suggested, in an intermittent lull in between waves of high growth, or, as others contend, in a “new normal” of lower growth that has resulted from fundamentally diminished returns to innovation? The answer is not known at the moment, and only time—and additional data in our time series—will tell us.

At the same time, one thing that we can say for certain about our present situation is that the productivity slowdown of the past decade and a half has left the U.S. economy in a weaker position—yielding a sizable loss of potential output during these years—and perhaps even more importantly, it has also left the economy in a weaker position going forward. This is because the productivity slowdown has resulted in a lower base of output from which to grow onward from here, relative to the more elevated starting position that the economy would instead now have if productivity had continued to grow at the long-term historical trend after 2005.

Thus, it will be important for participants of the U.S. economy to keep an eye on productivity data in coming years, to determine whether the slowdown since 2005 simply represented a periodic variation in trend, which can be explained from recent cyclical and noncyclical factors, as some observers have claimed, or whether it comes to be seen as a continuation of the low-growth economy of the last few decades of the 20th century. BLS productivity

data, including labor productivity, multifactor productivity, and capital and labor data, at both the economy-wide and industry levels, will continue to shed light on this issue.

Appendix. Full list of industry contributions

Table 1. Industry contributions to slowdown in private nonfarm business labor productivity growth, from **1997–2005 period to 2005–18 period, percentage points**

Industry	Contributions from industry MFP growth			Contributions from industry contribution of capital intensity		
	1997–2005 period	**2005–18** period	Difference	**1997–2005** period	**2005–18** period	Difference
Forestry, fishing, and related activities	0.011	–0.001	–0.012	0.002	0.002	0.001
Oil and gas extraction	–0.029	0.122	0.15	0.004	–0.035	–0.039
Mining, except oil and gas	0.014	–0.020	–0.034	0	0.014	0.014
Support activities for mining	–0.004	0.016	0.02	–0.004	–0.001	0.003
Utilities	–0.067	0.042	0.109	0.044	0.029	–0.015
Construction	–0.091	–0.122	–0.031	0.036	0.014	–0.023
Food and beverage and tobacco products	0.019	–0.020	–0.039	0.022	–0.001	–0.023
Textile mills and textile product mills	0.007	–0.001	–0.008	0.004	0.001	–0.004
Apparel and leather and applied products	0	–0.002	–0.002	0.007	0	–0.007
Wood products	0.001	0.004	0.003	0.002	0.001	–0.001
Paper products	0.003	0	–0.004	0.01	0.003	–0.007
Printing and related support activities	0.022	0.009	–0.013	0.006	0.003	–0.003
Petroleum and coal products	0.019	–0.021	–0.040	0.014	0.018	0.004
Chemical products	–0.001	–0.075	–0.074	0.103	0.071	–0.032
Plastics and rubber products	0.027	–0.002	–0.028	0.016	0.002	–0.014
Nonmetallic mineral products	0.003	–0.004	–0.006	0.005	0.003	–0.002
Primary metal products	0.027	0.004	–0.023	0.004	0.004	0.001
Fabricated metal products	0.007	–0.015	–0.022	0.014	0.006	–0.007
Machinery	0.027	–0.004	–0.030	0.023	0.007	–0.016
Computer and electronic products	0.445	0.104	–0.341	0.09	0.032	–0.058
Electrical equipment, appliances, and components	0.008	0.003	–0.006	0.009	0.003	–0.006
Motor vehicles, bodies and trailers, and parts	0.076	0.001	–0.074	0.037	0.001	–0.036
Other transportation equipment	0.009	0.015	0.006	0.01	0.009	–0.001
Furniture and related products	0	–0.003	–0.002	0.004	0.002	–0.002
Miscellaneous manufacturing	0.023	0.006	–0.017	0.012	0.007	–0.005
Wholesale trade	0.181	–0.015	–0.196	0.1	0.059	–0.041
Retail trade	0.216	–0.007	–0.223	0.099	0.041	–0.058
Air transportation	0.042	0.033	–0.009	0.009	0.005	–0.004
Rail transportation	0.014	0	–0.014	0.003	0.003	0
Water transportation	–0.005	0.008	0.012	–0.003	0.001	0.004
Truck transportation	–0.008	–0.007	0.001	0.007	0.008	0
Transit and ground passenger transportation	0.003	–0.003	–0.007	0.003	–0.001	–0.004
Pipeline transportation	0.009	0.007	–0.002	0.004	0.005	0.001
Other transportation and support activities	0.029	–0.035	–0.065	0.001	–0.004	–0.005
Warehousing and storage	0.015	–0.003	–0.017	–0.001	–0.002	–0.001

See footnotes at end of table.

Table 1. Industry contributions to slowdown in private nonfarm business labor productivity growth, from **1997–2005 period to 2005–18 period, percentage points**

Industry	Contributions from industry MFP growth			Contributions from industry contribution of capital intensity		
	1997–2005 period	**2005–18** period	Difference	**1997–2005** period	**2005–18** period	Difference
Publishing industries, except internet (includes software)	–0.006	0.042	0.048	0.073	0.053	–0.020
Motion picture and sound recording industries	0.025	0.021	–0.004	0.018	0.005	–0.012
Broadcasting and telecommunications	0.121	0.044	–0.077	0.125	0.173	0.048
Data processing, internet publishing, and other information services	0.027	0.015	–0.013	0.046	0.063	0.017
Federal reserve banks, credit intermediation, and related activities	0.03	–0.096	–0.126	0.112	0.071	–0.041
Securities, commodity contracts, and other financial investments and related activities	0.069	–0.042	–0.111	0.011	0.003	–0.009
Insurance carriers and related activities	0.05	0.046	–0.004	0.073	0.018	–0.055
Funds, trusts, and other financial vehicles	0.008	–0.003	–0.011	0.006	–0.020	–0.026
Real estate	–0.009	0.124	0.133	0.022	–0.015	–0.037
Rental and leasing services and lessors of intangible assets	–0.098	–0.002	0.095	0.117	0.057	–0.061
Legal services	0.006	–0.033	–0.039	0.012	0.006	–0.006
Miscellaneous professional, scientific, and technical services	–0.052	0.02	0.072	0.078	0.026	–0.052
Computer systems design and related services	0.047	0.095	0.048	0.019	–0.006	–0.024
Management of companies and enterprises	0.002	0.023	0.021	0.008	–0.003	–0.011
Administrative and support services	0.08	0.023	–0.057	0.046	0.019	–0.026
Waste management and remediation services	0.007	–0.003	–0.010	–0.002	–0.001	0.002
Educational services	–0.015	–0.007	0.008	–0.005	0.002	0.007
Ambulatory health care services	0.035	0.034	–0.002	0.004	0.002	–0.002
Hospitals and nursing and residential care facilities	–0.011	–0.015	–0.003	0.009	0.011	0.003
Social assistance	0.005	–0.003	–0.008	0	0	–0.001
Performing arts, spectator sports, museums, and related activities	0.006	0.011	0.005	0.005	0.002	–0.003
Amusements, gambling, and recreation industries	–0.014	0	0.014	0.006	0.004	–0.002
Accommodation	0.007	0.006	–0.001	0.015	0.008	–0.007
Food services and drinking places	0.041	–0.007	–0.048	–0.006	–0.008	–0.001
Other services, except government	–0.023	–0.032	–0.009	0.009	0.003	–0.005

Note: MFP = multifactor productivity.

Source: U.S. Bureau of Labor Statistics.

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NOTES

1 The overall estimated output loss figure ($10.9 trillion) represents the difference between (1) the sum of annual real output amounts in the nonfarm business sector from 2006 to 2018 and (2) the sum of annual real output amounts during this period assuming that labor productivity had continued to grow at the same long-term average rate observed from 1947 to 2005 and that all of the additional gains in labor productivity contributed to higher output rather than higher nonwork time. For more information on the estimation of this figure, as well as an example in which the additional gains in labor productivity contributed to higher nonwork time rather than higher output, see the section “Dollar and time costs of the productivity slowdown” in this article. Also, note that the loss for the entire U.S economy is likely sizably greater than the presented output loss figure. However, because we cannot measure the productivity of the noncovered sectors that represent the difference (including general government, nonprofit institutions, and private households, which include owner-occupied housing), since the output data for these sectors are not suitable for productivity measurement, we can only estimate what the effect would have been for the 76 percent of the U.S. economy covered by the nonfarm business sector. Also note that the estimated output loss per worker figure ($95,000) does not represent the loss in compensation per worker due to the slowdown, which would have been sizably less than that figure, given that only a portion of output accrues to workers as compensation for their labor. For more information on this aspect, see Michael D. Giandrea and Shawn A. Sprague, “Estimating the U.S. labor share,” Monthly Labor Review, February 2017, https://www.bls.gov/opub/mlr/2017/article/estimating-the-us-labor-share.htm.

2 See figure 2 of Martin Neil Baily and Nicholas Montalbano, “Why is U.S. productivity growth so slow? Possible explanations and policy responses,” Hutchins Center Working Paper 22 (Washington, DC: Brookings Institution, September 2016), p. 4. Baily and Montalbano provide an excellent overview of the productivity slowdown and also offer potential policy responses. In addition, other overviews of the slowdown include Alexander Murray, “What explains the post-2004 U.S. productivity slowdown?” International Productivity Monitor, no. 34, Spring 2018, p. 81–109; and Emily Moss, Ryan Nunn, and Jay Shambaugh, “The slowdown in productivity growth and policies that can restore it,” The Hamilton Project (Washington, DC: Brookings Institution, June 2020).

3 In Dale W. Jorgenson, Mun S. Ho, and Kevin J. Stiroh, “A retrospective look at the U.S. productivity growth resurgence,” Journal of Economic Perspectives, no. 1, vol. 22, Winter 2008, p. 4, the authors offer an anecdote illustrating the changed perspective during this period: “in just four years, from 1997 to 2001, the Congressional Budget Office more than doubled its ten-year projection of nonfarm business productivity growth from 1.2 to 2.7 percent!”

4 All percent changes in this article, unless otherwise noted, refer to average annual percent changes.

5 Although labor productivity growth theoretically provides a foundation for potential gains in worker compensation, it has historically been the case that commensurate gains in worker compensation do not necessarily accompany gains in labor productivity. Since the early 1970s, real hourly compensation growth has lagged far behind labor productivity growth. For more information, see Susan Fleck, John Glaser, and Shawn Sprague, “The compensation−productivity gap: a visual essay,” Monthly Labor Review, January 2011, https://www.bls.gov/opub/mlr/2011/01/art3full.pdf.

6 There are two main ways of dividing time periods when one is doing a historical productivity analysis such as the one in this article: using business cycles or using variation in trends that are apparent in the data. For the present article, I use variation in trends to define the speedup period (1997–2005) and the slowdown period (2005–18). I selected these two periods because they correspond to the periods that are generally discussed in the literature on this issue and because it is apparent from the data that the question at hand (“What were the sources of the slowdown?”) could not be addressed by operating strictly within the macroeconomic business cycle framework. One reason for this is that the industry-level sources of the slowdown exhibited their own trends that did not necessarily fit within the economy-wide business cycles. Another reason is that although using either a cyclical or trend approach for the slowdown period made little difference (because the business cycle that began in 2007 began just 2 years following the beginning

of the trend-based period [2005]), for the speedup period, it appeared to be preferable to use a trend-based approach. This preference was due to the fact that using the business-cycle break (in 2001) would have split the widely cited speedup period (1997–2005) roughly in half, disallowing for a one-to-one comparison of a speedup and slowdown period. If a business cycle approach had been taken instead, then the comparison would have been between two speedup periods (1990–2001 and 2001–07) and one slowdown period (2007–18), as parts of each of those two preceding periods contain a portion of the speedup in the trend, and the industry-level and broad-based changes in the economy during the speedup period from 1997 to 2005 would have been split into two separate periods. It is notable that this disjuncture between business cycles and trend-based periods in terms of the current productivity slowdown did not occur with the last major productivity slowdown, in the 1970s. This widely cited slowdown, which was apparent in the data beginning in 1973, represented both a business cycle break and a clear demarcation between extended periods of high growth (before 1973) and low growth (after 1973). This result contrasts the present slowdown, the period selection of which was not as clear-cut. As for defining the periods since 1947 that occurred before the speedup period (1997–2005), I use a grouped business cycle approach (by grouping adjacent business cycles with similar trends) to make the interperiod comparisons in the figures more concise and make the broad trends over the past 70 years easier to absorb. The fact that the last major productivity slowdown (in the 1970s) had a match between business cycle breaks and trend-period breaks makes the 1948–1997 period somewhat easier to break up into periods. Also, for a strictly business cycle analysis of the present slowdown, see Shawn Sprague, “Below trend: the U.S. productivity slowdown since the Great Recession,” Beyond the Numbers: Productivity, vol. 6, no. 2 (U.S. Bureau of Labor Statistics, January 2017), https://www.bls.gov/opub/btn/volume-6/below-trend-the-us-productivity-slowdown-since-the-great-recession.htm.

7 Multifactor productivity (MFP) data for the U.S. private nonfarm business sector are available on an annual basis, beginning with data for 1948. This sector accounted for approximately 74 percent of the total U.S. economic output (gross domestic product [GDP]) as of 2017. As denoted by the term “business” in the series name, three nonbusiness sectors are excluded from GDP: general government, nonprofit institutions, and private households (including owner-occupied housing). These three sectors are excluded because their output is measured largely with the use of compensation data, which measure an input to production rather than an output from production, thus rendering these sectors inappropriate for productivity measurement. Also, farm sector data are excluded to reduce volatility in the overall measure. And, as denoted by the term “private” in the series name, government enterprises are excluded, because satisfactory capital measures are unavailable for this sector. In addition, note that the term “MFP” is synonymous with “TFP” or total-factor productivity, which is used throughout the economic literature and refers to the same measure. (For more information on this, see the U.S. Bureau of Labor Statistics (BLS) Division of Productivity Research and Program Development Frequently Asked Questions (FAQs) page at https://www.bls.gov/dpr/faqs.htm#Q01). On another note, although for this article we are looking at private nonfarm business MFP growth, which only includes labor and capital as inputs, BLS also publishes other measures of MFP growth, one of which is referred to as KLEMS (K-capital, L-labor, E-energy, M-materials, and S-purchased services), which includes additional inputs as well.

8 Although figure 2 shows a slight shift in the contribution of labor composition (from 0.2 percent to 0.3 percent) from the speedup period to the slowdown period, looking at these data with more precision reveals a trivial shift in the contribution of labor composition during the slowdown, with an upward shift of just 0.01 percentage point, from 0.24 percent in the speedup period to 0.25 percent in the slowdown period.

9 Alistair Dieppe, Neville Francis, and Gene Kindberg-Hanlon observe this phenomenon in both advanced economies and emerging market economies, in the period from 1980 to 2018: “The volatility of labor productivity is largely accounted for by [MFP] across both advanced economies and EMDEs, where [MFP] accounts for 75–80 percent of labor productivity variance. The high proportion of volatility present in [MFP] reflects its role as a residual, explaining all productivity variation not driven by slower-moving developments in the capital stock and human capital.” Alistair Dieppe, Neville Francis, and Gene Kindberg-Hanlon, “A tale of two dynamics: exploring productivity and business-cycle drivers of developed and emerging market economies,” working paper, July 24, 2020, p. 6.

10 For this article, we are looking at private nonfarm business MFP growth, which only includes labor and capital as inputs. However, BLS also publishes other measures of MFP growth that include other inputs, referred to as KLEMS (capital, labor, energy, materials, and services).

11 See Brian Resnick, “Dark matter, humility, and coming to grips with the unknown,” Vox, November 25, 2020.

12 From 1929 to 1933, GDP fell by a cumulative 26.3 percent, whereas from 2007 to 2009, GDP fell by a cumulative 2.7 percent. For more information, see National Data, National Income and Product Accounts (NIPA), Table 1.1.6. Real gross domestic product, chained dollars (U.S. Bureau of Economic Analysis).

13 From 1933 to 1940, GDP grew at an average annual rate of 7.2 percent, and from 2009 second quarter to 2018 fourth quarter, GDP grew at an average annual rate of 2.3 percent. NIPA, Table 1.1.6.

14 The U.S. population grew at an average annual rate of 0.7 percent from 1929 to 1940 and from 2007 to 2018. NIPA, Table 7.1 Selected per capita product and income series in current and chained dollars, line 18 (U.S. Bureau of Economic Analysis).

15 Valerie Cerra and Sweta Chaman Saxena, "Growth dynamics: the myth of economic recovery," American Economic Review, vol. 98, no. 1, March 2008, pp. 439–57; Carmen M. Reinhart and Kenneth S. Rogoff, This Time is Different: Eight Centuries of Financial Folly (Princeton, NJ: Princeton University Press, 2009); and Carmen M. Reinhart and Vincent R. Reinhart, "After the fall," Working Paper 16334 (Cambridge, MA: National Bureau of Economic Research, September 2010).

16 International Monetary Fund, World Economic Outlook, October 2009: Sustaining the Recovery (Washington: International Monetary Fund, 2009), p. 125.

17 Daisuke Ikeda and Takushi Kurozumi, "Slow post-financial crisis recovery and monetary policy," Working Paper 347 (Federal Reserve Bank of Dallas Globalization Institute, October 2018), p. 4. As noted in endnote 7, in this article, I use MFP to refer to multifactor productivity, although others in the literature refer to the measure as TFP or total factor productivity. These acronyms and names refer to the same measure. For more information, see the BLS Division of Productivity Research and Program Development FAQ page at https://www.bls.gov/dpr/faqs.htm#Q01.

18 These changes in demographics "include, most prominently, the demographic shifts of the surge of women into the labor force in the 1970s–1990s and, more recently, the baby boom[ers] beginning to retire." James H. Stock and Mark W. Watson, "Why has GDP growth been so slow to recover?" (draft paper presented at the Boston Federal Reserve's conference, "The elusive 'great recovery': causes and implications for future business cycle dynamics," October 2016), p. 1.

19 Ray C. Fair, "Explaining the slow U.S. recovery: 2010–2017," Business Economics, vol. 53, no. 4, pp. 184–194, October 2018.

20 Robert E. Hall, "The routes into and out of the zero lower bound," in Proceedings—Economic Policy Symposium—Jackson Hole (Federal Reserve Bank of Kansas City, 2013), p. 3.

21 Robert J. Barro, "The job-filled non-recovery" (Cambridge, MA: Harvard University, September 2016), p. 6.

22 Ikeda and Kurozumi, "Slow post-financial crisis recovery and monetary policy," p. 4.

23 David M. Byrne, Stephen D. Oliner, and Daniel E. Sichel, "Is the information technology revolution over?" International Productivity Monitor, vol. 25, Spring 2013, p. 21.

24 Romain Duval, Gee Hee Hong, and Yannick Timmer, "Financial frictions and the great productivity slowdown," Working Paper 17/129 (International Monetary Fund Working Papers, May 2017), p. 1.

25 Duval et al., "Financial frictions and the great productivity slowdown," p. 17. Intangible assets are nonphysical assets such as intellectual property, including software, research and development, patents, trademarks, and goodwill. Germán Gutiérrez and Thomas Philippon, in "Investment-less growth: an empirical investigation," abstract, Working Paper 22897 (Cambridge, MA: National Bureau of Economic Research, December 2016), also cite decreased investment in intangibles; see section (in this article) "The slowdown in the contribution of capital intensity." In addition to having an indirect effect on the MFP growth measure, as noted by Duval et al., a slowdown in intangibles would also have a direct effect on the contribution of capital intensity measure, by explicitly reducing the numerator of the change in the capital-labor ratio. In addition, the fallout from the Great Recession may have also hampered rates of reallocation—the process of moving more resources toward high-productivity firms and away from low productivity firms—according to Lucia Foster, Cheryl Grim, and John Haltiwanger, "Reallocation in the Great Recession: cleansing or not?" abstract, Working Paper 20427 (Cambridge, MA: National Bureau of Economic Research, August 2014). These authors observe faltering rates of reallocation during the Great Recession, which is the inverse of the typical case for recessions, perhaps indicating that the magnitude of this recession adversely affected prospects for productivity growth. Even worse, they state that "the reallocation

that did occur [during the Great Recession] was less productivity enhancing than in prior recessions." Nicholas Bloom, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry also cite weak rates of reallocation, which they claim is undergirded by an increase in uncertainty during recessions, contending that "increased uncertainty also reduces productivity growth because it reduces the degree of reallocation in the economy. Higher uncertainty leads productive plants to pause expanding and unproductive plants to pause contracting, which in the . . . U.S. economy drives much of aggregate productivity growth." Nicholas Bloom, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry, "Really uncertain business cycles," Working Paper 18245 (Cambridge, MA: National Bureau of Economic Research, July 2012), p. 1–2.

26 John G. Fernald downplays the importance of the Great Recession in the post-2005 productivity slowdown, claiming that "the Great Recession seem[s] less important than trends related to information technology (IT) that predated the Great Recession." See his paper, "Productivity and potential output before, during, and after the Great Recession," Working Paper 2014–15 (Federal Reserve Bank of San Francisco, June 2014). (Note that the effect of IT-intensive industries on the slowdown will be addressed in the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article.)

27 Ryan A. Decker, John C. Haltiwanger, Ron S. Jarmin, and Javier Miranda, "Changing business dynamism and productivity: shocks vs. responsiveness," Working Paper 24236 (Cambridge, MA: National Bureau of Economic Research, January 2018). Also, in addition to the works cited in this section on the topic of productivity dispersion, note that data on productivity dispersion are now available from BLS and the Census Bureau, via the Collaborative Micro-Productivity Project (CMP), which has developed and published experimental statistics on within-industry dispersion. The public-use statistics (referred to as the Dispersion Statistics on Productivity) developed via this project, were released in fall 2019 and cover all four-digit North American Industry Classification System industries in the manufacturing sector. Restricted-use establishment-level data with microbased estimates of productivity as well as its underlying components (e.g., output and input measures) are also available to qualified researchers on approved projects in secure Federal Statistical Research Data Centers. More information on these data can be obtained at https://www.bls.gov/lpc/productivity-dispersion.htm.

28 Michael Gort and Steven Klepper, "Time paths in the diffusion of product innovations," Economic Journal, vol. 92, no. 367, September 1982, pp. 630–653.

29 Decker et al., "Changing business dynamism and productivity."

30 Decker et al., "Changing business dynamism and productivity," p. 27. An in-depth discussion of high-tech industries, and their relationship to the economy-wide productivity slowdown, is in the "Industry-level analysis of the U.S. labor productivity slowdown" section of this article.

31 Ibid.

32 Jan De Loecker, Jan Eeckhout, and Gabriel Unger, "The rise of market power and the macroeconomic implications," working paper, 2018.

33 Ibid., p. 52.

34 Gustavo Grullon, Yelena Larkin, and Roni Michaely, "Are US Industries becoming more concentrated?" abstract, working paper, 2017.

35 Miguel Antón, Florian Ederer, Mireia Giné, and Martin C. Schmalz, "Common ownership, competition, and top management incentives," Finance Working Paper 511/2017 (Brussels: Belgium, European Corporate Governance Institute), February 2018; and José Azar, Sahil Raina, and Martin C. Schmalz, "Ultimate ownership and bank competition," working paper (SSRN, March 17, 2016).

36 John E. Kwoka, Jr. "Mergers, merger control, and remedies: a response to the FTC critique," working paper (SSRN, March 2017); Bruce A. Blonigen and Justin R. Pierce, "Evidence for the effects of mergers on market power and efficiency, " Working Paper 22750 (Cambridge, MA: National Bureau of Economic Research, October 2016); Council of Economic Advisers, "Occupational licensing: a framework for policymakers," The White House: Washington, DC, July 2015; Jason Furman, "Barriers to shared growth: the case of land use regulation and economic rents" (remarks at The Urban Institute, November 20, 2015); Jason Furman, "Market concentration —note by Jason Furman" (paper presented at Organisation for Economic Cooperation and Development [OECD], Directorate for

Financial and Enterprise Affairs Competition Committee Hearing on Market Concentration, June 7, 2018); and Brookings Institution, "The productivity puzzle: How can we speed up the growth of the economy?" panel discussion (Washington, DC, September 9, 2016). In addition, Ernest Liu, Atif Mian, and Amir Sufi theorize that the low interest rates of the past decade have helped increase concentration, asserting that "low interest rates encourage market concentration by raising industry leaders' incentive to gain a strategic advantage over followers, and this effect strengthens as the interest rate approaches zero." For more information, see Ernest Liu, Atif Mian, and Amir Sufi, "Low interest rates, market power, and productivity growth" abstract, Working Paper 25505 (Cambridge, MA: National Bureau of Economic Research, August 2019).

37 Dan Andrews, Chiara Criscuolo, and Peter N. Gal, "The global productivity slowdown, technology divergence and public policy: a firm level perspective," Hutchins Center Working Paper 24 (Washington, DC: Brookings Institution, September 2016), https://www.brookings.edu/research/the-global-productivity-slowdown-technology-divergence/, p. 3.

38 Decker et al., "Changing business dynamism and productivity," p. 24. Additionally, there is another widely cited firm-level theory that has been offered to explain the increased productivity dispersion, which is from Adalet McGowan, Andrews, and Millot. Müge Adalet McGowan, Dan Andrews, and Valentine Millot, "Insolvency regimes, zombie firms and capital reallocation," OECD Economics Department Working Papers No. 1399, June 28, 2017. Adalet McGowan et al. remark that the prevalence of so-called "zombie firms," or low-productivity firms that are unable to properly service their debts, have increased in OECD countries since the mid-2000s. The authors hypothesize that the stubborn persistence of these low-growth firms is potentially not only keeping resources from reallocating to high-growth firms, but it is also creating entry barriers and inhibiting the growth of new firms. However, this theory appears not to be relevant specifically for the United States, which, unlike other OECD countries and especially European countries, has actually had a decline in the share of zombie firms in recent years. For more information, see Dan Andrews and Giuseppe Nicoletti, "Confronting the zombies: policies for productivity revival" slide 7, OECD Economic Policy Papers, no. 21 (presented at the Peterson Institute for International Economics, January 23, 2018).

39 Jason Furman and Peter Orszag, "Slower productivity and higher inequality: Are they related?" Working Paper 18–4 (Peterson Institute for International Economics, June 2018).

40 Ibid., p. 2. See also Alexander M. Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenan, "Who becomes an inventor in America? The importance of exposure to innovation," Working Paper 24062 (Cambridge, MA: National Bureau of Economic Research, November 2017); Frederico Cingano, "Trends in income inequality and its impact on economic growth," OECD Social, Employment and Migration Working Papers, no. 163 (Paris: Organisation for Economic Cooperation and Development Publishing, December 9, 2014); and Jonathan D. Ostry, Andrew Berg, and Charalambos G. Tsangarides. "Redistribution, inequality, and growth," Staff Discussion Note (Washington, DC: International Monetary Fund, February 2014).

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65 Also, note that the low productivity growth of the 2005–18 period itself reduced the long-term rate since 1947 from 2.3 percent—what it had been as of 2005—to 2.1 percent as of 2018.

66 The data underlying the labor composition series bear this phenomenon out during the Great Recession: the labor cost share of workers under 45 and workers without a college degree plunged much more than it did for workers over 45 and workers with a college degree, during the Great Recession.

67 In this case, I use the long-term historical trend rate from 1947 to 2005, which is 2.3 percent, rather than the rate from 1947 to 2018, which is 2.1 percent. This is because, in this exercise, we are attempting to determine what growth would have been after 2005 if it had continued at the rate observed prior to 2005.

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70 For this computation of hypothetical average weekly hours, we are assuming that all the reduction in overall hours went to a reduction in average weekly hours and not to employment. This approach was taken to show the additional leisure or nonwork time that would have been hypothetically available for this group of workers who were employed during 2005–18.

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APRIL 2021

Are temporary layoffs becoming permanent during COVID-19?

Cody Parkinson

Job loss during the coronavirus disease 2019 (COVID-19) pandemic has been catastrophic. Firm–worker relationships are important in determining how quickly the U.S. economy will recover. In "Temporary layoffs and unemployment in the pandemic" (*FRBSF Economic Letter*, Federal Reserve Bank of San Francisco, November 16, 2020), Erin Wolcott, Mitchell G. Ochse, Marianna Kudlyak, and Noah A. Kouchekinia examine unemployment data relating to temporary versus permanent layoffs during the current pandemic and other recent recessions to assess the shape and speed of economic recovery.

Data and definitions from the Current Population Survey (CPS) are used for the analysis. During the survey process, people classified as unemployed are asked a series of questions to determine the reasons for their unemployment. These reasons include being on temporary layoff, permanent layoff, quitting their job, reentering the labor force, and so forth. People on temporary layoff have either received a date to return to work by their employer or expect to be recalled to their job within 6 months. When firms and workers have preestablished relationships, the process for returning to work is generally less time consuming and less costly than situations in which firms and workers need to establish a new employment relationship.

During periods of high unemployment, a higher aggregate share of people on temporary layoff generally signals a more rapid recovery. The authors present data showing that temporary layoffs were the main contributor to the high unemployment rate of 14.7 percent in April 2020. Temporary layoffs contributed 11.5 percent to the total rate, which was the highest contribution of temporary layoffs to total unemployment since at least 1967. In October 2020, temporary layoffs accounted for 2.0 percent of the 6.9 percent unemployment rate. Data from the Survey of Business Uncertainty also confirmed that temporary layoffs contributed to the increase in the unemployment rate. However, reasons for unemployment other than temporary layoffs have increased. If people continue to cycle through periods of joblessness, hold short-term jobs, or remain out of the labor force entirely, then future unemployment could remain persistently elevated.

Using CPS data, the authors can track changes in the labor market status of workers from one month to the next. The data show that the probability of someone moving from temporary layoff to permanent layoff increased during the COVID-19 pandemic but remains low by historical standards. Other than temporary layoffs, the April 2020 unemployment increase was largely attributable to people moving from employed to permanent layoff. However, the proportion of people moving from employed to permanent layoff fell in May and June. The proportion of people moving from out of the labor force to unemployed increased in May and June and has remained around the same level through at least September 2020. The data show that temporary layoffs are generally not turning into permanent layoffs. In addition, while the number of people who are considered long-term unemployed is still lower than the number during the 2007–09 recession, that amount may increase if the pandemic continues.

The authors close by summarizing their findings, stating that despite unemployment being well above prepandemic levels, data do not show that temporary layoffs are becoming permanent. However, as the crisis continues, recovery may slow as people battle persistent types of joblessness.

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Has COVID-19 affected mothers' labor market outcomes?

Demetrio Scopelliti

The coronavirus disease 2019 (COVID-19) pandemic has posed several challenges to parents continuing to work while also taking care of children who are unable to attend school or daycare because of safety regulations. While some parents are able to stay with their children by working from home, many work in industries and occupations that require them to work away from home. Because of the duration of the pandemic, childcare concerns have caused some parents in single-parent and multiparent households to consider leaving the labor force, limiting the hours they work in their current jobs, or changing jobs to work in occupations that allow them to work from home.

In "Did Covid-19 disproportionately affect mothers' labor market activity?" authors Daniel Aaronson, Luojia Hu, and Aastha Rajan (Chicago Fed Letter, Federal Reserve Bank of Chicago, January 2021) argue that COVID-19 has adversely affected parents' labor force participation that has disproportionately affected working mothers. Aaronson and colleagues acknowledge that other studies have shown that COVID-19 has not substantially affected parents' labor force participation. However, their assessment of labor market activity of parents (ages 25 to 54) through fall 2020 shows that labor force participation of mothers was 0.6 percentage point lower in the spring and 0.3 percentage point lower in the fall than that of adults in the same age group without kids. This finding means that approximately 120,000 mothers left the labor force in spring 2020 and approximately 60,000 left in fall 2020. In analyzing the demographics of those mothers who chose to leave the labor force beginning in March 2020, the authors found that the negative affect was disproportionately experienced by Black, single, and noncollege-educated mothers, reflecting disparities in the broader labor market over the same period.

Aaronson, Hu, and Rajan note that, while they assert gender disparity in labor market activity during COVID-19, their findings are not consistent with a trend toward the convergence of men's and women's labor market activity in the United States. Although the authors do not discuss the reasons why a gender disparity in labor market activity exists during COVID-19, they suggest that the disparity may be attributed to a higher proportion of women working in service industries, such as leisure and hospitality, that have been drastically affected by COVID-19. Another reason may be that mothers are still predominantly viewed as primary caregivers and more likely to be affected by the absence of children from schools and childcare. The impact on primary caregivers has been further complicated by the duration of the pandemic and safety concerns that have made relying on extended family for assistance more difficult. Regardless, the impact of the COVID-19 pandemic on labor market activity going forward remains to be seen.

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How does the labor market for parents change during the COVID-19 pandemic?

Lisa N. Huynh

Differences in labor force participation rates between genders are prevalent within the labor market, but these differences have been amplified with the onset of the coronavirus 2019 disease (COVID-19) pandemic, especially for mothers. In a working paper titled "Parents in a pandemic labor market" (Federal Reserve Bank of San Francisco, Working Paper 2021-04, February 4, 2021), authors Olivia Lofton, Nicolas Petrosky-Nadeau, and Lily Seitelman identify the different labor market outcomes between working men and women and working parents.

Lofton and coauthors find that, overall, employment of men declined by 12 percent compared with 15 percent of women in April 2020 (relative to February 2020). While the initial fall and recovery in employment were similar between nonparent men and women, the initial fall in employment was smaller for fathers than for mothers and nonparents. In addition, recovery prospects for mothers stalled compared with fathers and nonparents. Once the new school year started, recovery halted and the gender employment gap for parents continued to rise, whereas the labor force participation for nonparent women and men remained similar. The authors note that this finding would mean that the employment gap itself was driven more by parent status than by gender differences.

In addition, the authors discover that the labor force participation rates and employment to population ratio disproportionately affected both women and mothers. After controlling for demographic characteristics, the authors observe that these data show that the pandemic had a greater effect (2 times as large) on mothers with less education compared with the effect on college-educated mothers. These data also show that mothers in the lowest income tercile were largely affected (5 times as large) by the pandemic as compared with mothers in the highest income tercile. Interestingly, the age of the youngest child in the household appears not to have affected any labor market outcomes for parents.

Jobs with flexible working hours have helped cushion the overall effect of the pandemic on employment prospects, limiting the decline in employment numbers among mothers. However, simply having the ability to telework has not changed outcomes for either mothers or fathers. The authors find that jobs with flexible working hours are more important than telework capability during a pandemic when parents need to prioritize childcare. Disruptions to a child's schooling can also affect the labor force participation rates of mothers because of the absence of childcare options. In general, the authors note a negative relationship between the degree of the disruption of schooling and the change in the labor force participation rates among mothers and nonparent women.

Unlike its role in previous recessions, the role of childcare during the pandemic recession has been critical in introducing mothers back into the workforce, which suggests that childcare obligations could hold recovery back.

The authors suggest that reopening schools and daycare centers and increasing job flexibility would help recover the labor force participation rates to prepandemic levels and assist the growth prospects during the pandemic.

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Consumer inflation during the COVID-19 pandemic

Richard Works

The coronavirus disease 2019 (COVID-19) outbreak of 2020 created an awareness among financial media, academics, and bankers regarding the challenges of measuring inflation during a pandemic. While consumption patterns were affected by social distancing and lockdown mandates, these sudden changes can introduce biases in inflation measures. In "Inflation with Covid consumption baskets" (National Bureau of Economic Research, Working Paper 27352, July 2020), author Alberto Cavallo investigates the impact on inflation measures from changes in expenditures patterns because of the 2020 coronavirus pandemic. The author suggests that "the welfare implications are particularly relevant for lower-income households and [also] extend to countries experiencing a divergence [across] sectoral inflation rates" due to price movements. The term "sectoral inflation" refers to the rise in prices occurring in different commercial sectors of a country. For example, the industries under the transportation sector include new vehicles, motor fuels, used cars and trucks, and car and truck rental.

For this research, Cavallo used data collected on debit and credit card transactions from the Opportunity Insights Tracker (a mechanism that measures the daily change in U.S. consumption patterns). To produce COVID-19 consumer price index (CPI) indexes, he combined real-time expenditure estimates with official inflation measures from January 2019 to May 2020 that were not seasonally adjusted. This data collection was done for several countries, including the United States in which the index data used were produced by the U.S. Bureau of Labor Statistics (BLS). However, Cavallo found that matching data from the Opportunity Insights Tracker to data from various statistical offices from around the world was not always straightforward. For example, some countries that were investigated use a different classification system than the North American Industry Classification System that the United States uses. Thus, to match data from country to country, the author made mathematical assumptions to adjust for the differences in classifications. In addition, he employed Opportunity Insights Tracker data to obtain real-time estimates of expenditures.

From his results, Cavallo discovered that the official CPI from BLS and his calculated COVID-19 CPI were nearly identical in the United States in January and February 2020. But in March of that year (the start of the pandemic's initial outbreak in the United States), the COVID-19 inflation estimate was higher than the official CPI, although both showed deflation. As the pandemic grew, so did the difference between the two inflation rates. The official CPI fell 0.69 percent between March and April compared with the COVID-19 CPI, which decreased only 0.09 percent. Also, in May 2020, the official CPI experienced deflation, whereas the COVID-19 CPI had a positive rate of inflation. Some countries had higher COVID-19 inflation because vastly different price movements occurred across items (and the price divergence happened simultaneously with shifting weights).

Most of the differences between the official inflation measures and the COVID-19 inflation measures were found in spending on food and fuel. One reason for the difference is from expenditure weights that are generally lagged, whereas the COVID-19 CPI used real-time expenditure data. (BLS CPI data, however, are updated every 2 years

for weights.) As Cavallo explains, the “Core CPI” index excludes food and fuel, but the “Covid core” was still higher than the official All items less food and energy CPI in May 2020. These differences were due to less expenditure weight on nonenergy transportation sector subcategories, such as public transportation or new and used motor vehicles, with higher deflation.

The author’s findings suggest that during the coronavirus pandemic, the cost of living increased faster than the cost of living of the official CPI. To examine the household impact, the author used data from the 2018 BLS Consumer Expenditure Survey and then updated weights using monthly data of income quintiles from the Opportunity Insights Tracker. The results showed that low-income households spent more on food than on transportation, which exacerbated the difference in the inflation measures during the beginning of the pandemic. Cavallo suggests that low-income households had higher rates of COVID-19 inflation (1.12 percent in May 2020) during the pandemic when compared with higher income households (only 0.57 percent).

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April 2021

Why has the employment–population ratio declined in the United States?

Lawrence H. Leith

For the past two decades, the employment–population ratio—the percentage of the population that is employed—has been slowly declining in the United States among people of prime working age (ages 25 to 54). The employment–population ratio has declined the most among less educated men, but it has declined among other groups as well. The ratio for prime-age women, for example, rose steadily throughout the post-World War II period and peaked in 2000; it has gradually declined since then. Although the 2001 and 2007–09 recessions—and the impact of the COVID-19 pandemic beginning in early 2020—have exacerbated these declines, they have been driven largely by more long-term economic factors. In a recent article titled "Explaining the decline in the U.S. employment-to-population ratio: a review of the evidence" (Journal of Economic Literature, September 2020), former Commissioner of the U.S. Bureau of Labor Statistics Katharine G. Abraham and her coauthor, economist Melissa S. Kearney, examine these trends for the period from 1999 to 2018 and seek to explain the economic factors driving them.

Abraham and Kearney quantify and rank some of the factors that contributed to the declines in the employment–population ratios among prime-age men and women over the 1999–2018 period. The authors warn that none of the factors they examine work in isolation and are, in fact, interrelated; moreover, they were unable to quantify some of the factors because the evidence was too sparse. Nevertheless, Abraham and Kearney find that "labor demand factors are the most important drivers" of the overall decline in the employment–population ratio among 25- to 54-year-olds over the period. In particular, they cite the marked increased in imported goods from China as the single most important factor driving the decline, reducing the ratio by approximately 0.92 percentage point. The second-largest factor is the increase in automation in the U.S. economy—especially robot technology—which reduces the demand for human labor. The authors estimate that this factor reduced the employment–population ratio for prime-age workers by another 0.43 percentage point over the 20-year period. Other things equal, the more that machines can do what human beings used to do, the more that the percentage of employed people will continue to decline.

Abraham and Kearney also find that labor supply factors have been less important than labor demand factors in the decline of the employment–population ratio for 25- to 54-year-olds over the past two decades. They examine the increase in the number of people receiving Social Security Disability Insurance during the period, for example, and find that it reduced the ratio by 0.09 percentage point. Similarly, the authors look at the Veterans Affairs Disability Compensation program and estimate that its growth reduced the ratio by 0.07 percentage point. The authors note that other "social safety net" programs, such as the Supplemental Nutrition Assistance Program

(formerly known as food stamps) and the Earned Income Tax Credit, had negligible effects on the decline in the employment–population ratio over the 1999–2018 period.

The authors suggest that several other factors warrant further research to determine how much they might also have contributed to the decline in the prime-age employment–population ratio over the past two decades. One such factor involves the challenge that many parents face in reconciling their family and work responsibilities. This challenge is especially relevant for lower wage workers, many of whom often have unpredictable and inflexible schedules. For many parents, the relatively high cost of childcare can make not working more attractive than working. As a result, one parent might choose not to work and instead stay home to care for children. Other factors that Abraham and Kearney suggest warrant further research include increased incarceration rates, stricter licensing requirements, and certain changing social norms, such as young adults in their twenties and beyond living with their parents or other relatives.

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Immigration and innovation

The impact of foreign-born workers on the U.S. labor market remains a primary focus of immigration policy and research. In a recent book titled The Roles of Immigrants and Foreign Students in U.S. Science, Innovation, and Entrepreneurship, editors Ina Ganguli, Shulamit Kahn, and Megan MacGarvie offer a collection of eight novel papers presenting recent findings in the literature on immigration economics. The collection provides evidence that (1) foreign-born students still want to work in the United States, although this may be changing for Chinese students, (2) foreign-born students who remain to work in the United States after graduation are positively selected by ability, and (3) the presence of more foreign-born entrepreneurs or employees in a firm is associated with more productivity growth and innovation by most measures.

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Many foreign-born students come to the United States to attend top-rated academic institutions. A relevant question with implications for student visa policies is how many foreign students who build human capital in the United States actually remain in the country to use that capital in the U.S. labor market. In chapter 2, Ina Ganguli and Patrick Gaulé estimate that, among Ph.D. students, foreign-born students are more likely to accept postdoctoral appointments in the United States than are native-born students. This difference is robust to test scores and career preferences, suggesting that American educational institutions select students interested in living in the United States. Similarly, in chapter 8, Michael Roach, Henry Sauermann, and John Skrentny show that about 42 percent of foreign-born Ph.D. students wish to stay in the United States permanently and about 37 percent wish to work in the country for some time before returning home. These rates are similar across degree fields, but the average is pulled down by Chinese students, only about 17 percent of whom intend to stay in the United States permanently. The authors urge further study of this difference between

Chinese and other foreign-born students, but they provide ample evidence that immigrants sourced from institutions of higher education have a lasting presence in the United States.

In chapter 1, Stefano Breschi, Francesco Lissoni, and Ernest Miguelez examine why some foreign-born students stay to work in the United States, whereas others return to their home countries. The chapter explores this question by using a novel dataset (based on a data-linkage project between LinkedIn and PatentsView) of patent-holding Indian immigrants employed in the U.S. information and communications technologies (ICT) industry. Using PatentsView, the authors pull data on patents from the top 179 ICT companies. After linking patent holders from these companies to LinkedIn profiles and restricting the sample to Indian inventors whose first move outside of India was to the United States, the authors arrive at a dataset containing around 5,500 such individuals. The analysis explores differences between those who return home and those who stay in the United States, distinguishing between “education” migrants (those who studied at an educational institution at the time of migration) and “work” migrants (those who worked at the time of migration). Breschi, Lissoni, and Miguelez find evidence that return migrants in both the education and work categories are negatively selected with respect to education; that is, those who stay in the United States tend to have higher educational attainment, on average. On the other hand, the authors also find that work migrants who return home are positively selected by the number of patents, implying that those with more patents are more likely to return to India. The authors urge caution in interpreting this mixed result in the absence of further research, but they do demonstrate that many of the latter migrants publish patents and work in the United States for a considerable time.

Given the evidence that many immigrants come to the United States for work, what is their effect on innovation and the firms that hire them? The other papers in the book seek to answer this question. Chapters 3, 4, and 6 explore the relationship between immigration and innovation at the firm level. Because much of the high-skilled immigration to the United States occurs through the H-1B work visa program, which allows the admission of a limited number of immigrants with a college degree up to an annual cap, chapters 3 and 4 focus on the impact of those immigrants.

Using Labor Condition Applications (LCAs), which are documents filed by firms seeking to employ an H-1B worker, Gaurav Khanna and Munseob Lee (chapter 3) compare the performance of firms that file LCAs with the performance of firms that do not. The authors stress that, since filing an LCA is the first step involved in the H-1B program and because not all LCAs are approved, their data reflect a firm’s tendency to hire high-skilled immigrants. For their dependent variable, Khanna and Lee construct a measure of product reallocation that reflects how many products come off and on the market—a measure of creative destruction. The authors find that LCAs are positively associated with product reallocation, with firms that apply for foreign workers more dynamically bringing in new products and taking out old ones. Although causation is difficult to establish, the authors do find that increased LCAs precede greater product reallocation, but periods of greater product reallocation have no correlation with later LCAs.

Anna Maria Mayda et al. (chapter 4) take a similar approach by using a firm’s number of approved H-1B workers as a treatment variable. Through a Freedom of Information Act request filed with the U.S. Citizenship and Immigration Services, the authors obtained data on the entire universe of approved H-1B applications from 1997 to 2012. Their findings, like those reported in chapter 3, suggest that larger companies (based on revenue) have a

higher propensity to employ H-1B workers and that greater revenue growth follows the introduction of more such workers.

Taking a different approach, J. David Brown et al. (chapter 6) examine immigrant-owned tech firms with data from the U.S. Census Bureau American Survey of Entrepreneurs. Since tech firms have relatively high rates of innovation and employ many foreign-born workers, the authors try to estimate the effect of immigrant ownership on innovation. Their measures include product and process innovation, intellectual property, and R&D spending. All measures are positively associated with immigrant ownership, and except for intellectual property, they are significant. Many of the innovation measures, most notably R&D spending, are robust to a myriad of controls.

Academics interested in the relationship between immigration and U.S. scientific and technological innovation should explore the evidence presented in this book. Although the book applies some advanced econometric concepts and may challenge nontechnical audiences, it is a welcome advance in the literature on immigration economics. Those with academic or policy interests concerned with the effects of foreign-born workers on the labor market may find it valuable, and those who wish to add to the literature may benefit from learning more about the novel datasets created by some authors.

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Employee access to sick leave before and during the COVID-19 pandemic

In response to the coronavirus disease 2019 (COVID-19) pandemic, many private industry employers implemented changes to their sick leave policies. Using data from the U.S. Bureau of Labor Statistics (BLS) National *Compensation Survey and two BLS supplemental surveys,* this article examines changes to sick leave provisions and use before and during the pandemic.

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The National Compensation Survey (NCS), collected by the U.S. Bureau of Labor Statistics (BLS), is used to produce multiple data outputs, including the Employment Cost Index, employer compensation costs, and employee benefits. The survey is unique in collecting compensation information from employers, gathering data not only on worker wages and salaries but also on employer-provided benefits.[1] Among the benefits collected are various types of employee leave, including sick leave. Information on the incidence and provision of benefits is published annually.

The coronavirus disease 2019 (COVID-19) pandemic resulted in many employers changing their leave policies, affecting sick leave provisions shortly after the NCS reference period in March 2020. To capture data on these pandemic-induced changes, BLS collected two additional surveys: (1) a supplement to the NCS and (2) an establishment survey, called the Business Response Survey (BRS).[2] In this article, we present and analyze data on sick leave provisions and use before and during the pandemic.

Prepandemic information on paid sick leave

To contextualize sick leave changes due to the COVID-19 pandemic, we first provide information on employer-provided sick leave in private industry before the pandemic, relying on NCS data from March 2020. Table 1

presents data—by occupational characteristics, industry, and establishment size—on employee access to sick leave, types of sick leave provisions, and leave combinations.

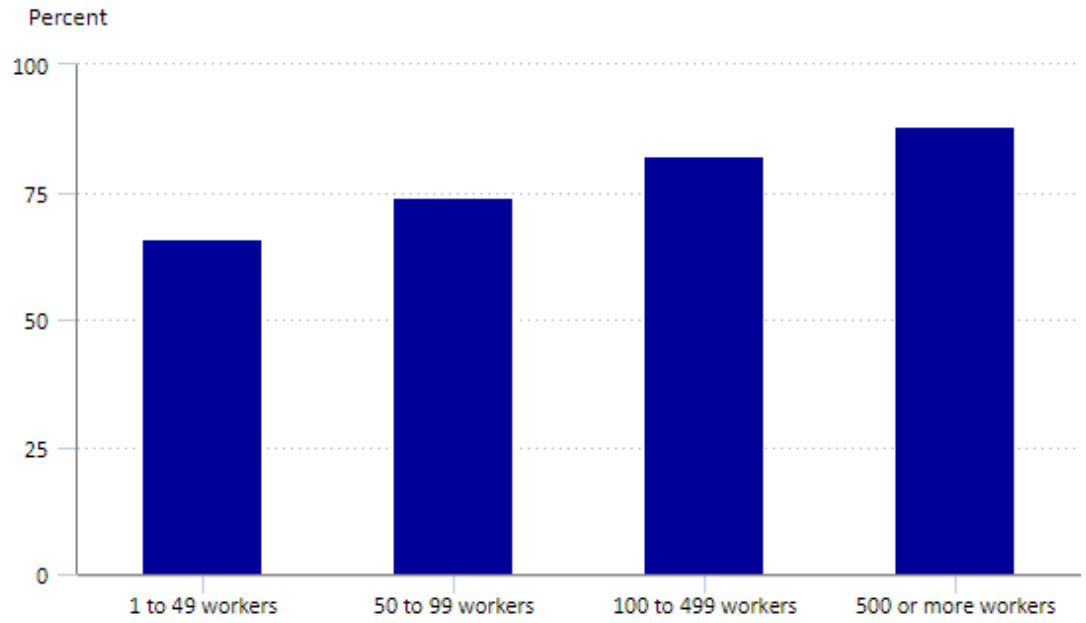
Table 1. Sick leave access, provision type, and combinations of leave benefits, private industry, March 2020

Access to paid sick leave

In March 2020, 75 percent of all private industry workers had access to paid sick leave. Paid sick leave was more prevalent among full-time workers (86 percent) than among part-time workers (45 percent), and it was also more prevalent among union workers (88 percent) than among nonunion workers (74 percent). In addition, access to sick leave varied by occupation, with workers in management, professional, and related occupations having the highest access rate (92 percent) and workers in service occupations having the lowest rate (59 percent).[3]

In terms of establishment characteristics, access to sick leave tended to increase with establishment size. (See chart 1.) In establishments with 1 to 49 workers, 66 percent of workers had access to sick leave, compared with 74 percent in establishments with 50 to 99 workers, 82 percent in establishments with 100 to 499 workers, and 88 percent in establishments with 500 or more workers.[4]

Chart 1. Percentage of workers with access to sick leave, by establishment size, private industry, March 2020



Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics, National Compensation Survey.

Before the pandemic, sick leave access rates also differed by industry. Although table 1 shows that these rates did not vary significantly between goods-producing establishments (74 percent) and service-providing establishments (76 percent), they did vary considerably by industry segment. Looking at two-digit North American Industry Classification System industry sectors, one sees that, in several sectors, about 90 percent of workers had access

to sick leave. These sectors include finance and insurance (97 percent), utilities (96 percent), and professional and technical services (93 percent).

Sick leave provisions

As shown in the leave provisions columns of table 1, among workers with access to sick leave in March 2020, 63 percent were in plans providing a fixed number of days per year, 34 percent were in consolidated leave plans,[5] and 3 percent could take sick leave days as needed, meaning that their plans did not specify a maximum number of days. Plans allowing workers to take days as needed were relatively rare. Six percent of workers in educational services had this plan feature, and this rate was the highest across all published industry sectors.

Access to consolidated leave plans varied by worker and establishment characteristics. Among production, transportation, and material-moving workers with access to sick leave, 24 percent received this benefit as part of a consolidated leave plan, a rate significantly lower than the rates for service workers (30 percent), sales and office workers (37 percent), and workers in management, professional, and related occupations (37 percent).

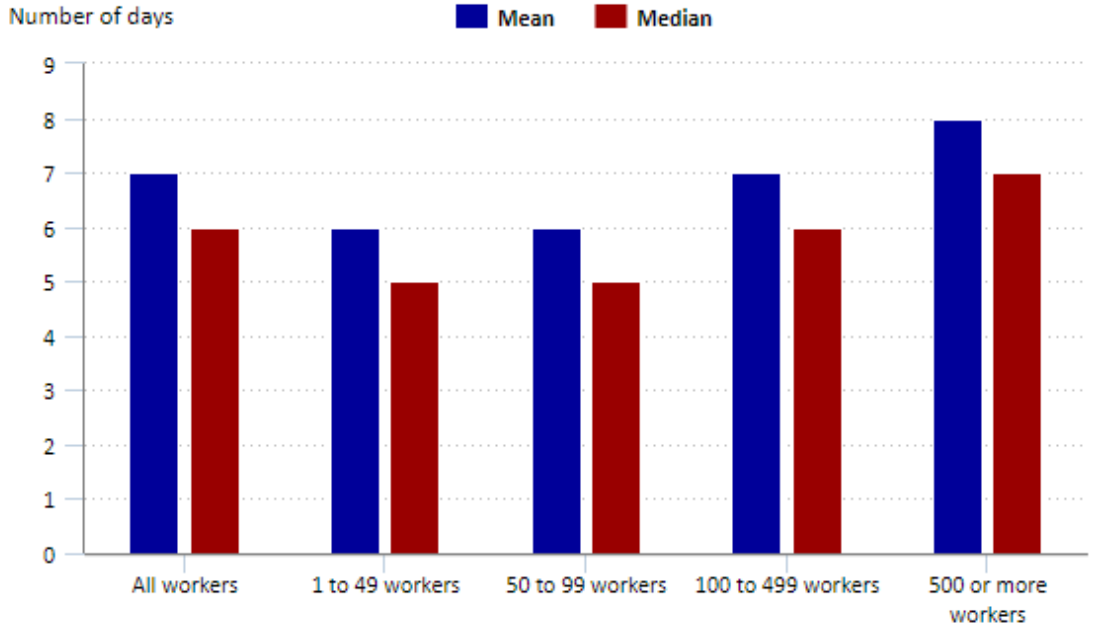
Consolidated leave plans also were more prevalent at larger establishments. In establishments with 1 to 99 workers, 31 percent of workers with sick leave access had a consolidated leave plan, compared with 36 percent of workers in establishments with 100 or more workers. Among industry sectors, the rates of access to consolidated leave plans were 20 percent for workers in leisure and hospitality and 40 percent for workers in financial activities.

How much sick leave did workers receive?

Table 2 presents estimates of mean and median days of paid sick leave by length of service and establishment size. As seen in the table, in March 2020, there was little variation in the amount of leave offered by length of service, especially among smaller establishments. In fact, the mean and median days for establishments with 1 to 49 workers and establishments with 50 to 99 workers were mostly the same across the various categories for length of service. For this reason, we focus on differences in paid sick leave by establishment size for workers with more than 1 year of service. (See chart 2.)

Table 2. Number of annual days of paid sick leave, by service requirement and establishment size, private industry, March 2020

Chart 2. Number of annual days of paid sick leave after 1 year of service, by establishment size, private industry, March 2020



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics, National Compensation Survey.

Employees at establishments with 1 to 49 workers and 50 to 99 workers were offered an average of 6 days of sick leave per year, with a median of 5 days. Employees at establishments with 100 to 499 workers were offered an average of 7 days of sick leave, with a median of 6 days. Employees at establishments with 500 or more workers had the most generous sick leave, an average of 8 days per year, with a median of 7 days.

Leave combinations

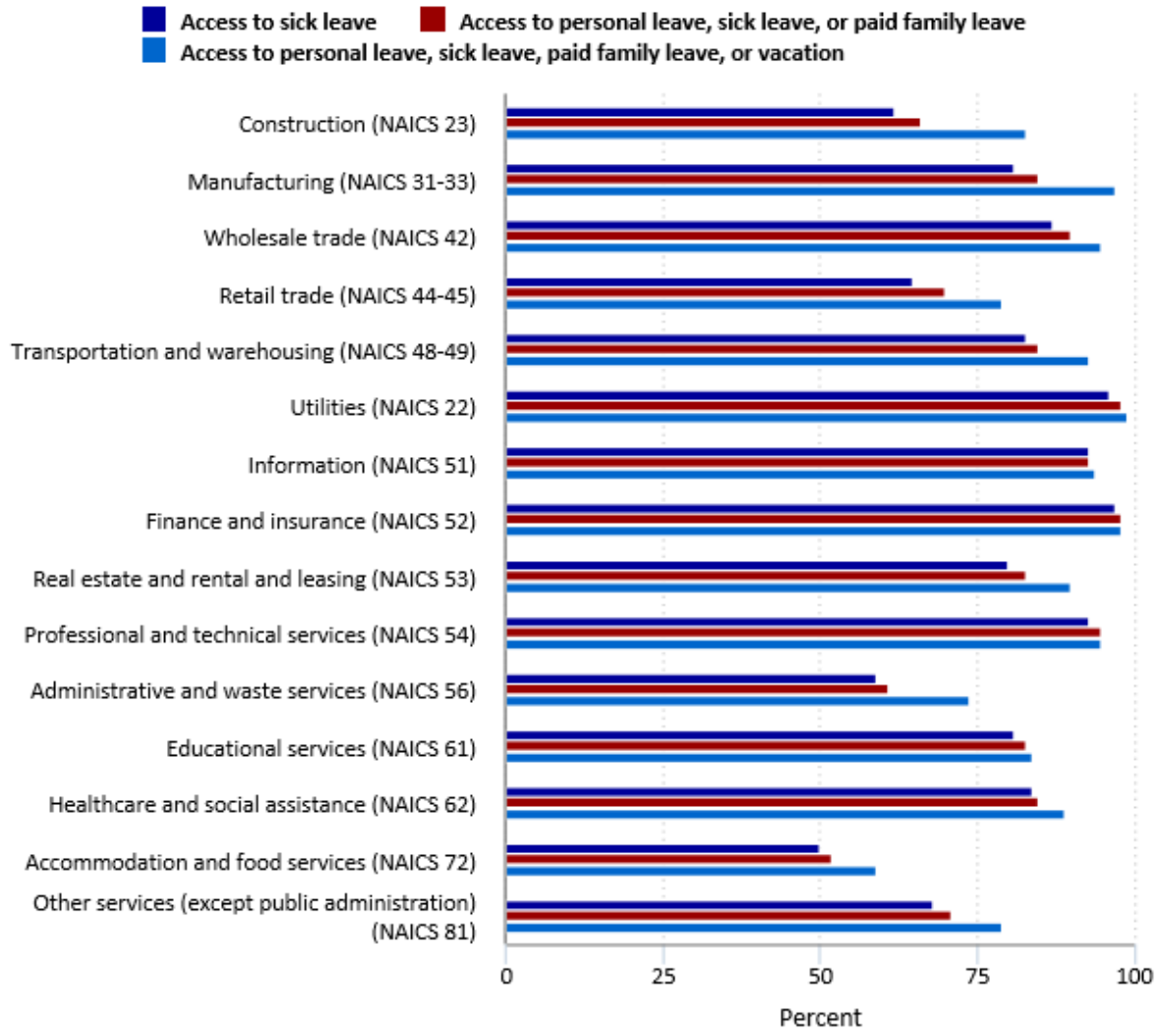
The data on sick leave provisions indicate that, in March 2020, roughly one-third of private industry workers were offered consolidated leave plans. Other workers may have been offered a more traditional leave package distinguishing among different types of paid leave. The last four columns of table 1 focus on access to different combinations of paid leave.

Much like access to sick leave, access to leave combinations varied by establishment size. Before the pandemic, the rate of access to personal leave, sick leave, paid family leave, or vacation was 77 percent at establishments with 1 to 49 workers, 85 percent at establishments with 50 to 99 workers, and 92 percent at establishments with 100 or more workers.

Access to leave including personal leave, sick leave, paid family leave, or vacation also varied by industry, but slightly differently than did access to sick leave alone. (See chart 3.) Although access rates in utilities, finance and insurance, and professional and technical services were relatively high (in the mid- to high 90-percent range), they were found to increase by only a few percentage points with the inclusion of additional forms of leave. This pattern is not surprising, particularly in the case of finance and insurance and professional and technical services, because these industries have relatively high offerings of consolidated leave plans. Workers in manufacturing had access to

sick leave at a rate of 81 percent, but once other leave types were included in the measure, the access rate increased to 97 percent.

Chart 3. Sick leave access and combinations of leave benefits, selected private industries, March 2020



Click legend items to change data display. Hover over chart to view data.
Note: NAICS = North American Industry Classification System.
Source: U.S. Bureau of Labor Statistics, National Compensation Survey.

Workers in accommodation and food services and in construction had relatively low rates of access to sick leave. As seen in table 1, however, with the inclusion of other types of paid leave, the former's rate of leave access rises to 59 percent, an increase of 9 percentage points, and the latter's rate increases to 83 percent, a jump of 21 percentage points.

NCS COVID-19 supplement

In response to the COVID-19 pandemic, BLS added supplemental questions to the NCS, asking employers about leave plan changes due to the pandemic. These questions focused on whether private industry establishments

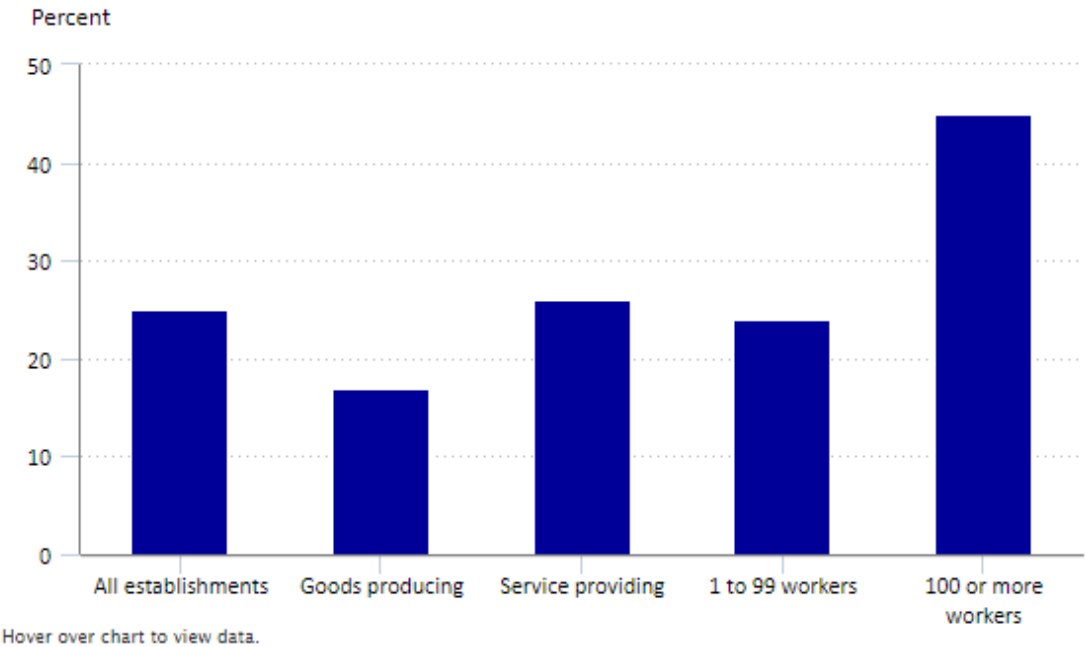
changed their leave policies and on whether employees used sick leave between March 1 and May 31, 2020. Survey data were collected from June 1 to July 21, 2020, representing about 6.5 million private industry establishments from approximately 1,500 responding units in the United States. The response rate was roughly 25 percent.

Unlike the NCS estimates, which capture the share of workers receiving benefits, the supplemental estimates capture establishment shares, because the supplemental data were collected at the establishment, not at the job, level. Since the sample size of the NCS supplement is relatively small, the level of detail provided in the supplemental data is limited. Estimates are presented for all private industry establishments, goods-producing establishments, service-providing establishments, establishments with 1 to 99 workers, and establishments with 100 or more workers.

Changes to paid sick leave or paid-time-off plans

As shown in chart 4, 25 percent of all private industry establishments created or modified paid sick leave or paid-time-off plans because of the COVID-19 pandemic. This rate was 45 percent among establishments with 100 or more workers and 24 percent among establishments with fewer than 100 workers.

Chart 4. Percentage of establishments that created or modified sick leave or paid-time-off plans because of COVID-19, June 2020



Hover over chart to view data.
Note: COVID-19 = coronavirus disease 2019.
Source: U.S. Bureau of Labor Statistics, National Compensation Survey supplement.

How many days of paid leave did establishments add? Table 3 presents the distribution of these additions for the subset of establishments that modified existing paid leave plans or created new plans. Of these establishments, 34 percent added 1 to 5 paid leave days to their plans, 20 percent added 6 to 10 days, and 37 percent added more than 10 days. (The remaining 8 percent had an unknown number of days added.) Among goods-producing establishments, 44 percent added 1 to 5 paid days, 34 percent added 6 to 10 days, and 19 percent added more

than 10 days. Among service-providing establishments, 33 percent added 1 to 5 paid days, 19 percent added 6 to 10 days, and 39 percent added more than 10 days.

Table 3. Percentage of establishments that added paid days to new or existing leave plans because of COVID-19, by number of days added, June 2020

Category	1 to 5 days	6 to 10 days	More than 10 days	Unknown
All establishments	34	20	37	8
Sector				
Goods producing	44	34	19	3
Service providing	33	19	39	9
Establishment size				
1 to 99 workers	37	17	39	8
100 or more workers	9	61	20	10

Note: COVID-19 = coronavirus disease 2019.

Source: U.S. Bureau of Labor Statistics, National Compensation Survey supplement.

Use of sick leave

For the period between March 1 and May 31, 2020, 42 percent of all establishments reported that the average number of sick leave days (paid and unpaid) used per employee was zero. Twenty percent of establishments reported that the average employee used between 1 and 5 sick leave days during the same period, and 10 percent of establishments reported that the average employee used more than 5 sick leave days. Nineteen percent of establishments with 100 or more workers indicated that the average employee used more than 5 sick leave days, compared with 9 percent of establishments with less than 100 workers who reported the same.

Among establishments that modified existing paid and unpaid sick leave plans or created new plans, 90 percent indicated that their plan changes were temporary. The remaining 10 percent either reported that their plan changes were permanent or indicated that they could not provide information on whether the changes would be permanent.

Business Response Survey information on sick leave

The Business Response Survey (BRS) was collected between July 20 and September 30, 2020, leveraging the existing BLS internet data collection portal used for a variety of establishment-level data collections, including the Annual Refiling Survey of the Quarterly Census of Employment and Wages (QCEW). The BRS uses the QCEW as its sampling frame and has a scope of private industry establishments in the 50 states, the District of Columbia, and Puerto Rico.[6] The NCS also uses the QCEW as its sampling frame, but its scope is somewhat different from that of the BRS, most notably in that it excludes agriculture. The usable response rate for the BRS was 27.2 percent, comparable to that of the NCS sick leave supplement.

The reference period for the BRS was from January 1, 2020, to the time the respondent completed the survey. The BRS asked the following question related to sick leave: “As a result of the coronavirus pandemic, did this business location increase the amount of paid sick leave provided to employees?” The answer options included “yes, provided paid sick leave to employees who did not have paid sick leave prior to the coronavirus pandemic”; “yes,

increased amount of paid sick leave for employees who already had sick leave prior to the coronavirus pandemic"; "no change to paid sick leave or no paid sick leave provided"; and "don't know."

Our analysis focuses on the combined "yes" responses, aiding a comparison with the NCS supplement, which aggregated both newly created leave plans and modified existing plans. BRS estimates are presented both as the percentage of establishments adding sick leave and as the percentage of employment in establishments adding sick leave. The former measure is similar to that in the NCS supplement, and the latter is comparable to the March estimate on percentage of workers from the NCS.

Table 4 provides a set of BRS estimates by industry and establishment size. Among all private industry establishments, 14 percent increased sick leave because of COVID-19. This percentage is lower than the NCS supplement estimate of 25 percent. Despite this difference, the patterns by establishment size are similar between the NCS supplement and the BRS, which, because of its larger sample size, provides more granular estimates by establishment size.

Table 4. Sick leave increases due to COVID-19, by industry and establishment size, 2020

Category	Establishments with increased paid sick leave		Employment in establishments with increased paid sick leave	
	Percent	Standard error	Percent	Standard error
Industry				
U.S. total, private sector	14	0.2	28	0.4
Agriculture, forestry, fishing, and hunting (NAICS 11)	11	1.9	42	3.8
Mining, quarrying, and oil and gas extraction (NAICS 21)	13	1.2	23	3.2
Utilities (NAICS 22)	26	3.4	49	1.8
Construction (NAICS 23)	11	0.3	25	1.1
Manufacturing (NAICS 31-33)	19	0.4	36	1.0
Wholesale trade (NAICS 42)	19	0.9	34	1.9
Retail trade (NAICS 44-45)	15	0.4	29	1.6
Transportation and warehousing (excluding scheduled air transportation and truck transportation) (NAICS 48-49A)	17	2.0	27	3.2
Scheduled air transportation (NAICS 4811)	20	2.6	31	3.1
Truck transportation (NAICS 484)	11	2.1	24	2.4
Information (NAICS 51)	12	1.6	30	3.4
Finance and insurance (NAICS 52)	21	1.1	36	2.0
Real estate and rental and leasing (NAICS 53)	13	1.2	27	2.4
Professional and technical services (NAICS 54)	11	0.6	25	2.2
Management of companies and enterprises (NAICS 55)	21	2.8	41	2.6
Administrative and waste services (NAICS 56)	12	0.9	21	2.3
Educational services (NAICS 61)	10	1.5	31	2.4
Healthcare (NAICS 621-623)	17	0.4	32	1.2
Social assistance (NAICS 624)	20	5.7	30	1.9
Arts, entertainment, and recreation (NAICS 71)	7	1.3	17	2.2

See footnotes at end of table.

Table 4. Sick leave increases due to COVID-19, by industry and establishment size, 2020

Category	Establishments with increased paid sick leave		Employment in establishments with increased paid sick leave	
	Percent	Standard error	Percent	Standard error
Accommodation and food services (NAICS 72)	11	0.4	19	0.8
Other services (except public administration) (NAICS 81)	8	0.6	17	1.2
Establishment size				
Small (1 to 499 workers)	14	0.2	26	0.5
1 to 4 workers	9	0.4	9	0.4
5 to 9 workers	14	0.4	14	0.4
10 to 19 workers	19	0.6	19	0.6
20 to 49 workers	25	0.7	25	0.7
50 to 99 workers	30	1.3	30	1.3
100 to 249 workers	36	1.7	36	1.7
250 to 499 workers	36	1.8	36	1.8
Large (500 or more workers)	36	0.8	37	1.0
500 to 999 workers	35	1.0	35	1.0
1,000 or more workers	38	1.5	38	1.5

Note: COVID-19 = coronavirus disease 2019; NAICS = North American Industry Classification System.

Source: U.S. Bureau of Labor Statistics, Business Response Survey.

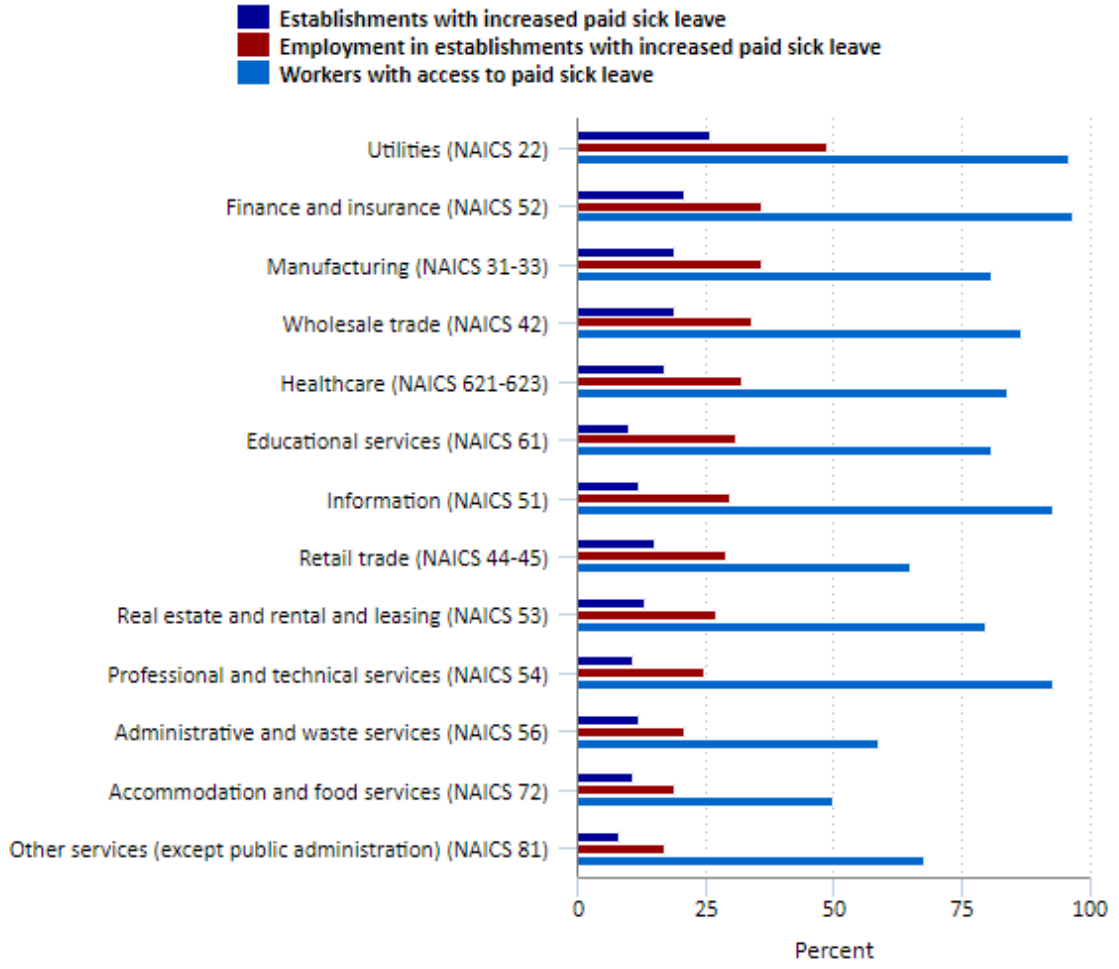
As seen in table 4, initial increases in establishment size correspond to increases in the percentage of establishments that expanded sick leave because of the pandemic. Among establishments with 50 to 99 workers, 30 percent increased the amount of paid sick leave provided to employees. Although the point estimates in the table tend to increase with establishment size, the increases between adjacent size classes are not statistically significant.

While the sample size of the NCS supplement was not large enough to provide estimates by industry, such estimation was possible with the BRS. A pandemic-induced expansion of sick leave was relatively uncommon among establishments in the arts, entertainment, and recreation industry (7 percent) and more common among establishments in the utilities (26 percent) and finance and insurance (21 percent) industries.

As was shown in table 1, workers in utilities and in finance and insurance had relatively high rates of access to sick leave before the pandemic. Chart 5 combines, for selected private industries, the prepandemic sick leave access rates from the NCS with the establishment- and employment-level estimates from the BRS. Industries are sorted by the percentage of employment in establishments that increased sick leave during the pandemic. As seen toward the top of the chart, industries such as utilities and finance and insurance, which had prepandemic sick leave access of 96 and 97 percent, respectively, also had relatively high rates of sick leave expansion during the pandemic. Shown at the bottom of the chart, industries in which employees had relatively low rates of

prepandemic sick leave access, such as administrative and waste services, accommodation and food services, and other services, also had relatively low rates of sick leave expansion during the pandemic.

Chart 5. Access to sick leave and increases in sick leave due to COVID-19, selected private industries



Click legend items to change data display. Hover over chart to view data.
Note: COVID-19 = coronavirus disease 2019; NAICS = North American Industry Classification System.
Source: U.S. Bureau of Labor Statistics, Business Response Survey (2020) and National Compensation Survey (NCS) (March 2020).
Healthcare numbers for the NCS include social assistance.

There are exceptions to this pattern. For example, although 93 percent of workers in professional and technical services had access to sick leave before the pandemic, only 11 percent of establishments in this industry sector, covering 25 percent of employment, expanded sick leave access because of COVID-19. In retail trade, 65 percent of workers had access to sick leave before the pandemic—one of the lowest industry access rates—but 15 percent of establishments in this industry sector, covering 29 percent of employment, expanded sick leave access because of COVID-19, which places retail trade roughly in the middle of the industry distribution.

Taken as a whole, however, the numbers suggest that establishments that had relatively generous leave benefits before the pandemic were also more likely to expand sick leave during the pandemic.

Conclusion

In this article, we used data from the NCS and two supplemental surveys to examine how sick leave provisions in the private industry changed in response to the COVID-19 pandemic. Our analysis suggests that, after the pandemic hit, 25 percent of private industry establishments created or modified paid sick leave or paid-time-off plans, with 90 percent of these establishments indicating that plan changes would be temporary. In addition, we found that about 14 percent of private industry establishments increased the amount of paid sick leave in response to the pandemic.

Tables

Table 1. Sick leave access, provision type, and combinations of leave benefits, private industry workers, March 2020

Category	Access to sick leave (all workers = 100 percent)		Type of provision (all workers with paid sick leave = 100 percent)						Combinations (all workers = 100 percent)			
	Percent	Standard error	Fixed number of days		As needed		Part of consolidated leave plan		Personal leave, sick leave, or paid family leave		Personal leave, sick leave, paid family leave, or vacation	
			Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error
All workers	75	0.9	63	1.0	3	0.2	34	0.9	78	0.9	85	0.7
Occupation												
Management, professional, and related	92	0.7	59	1.7	4	0.5	37	1.6	93	0.6	95	0.6
Service	59	2.0	68	2.5	2	0.4	30	2.5	61	2.0	69	1.8
Sales and office	77	1.1	60	1.3	3	0.2	37	1.2	79	1.0	86	1.0
Natural resources, construction, and maintenance	68	1.6	64	2.3	5	1.2	32	2.2	72	1.9	85	1.7
Production, transportation, and material moving	72	1.6	74	1.4	2	0.4	24	1.5	76	1.3	90	1.0
Job status												
Full time	86	0.7	61	1.1	3	0.3	35	1.1	88	0.6	94	0.5
Part time	45	1.6	76	2.0	1	0.4	23	1.9	49	1.7	57	1.6
Union status												
Union	88	1.4	62	1.1	3	0.3	35	1.1	91	1.2	94	1.0
Nonunion	74	1.0	—	—	—	—	—	—	77	0.9	84	0.8
Sector												
Goods producing	74	1.3	65	2.0	4	0.7	30	1.9	78	1.4	92	1.1
Service providing	76	1.1	63	1.1	3	0.3	34	1.1	78	1.0	83	0.8
Industry												
Construction (NAICS 23)	62	2.0	64	3.0	2	0.7	34	2.8	66	2.2	83	2.9
Manufacturing (NAICS 31-33)	81	1.5	—	—	—	—	—	—	85	1.4	97	0.6

See footnotes at end of table.

Table 1. Sick leave access, provision type, and combinations of leave benefits, private industry workers, March 2020

Category	Access to sick leave (all workers = 100 percent)		Type of provision (all workers with paid sick leave = 100 percent)						Combinations (all workers = 100 percent)			
	Percent	Standard error	Fixed number of days		As needed		Part of consolidated leave plan		Personal leave, sick leave, or paid family leave		Personal leave, sick leave, paid family leave, or vacation	
			Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error
Trade, transportation, and utilities (NAICS 22, 42, 43, 48-49)	74	1.2	68	1.6	3	0.5	29	1.4	78	1.0	85	0.8
Wholesale trade (NAICS 42)	87	1.4	71	2.4	4	1.1	24	1.9	90	1.2	95	1.3
Retail trade (NAICS 44-45)	65	1.1	63	1.8	2	0.5	35	1.6	70	1.2	79	0.9
Transportation and warehousing (NAICS 48-49)	83	2.9	75	3.9	2	0.6	23	4.0	85	2.8	93	1.5
Utilities (NAICS 22)	96	2.8	—	—	—	—	—	—	98	1.1	99	0.8
Information (NAICS 51)	93	2.2	62	4.3	4	1.3	34	4.1	93	2.2	94	2.1
Financial activities (NAICS 52-53)	93	1.0	56	1.0	5	0.9	40	1.2	94	0.9	96	0.8
Finance and insurance (NAICS 52)	97	0.5	51	1.7	4	0.7	45	1.8	98	0.4	98	0.4
Real estate and rental and leasing (NAICS 53)	80	3.6	70	5.1	—	—	—	—	83	3.1	90	2.5
Professional and business services (NAICS 54-56)	79	2.1	—	—	—	—	—	—	81	2.0	87	1.7
Professional and technical services (NAICS 54)	93	1.8	56	5.1	3	1.4	41	5.0	95	1.7	95	1.7
Administrative and waste services (NAICS 56)	59	3.5	—	—	—	—	—	—	61	3.3	74	3.2
Education and health services (NAICS 61-62)	84	2.8	55	2.7	1	0.2	44	2.7	85	2.9	88	2.3
Educational services (NAICS 61)	81	3.0	83	3.1	6	1.4	11	2.9	83	3.0	84	3.1
Healthcare and social assistance (NAICS 62)	84	3.2	51	3.0	—	—	—	—	85	3.3	89	2.6

See footnotes at end of table.

Table 1. Sick leave access, provision type, and combinations of leave benefits, private industry workers, March 2020

Category	Access to sick leave (all workers = 100 percent)		Type of provision (all workers with paid sick leave = 100 percent)						Combinations (all workers = 100 percent)			
	Percent	Standard error	Fixed number of days		As needed		Part of consolidated leave plan		Personal leave, sick leave, or paid family leave		Personal leave, sick leave, paid family leave, or vacation	
			Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error	Percent	Standard error
Leisure and hospitality	52	2.6	78	3.4	2	1.0	20	3.5	54	2.5	60	2.3
Accommodation and food services (NAICS 72)	50	3.3	81	3.0	2	0.8	17	3.0	52	2.6	59	3.1
Other services (NAICS 81)	68	3.0	66	5.0	4	1.2	30	4.9	71	2.6	79	3.1
Establishment size												
1 to 99 workers	67	1.2	65	1.4	3	0.4	31	1.3	70	1.1	79	1.1
1 to 49 workers	66	1.4	65	1.8	4	0.5	31	1.7	68	1.3	77	1.3
50 to 99 workers	74	2.2	66	2.4	1	0.4	33	2.4	77	1.9	85	1.4
100 or more workers	85	1.2	62	1.3	2	0.4	36	1.3	87	1.1	92	1.0
100 to 499 workers	82	1.4	62	1.8	2	0.5	36	1.8	85	1.3	91	1.2
500 or more workers	88	2.0	62	1.9	3	0.6	35	1.8	90	1.9	93	1.6

Note: NAICS = North American Industry Classification System.

Source: U.S. Bureau of Labor Statistics, National Compensation Survey.

Table 2. Number of annual days of paid sick leave, by service requirement and establishment size, private industry, March 2020

Category	After 1 year of service				After 5 years of service				After 10 years of service				After 20 years of service			
	Mean	Standard error	Median	Standard error	Mean	Standard error	Median	Standard error	Mean	Standard error	Median	Standard error	Mean	Standard error	Median	Standard error

See footnotes at end of table.

Table 2. Number of annual days of paid sick leave, by service requirement and establishment size, private industry, March 2020

Category	After 1 year of service				After 5 years of service				After 10 years of service				After 20 years of service			
	Mean	Standard error	Median	Standard error	Mean	Standard error	Median	Standard error	Mean	Standard error	Median	Standard error	Mean	Standard error	Median	Standard error
All workers	7	0.1	6	0.0	7	0.1	6	0.0	7	0.1	6	0.0	7	0.2	6	0.0
Establishment size																
1 to 99 workers	6	0.2	5	0.1	6	0.2	5	0.2	6	0.2	5	0.3	6	0.2	5	0.3
1 to 49 workers	6	0.2	5	0.1	6	0.2	5	0.2	6	0.2	5	0.2	6	0.2	5	0.2
50 to 99 workers	6	0.3	5	0.2	6	0.3	5	0.7	6	0.3	5	0.8	7	0.3	5	0.8
100 or more workers	7	0.1	6	<0.05	8	0.1	6	<0.05	8	0.2	6	<0.05	8	0.2	6	0.1
100 to 499 workers	7	0.2	6	0.0	7	0.2	6	0.0	7	0.2	6	0.0	7	0.3	6	0.0
500 or more workers	8	0.2	7	0.3	8	0.2	8	0.7	8	0.2	8	0.7	9	0.2	8	0.6

Source: U.S. Bureau of Labor Statistics, National Compensation Survey.

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NOTES

1 For additional information, see “National compensation measures,” Handbook of Methods (U.S. Bureau of Labor Statistics), www.bls.gov/opub/hom/ncs/home.htm.

2 For information on the National Compensation Survey (NCS) supplement, see www.bls.gov/ncs/effects-of-coronavirus-on-sick-leave-policies.htm. For information on the Business Response Survey (BRS), see www.bls.gov/brs/.

3 While the NCS publication of annual benefits contains information on occupational and work characteristics, the NCS supplement and the BRS do not contain this information.

4 The increase in sick leave access is not statistically significant between establishments with 250 to 499 workers and establishments with 500 or more workers.

5 A consolidated leave plan combines multiple forms of leave that employees can allocate as they choose.

6 For additional information on BRS sampling and estimation, see www.bls.gov/brs/methods/technical-notes.htm.

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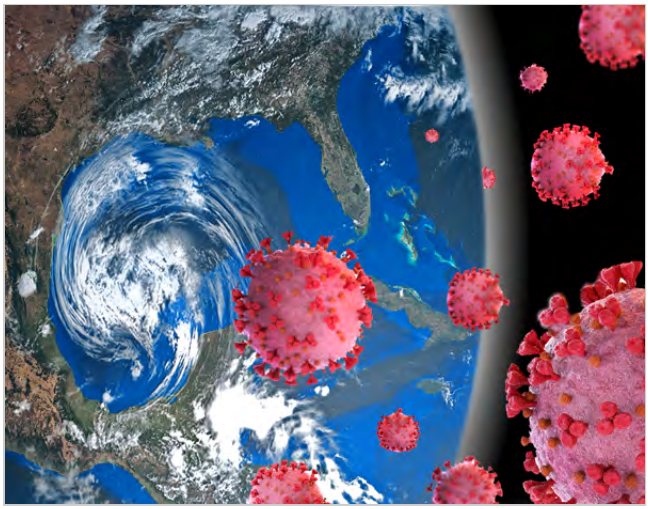
Estimating state and local employment in recent **disasters—from Hurricane Harvey to the COVID-19** pandemic

Natural disasters, including hurricanes, floods, wildfires, and the coronavirus disease 2019 (COVID-19) pandemic, have challenged the standard practices used to produce state and area employment estimates. In some cases, these challenges have led to modifications to the handling of reported business closures, assumptions regarding nonresponse, and the techniques used for modeling employment in domains with small samples for state and metropolitan areas. This article examines how a series of major hurricanes in 2017 and 2018 affected the estimation of state and metropolitan area payroll employment and how lessons learned from these disasters provided a playbook for producing estimates during the COVID-19 pandemic.



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The U.S. Bureau of Labor Statistics (BLS) Current Employment Statistics (CES) program produces some of the timeliest economic indicators each month, both for the nation as a whole and for varying levels of geographic detail. The CES program conducts a monthly survey of about 144,000 businesses and government agencies representing about 697,000 individual worksites. Respondents to the CES survey provide information on the number of employees, total payroll, and hours paid for the pay period that includes the 12th day of the month. The CES program uses these data to produce estimates of industry employment, hours, and earnings. BLS typically publishes national data within a week of the end of the reference month; data for the 50 states; Washington, DC; Puerto Rico; the U.S. Virgin Islands; and about 450 metropolitan areas are released approximately 2 weeks later.

Natural disasters challenge assumptions built into the employment estimation process regarding nonresponse and the relationship between business openings and closures, and the CES program must address this issue in order to produce accurate data. This article provides an overview of three aspects of the CES methodology that natural disasters confront. It then provides case studies of how the CES program dealt with these questions in developing state and metropolitan area estimates following five recent hurricanes—Harvey, Irma, and Maria in 2017, and

Florence and Michael in 2018—and how the lessons learned from the earlier experience were applied to producing estimates in the early months of the coronavirus disease 2019 (COVID-19) pandemic. (See table 1.)

Table 1. Selected natural disasters that affected state and local employment data

Disaster	Analyzed effect in Current Employment Statistics estimates
Hurricane Harvey	September 2017, Texas
Hurricane Irma	September 2017, Florida
Hurricane Maria	October 2017, Puerto Rico
Hurricane Florence	September 2018, North Carolina and South Carolina
Hurricane Michael	October 2018, Florida and Georgia
COVID-19 pandemic	March and April 2020, 50 states, plus Washington, DC, and Puerto Rico

Source: U.S. Bureau of Labor Statistics.

Note: COVID-19 = coronavirus disease 2019.

CES methodology and natural disasters

The CES program surveys businesses each month and uses the data and a consistent, objective methodology to produce estimates of industry employment, hours, and earnings. The methodology relies on assumptions that are continually evaluated and generally hold in normal times. However, natural disasters are extreme events, and this section explores three ways that such disasters raise questions about the usual CES methodological underpinnings.

Are survey respondents different from nonrespondents?

The CES survey is designed as a probability-based survey.[1] The BLS Quarterly Census of Employment and Wages (QCEW), which contains information on all employers required to participate in the unemployment insurance (UI) system and covers about 97 percent of all nonfarm payroll employment, provides both a sampling frame and the main benchmark source for the CES program.[2] In developing the QCEW as a sample frame, BLS stratifies the data by state, industry, and establishment size. The CES survey randomly selects businesses within these strata, with the inverse of the probability of selection used as the sample weight in estimation. The survey estimates are benchmarked to the administrative QCEW data annually. The difference between the benchmark data and the survey-based estimates—the benchmark revision—is regularly used to assess the accuracy of the CES estimates. After setting benchmark employment levels each year, the CES program estimates monthly employment growth rates with a weighted link-relative estimator. The estimator is essentially the ratio of the current month's weighted employment to that of the prior month in the set of matched respondents that reported nonzero employment for the pay period containing the 12th of both months. The generally small number of active survey units reporting zero employment in either the current or prior month is not used because of assumptions in the business birth–death model (discussed in the next subsection).

Equation 1 provides the weighted link-relative estimate ($\hat{R}_t$) for time t, where ae_i is reported employment for a matched respondent i in n matched sample establishments, w is the sampling weight, and d is a nonresponse weight adjustment (calculated for industries identified to respond at substantially higher or lower rates)[3]:

(1) $$\hat{R}_t = \frac{\sum_{i=1}^{n} w_i \times d_i \times ae_{i,t}}{\sum_{i=1}^{n} w_i \times d_i \times ae_{i,t-1}}.$$

Within each estimating domain (an area or industry combination in which the estimate calculation is performed—other published cells are summaries of estimating cells), the estimator implicitly imputes data for nonrespondents as well as businesses reporting zero employment in the current or prior month by using the growth rates of the matched units. State-level estimates are produced for "estimation supersectors," high-level industries (such as construction or leisure and hospitality) that are estimated directly and control the sum of estimates of more detailed industries. The sample size in these estimation supersectors is large enough to avoid using small-area modeling techniques in most cases, but domain estimates use respondents in businesses from quite different industries (for example, clothing stores, gas stations, and grocery stores mixed together in retail trade).

The implicit imputation follows from the form of the estimator, which does not require explicit imputation, and a missing-at-random assumption within each estimating cell (conditioned on the industries in d_i). The survey respondents stand in for the nonrespondents, and this assumption works well when they are similar, on average.[4]

Natural disasters challenge the missing-at-random assumption. Certain types of businesses—for example, those in federally designated disaster areas—might have more job losses than others in their state because of business disruptions, and they might respond to the CES survey at a lower rate, as other matters take a higher priority. Similarly, certain industries within an estimation supersector may fare differently from one another during a disaster in a way that correlates with response rates, and the same may be true for differences in employment trends and response rates between large and small establishments.

Are business births and deaths properly captured?

The ability to use the QCEW as a frame with a close match to the target population of all nonfarm payroll jobs is one of the CES program's greatest strengths. Two of the program's biggest challenges are accounting for businesses that have opened and closed since the frame was established. It is impossible to sample, enroll, and collect data on business births in real time because the QCEW lags the CES survey by several months. Establishment deaths—defined as worksites that no longer have any payroll employees, which may be temporary or permanent—present a challenge because businesses generally stop reporting when there are no employees. A small number of businesses report establishment deaths; however, they are mainly firms with multiple worksites. These two components of job growth generally offset one another, and the degree to which CES procedures do not capture the residual growth when applied to historical QCEW population data is known as the "net birth–death residual." This value is generally small and stable, and therefore the CES program forecasts historical values with a time-series model for use in estimation. Equation 2 provides the formula for the employment estimate ($\hat{Y}_t$):

(2) $$\hat{Y}_t = \hat{Y}_{t-1} \times \hat{R}_t + BD_t.$$

The CES program multiplies the prior month's employment level ($\hat{Y}_{t-1}$) by the weighted link relative ($\hat{R}_t$) and then adds the current month's forecast value (BD_t).[5]

Natural disasters strain the usual assumptions about business births and deaths. Disaster conditions may halt the formation of new businesses, while forcing many existing businesses to cease operations. But despite disruptions—and sometimes even severe damage to physical locations—many businesses continue to pay employees

through the hardship, mitigating the number of business deaths by CES definitions. Still, the net birth–death residual calculated from the QCEW is often noticeably lower in domains affected by natural disasters, and the forecast error tends to be positive in these cases.

Are small-area models adequate?

The CES program produces estimates with a version of the Fay-Herriot model for estimation supersectors and for many metropolitan areas with small sample sizes.[6] The model estimate is a weighted combination of the direct weighted link-relative estimate and a synthetic component consisting of a historical trend value corrected by a coefficient derived from the regression model in equation 3:

(3) $$Y1_{i,j} = \beta_i \times Y2_{i,j} + e_{i,j}.$$

$Y1_{i,j}$ represents the statewide weighted link-relative estimates for a given industrial supersector (i) and state (j), Y2 represents the corresponding historical trend values, β_i is an estimated coefficient, and $e_{i,j}$ is a model residual. The regression modeling is performed at a statewide supersector level, and the correction factor (β_i) from the state-level model is linked to detailed metropolitan areas. The Fay-Herriot estimate for metropolitan area k is displayed in equation 4:

(4) $$\hat{Y}_{i,k} = W_{i,k} \times Y1_{i,k} + (1 - W_{i,k}) \times \beta_i \times Y2_{i,k}.$$

The weight ($W_{i,k}$) assigned to the direct estimate ($Y1_{i,k}$) is a function of the variance of the direct and trend ($Y2_{i,k}$) components as well as the variance from the state-level model. When the relationship between the direct estimates and the historic trend is looser, the direct estimates receive a higher weight. The correction factor adjusts the historic trend values to the direct estimates roughly on average across the country, but it does not account for any clusters of heterogeneity among states or areas.

This model relies on assumptions about the similarity of industry behavior between areas in order to “borrow strength” across those areas; the model also relies on assumptions about the relationship between statewide and metropolitan area trends.[7] Hurricanes bring these assumptions into stark relief, as some affected states may be dissimilar to the nation as a whole, and even within those states some areas face devastation while others remain unscathed. Similarly, the COVID-19 pandemic affected jobs in states and cities to widely different degrees, despite broad-based shutdowns and job losses.

Five major hurricanes

Although the CES survey began in 1915, and the program has faced many natural disasters since then, the survey has evolved substantially over the years. The CES program fully implemented a probability-based design for the 50 states and Washington, DC, in 2003, BLS assumed responsibility for producing the state and local estimates in 2011, and estimation procedures and models have continued to evolve since then.[8] As a result, the 2017–18 hurricanes provided the best context in which to address estimation issues related to the COVID-19 pandemic.[9]

Several major hurricanes made landfall on the Gulf of Mexico and Atlantic coasts, as well as over U.S. territories in the Caribbean, during the 2017 and 2018 hurricane seasons.[10] The timing of these storms matters because anyone who worked or received pay for any portion of the pay period including the 12th day of the month was counted as employed. Hurricane Harvey made landfall at Port Aransas, Texas, as a category-4 storm, on Friday,

August 25, 2017, and produced heavy rainfall and severe flooding in coastal Texas and other parts of the Gulf Coast, most notably in Louisiana. The system that became Hurricane Irma also formed in August 2017 and made landfall over several Caribbean islands as a category-5 storm in early September; it struck the Florida Keys as a category-4 storm on Sunday, September 10, 2017, and reached the mainland later that day, continuing north along the Florida peninsula. Hurricane Maria formed in September 2017 and caused severe devastation as it made its way through the Caribbean that month. The center of the then-category-5 storm passed just south of St. Croix in the U.S. Virgin Islands on September 19, 2017, before moving diagonally across Puerto Rico the following day.[11] The next year, Hurricane Florence reached category-4 strength and weakened to a category-1 storm, before making landfall on Friday, September 14, 2018, near Wrightsville Beach, North Carolina; it then traveled into South Carolina, causing severe flooding and storm surges in both states. The following month, Hurricane Michael struck the Florida panhandle on Wednesday, October 10, 2018, as a category-5 hurricane.

Hurricanes Harvey and Irma both caused tragic loss of life and rank among the most severe U.S. natural disasters, in terms of property damage. Harvey caused 68 direct deaths in Texas and an estimated $125 billion in property damages in the region. Irma caused 10 direct deaths across three states—7 in Florida, 2 in Georgia, and 1 in South Carolina—and 3 direct deaths in the U.S. Virgin Islands, as well as $50 billion in property damages. The CES survey measured far fewer job losses associated with Harvey than with Irma, however. Texas employment grew in September 2017—adding 14,600 jobs, not far off the prior 12-month average growth of 16,900 jobs—with net job losses in coastal metropolitan areas such as Houston-The Woodlands-Sugar Land, TX (–8,800). The state added 39,300 jobs the following month as businesses bounced back. Florida, by contrast, lost 172,700 jobs in September 2017, before recovering 194,700 jobs the following month. The difference resulted from the timing of the storms. Irma struck Florida at the beginning of the week that included September 12, so workers on a weekly payroll who lost their shifts for 7 days showed up in the estimates as a job loss. By contrast, Harvey hit Texas more than 2 weeks earlier, so only prolonged layoffs resulted in a drop in measured employment in that state.[12] Hurricane Maria, despite hitting Puerto Rico and the Virgin Islands well before the October 2017 reference period, followed closely behind Irma's strike on the territories and caused lasting devastation that was evident in employment data for a prolonged period.

The birth–death model

In normal months, a small number of businesses report zero employment in the CES survey. The rate of reported establishment "deaths" generally follows a stable, seasonal pattern, and some of the deaths are temporary. Following Hurricanes Irma and Maria, the number of establishments reporting zero employment increased sharply. Table 2 shows the proportion of respondents that reported zero employment and compares the forecasted and actual birth–death residuals (later derived from the QCEW) in disaster months. In order to provide frames of reference, table 2 also shows the average proportion of business deaths in the sample over the 2-year period before the disaster and the average absolute monthly forecast error, in terms of employment. The proportion of reported establishment deaths was double the usual rate in Florida following Hurricane Irma and 7 times the usual rate in Puerto Rico following Hurricane Maria. This indicated that the usual birth–death relationship did not hold, and actual birth–death values from the QCEW—calculated several months after the initial release of the CES estimates—were substantially more negative than the forecast values. The forecast error of employment in Florida following Irma was nearly 4 times the average absolute monthly forecast error, while the forecast error for Puerto Rico following Maria was more than 8 times larger than average. Following other major hurricanes, the proportion

of reported establishment deaths was relatively normal, and the birth–death forecasts were closer to their mark and well within normal ranges. (See table 2.)

Table 2. Reported zeros and birth–death forecast errors

Event	Proportion of businesses reporting zero employment		Birth–death forecast error (mean absolute error, 2014–19)	
	Month	Percent	Month	Value (in thousands)
Harvey (Texas)	September 2017	0.23	September 2017	–0.3 (7.9)
	Average, September 2014, 2015, and 2016	0.15		
Irma (Florida)	September 2017	0.40	September 2017	28.4 (7.5)
	Average, September 2014, 2015, and 2016	0.19		
Maria (Puerto Rico)	October 2017	2.20	October 2017	13.8 (1.7)
	Average, October 2014, 2015, and 2016	0.32		
Florence (North Carolina)	September 2018	0.14	September 2018	4.9 (3.6)
	Average, September 2015, 2016, and 2017	0.16		
Florence (South Carolina)	September 2018	0.21	September 2018	–0.5 (2.1)
	Average, September 2 015, 2016, and 2017	0.20		
Michael (Florida)	October 2018	0.22	October 2018	4.5 (7.5)
	Average, October 2015, 2016, and 2017	0.18		
Michael (Georgia)	October 2018	0.13	October 2018	2.3 (5.0)
	Average, October 2015, 2016, and 2017	0.18		
COVID-19 (50 states, plus Washington, DC, and Puerto Rico)	March 2020	0.46	March 2020	Unavailable
	Average, March 2017, 2018, and 2019	0.18		
	April 2020	3.40	April 2020	Unavailable
	Average, April 2017, 2018, and 2019	0.22		

Source: U.S. Bureau of Labor Statistics.

Although reported establishment deaths generally are not used in the estimation process, the seven-fold increase in their rate in Puerto Rico following Hurricane Maria necessitated a different approach. BLS determined the risk of underestimating the number of business deaths to be substantial enough that reported zeros were treated the same as other matched reports and were used in the sample link relative. This change negatively affected the October 2017 employment estimates by 11,800 jobs, nearly offsetting the birth–death forecast error of 13,800. Because many of the closures were temporary, the returns from zero employment were also used in the estimates.

Following Hurricane Irma, the CES program did not initially use reported business deaths in the weighted link-relative estimator for Florida, but after benchmarking the September 2017 employment data, the program recognized that the initial sample-based estimates undercounted the extent of job loss.[13] The QCEW data contained a large increase in the number of establishments reporting zero employment, and had the sample-based estimates used the reported zeros, the estimated employment level would have been 35,000 lower—more closely tracking the population data—which would have accounted for the birth–death forecast error. (The actual value was 28,000 lower than the forecast value.) The CES program included the returns for businesses that had reported declines to zero following Irma in the sample-based estimates that were produced from the new September 2017 benchmark level, increasing Florida employment estimates in October 2017 by 32,000. Including these returns from zero and making other adjustments to account for reporting differences between the CES

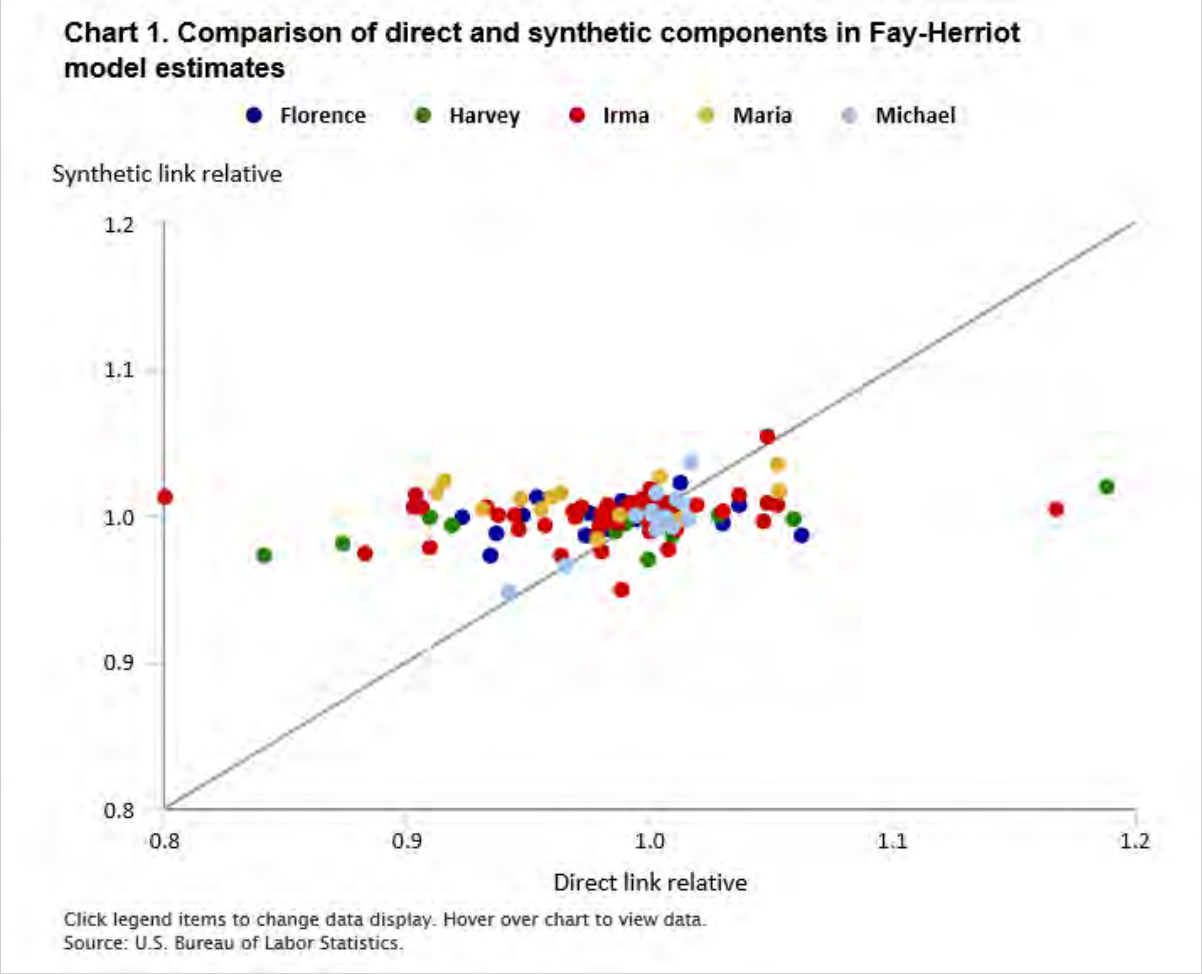
survey and the QCEW resulted in October–December 2017 reestimates that would more closely track the eventual benchmark data released in March 2019.

Nonresponse analysis

Following several major hurricanes, concerns arose over the possibility of businesses in severely affected areas responding at lower rates than those in the rest of the state, which would result in a violation of the missing-at-random assumption. The CES program has investigated nonresponse weight adjustments following hurricanes and other disasters such as floods and wildfires dating back to Katrina, in 2005, in order to appropriately represent disaster areas in statewide estimates. Although these adjustments can be calculated for different levels of devastation—for instance using flood maps—the set of counties designated by the Federal Emergency Management Agency (FEMA) as eligible for individual and public assistance has typically defined disaster areas for purposes of nonresponse analysis. The program now regularly monitors response rates and the impact of differential nonresponse in states affected by natural disasters. However, response rates were not significantly lower in disaster areas following the 2017–18 hurricanes, in part because of dedicated data collection efforts. Applying nonresponse adjustments following the 2017–18 hurricanes would have changed estimates little, with no obvious benefit, and therefore the estimates were not adjusted for differential nonresponse.

Small-area estimation

The CES program widely uses variants of the Fay-Herriot model in producing employment estimates, particularly at the metropolitan-area level.[14] In areas affected by recent major hurricanes, the direct employment estimates were lower than the synthetic components 65 percent of the time. This indicates a breakdown in the assumptions of similarity across states and among areas within each state. Chart 1 shows a comparison of the link relatives for the direct and synthetic parts of Fay-Herriot models in metropolitan areas containing counties designated by FEMA as eligible for individual and public assistance. (Three outlier values are not displayed.) The reference line has a slope of 1, and values above that line indicate a direct estimate lower than the synthetic one.



Although the direct estimates showed the job-losing effects of these hurricanes more, on average, than did the model as a whole, the sample in these domains is small and often quite volatile. Had the CES program used direct estimates instead of Fay-Herriot models, the root-mean-square benchmark revision to the link relatives would have been 37 percent higher.

Experiences following the 2017 and 2018 hurricanes led to the development of other modeling approaches that would generate better results and not violate important assumptions. Instead of modeling all statewide supersectors together and applying the results to metropolitan areas, the domains directly affected by hurricanes could be pooled and modeled together. Had it been used, this “hurricane variant” of the Fay-Herriot model would have produced benchmark revisions that were, on average, 12 percent lower, and it would have improved 64 percent of estimates. The variant model would have improved accuracy the most for the hurricanes with the largest effect on estimates, reducing benchmark revisions for Puerto Rico following Maria by 39 percent and for Florida following Irma by 11 percent. (The hurricane variant improved estimates 71 percent of the time for Puerto Rico and 74 percent of the time for Florida.) The hurricane variant model did not perform well for Texas following Harvey: although the correction factor better captured the drop in employment, worse model fit resulted in a much larger weight on the direct components, which would have resulted in higher benchmark revisions. (See table 3.)

Table 3. Root-mean-square benchmark revision of link relatives for Fay-Herriot modeled series in metropolitan areas during major hurricanes

Hurricane	Direct sample-based	Fay-Herriot	Fay-Herriot hurricane variant	Percentage improved by hurricane variant
All (n = 139)	0.056	0.041	0.036	64.7
Florence (n = 21)	0.031	0.027	0.026	61.9
Harvey (n = 22)	0.060	0.021	0.033	31.8
Irma (n = 68)	0.047	0.036	0.032	73.5
Maria (n = 14)	0.102	0.075	0.046	71.4
Michael (n = 14)	0.058	0.056	0.056	71.4

Source: U.S. Bureau of Labor Statistics.

Applying lessons learned to producing estimates during the COVID-19 pandemic

A historically unprecedented number of jobs were lost and regained in the months after the onset of the COVID-19 pandemic.[15] Health officials identified the first case of COVID-19 in the United States in Washington State on January 21, 2020.[16] However, it would be several weeks before community spread of the virus led to severe business disruptions and shutdowns. Many novel data sources show declining activity throughout the month of March 2020,[17] even before the issuance of formal shelter-in-place and stay-at-home orders.[18] The week of March 8–14 marked a turning point in business activity. Restaurant reservation data from OpenTable illustrate the evolving decline in business activity that week: as of Sunday, March 8, reservations were down only 2 percent over the year, but by the following Saturday (March 14), they showed a 42-percent decline.[19] Ohio was the first state to close all public schools on March 12, and by the end of the following week (March 15–21), nearly all public schools had closed,[20] air passenger travel had fallen by 75 percent,[21] and restaurant reservations had dropped by nearly 100 percent. The National Bureau of Economic Research (NBER) Business Cycle Dating Committee determined that the longest economic expansion in U.S history ended in February 2020 and a recession began in March.[22] Nationwide job losses in March (–1.7 million) and April (–20.7 million) marked the steepest employment decline in history, and were followed by the two largest monthly job gains ever in May (+2.8 million) and June (+4.8 million). The steepness and suddenness of these job losses, followed by a rapid (if partial) recovery, were more reminiscent to the losses seen after major hurricanes than those seen during a typical recession.

The birth–death model

The nationwide increases in the number of establishments reporting zero employment in March 2020 (2.6 times normal) and April 2020 (15 times normal) could only be compared with the spikes following Irma in Florida (2.1 times normal) and Maria in Puerto Rico (6.9 times normal). Evidence from Irma and Maria indicates that using reported zeros could reduce error. Beginning with the March final and April preliminary estimates, the CES state and area program incorporated “excess” reported zeros in the link relative in calculating the employment estimates. In order to avoid statistical bias, the program applied a weight-reduction adjustment value ranging between 0 and 1 to establishments reporting zero employment. In cases in which the proportion of reported zeros

at the state estimation supersector level was at or below normal, the factor was set to 0, and in those cases in which the proportion was many times the usual rate, the factor approached 1. The average weight adjustment factor for a reported zero was 0.603 in March and 0.954 in April. As with Hurricanes Irma and Maria, employment counts also needed to appropriately reflect returns from zero. Weight adjustment factors were also developed for returns, and they were first applied in the May preliminary estimates, as many business reopened. The use of excess reported drops-to and returns-from zero lowered the final sum of state employment estimates by 331,000 in March and 3.0 million in April, while increasing them by 1.0 million in May and 934,000 in June, as many businesses reopened.

In addition, the CES program augmented the time-series forecast component of the net birth–death model with information from the nonzero matched sample as an exogenous regressor in a regression model with autoregressive integrated moving average errors (regARIMA), beginning with the April values.[23] Earlier research indicated that this method could improve forecast accuracy during business cycle turning points, although it was not feasible to implement following hurricanes.[24] The CES program updated the forecast models at the national level and controlled the sum of the state subsector forecasts to the new national forecasts, incorporating sample information on the states and industries seeing spikes in reported zero employment to allocate the distribution of differences. This lowered the sum of state birth–death factors by 799,000 in April compared with what they would have been without the regressor. The models in turn processed more positive sample information in May and June 2020 into higher forecast values.

Nonresponse analysis

The COVID-19 recession led to nonresponse concerns about the state and area employment estimates that were different from but related to those explored after hurricanes. Subdividing states into affected and unaffected regions, as is done for a hurricane, was not a promising option because of the geographic pervasiveness of business disruption. The CES program explored making differential-response-rate adjustments based on business size (the hypothesis being that larger firms may be less disrupted and better able to continue paying employees), but the results were unclear and any adjustments may have exacerbated the effects of confounding factors. The program also explored conducting nonresponse analysis based on linked unemployment insurance filings, but doing so did not uncover notable differences between respondents and nonrespondents.

In producing the April 2020 state-level estimates, a major nonresponse problem appeared as certain detailed industries within the estimation supersectors were broadly underrepresented across states in the responding CES sample in a way that correlated with employment trends. In retail trade, clothing and clothing accessories stores closed almost everywhere in April 2020, and these establishments responded to the survey at relatively low rates, while general merchandise stores and building material and garden equipment stores had comparatively resilient employment and responded at higher rates. Within leisure and hospitality, full-service restaurants lost relatively more jobs and responded to the CES survey at lower rates than limited-service restaurants, while in the “other services” supersector, the laundry and personal care services industry showed steep losses and was underrepresented in the responding sample. This nonresponse issue did not arise in the national estimates because they are produced at a detailed industry level using samples from all states, in contrast to the approach used in the state and local estimates, where estimation supersectors pool samples from heterogeneous industries into a discrete geographic domain.[25]

The CES program took two approaches to nonresponse adjustments for these industries. If it was possible to do so, especially in very large states, the program calculated sample-based estimates at a more detailed level and summed them to replace the estimation supersectors.[26] In states for which this approach was infeasible, the CES program calculated nonresponse adjustments similar to those calculated (but not applied) following hurricanes and those obtained by using preidentified nonresponse factors in the link-relative estimator (d_i). Many of the response-rate differences were longstanding, but they had not substantially affected the estimates. In total, nonresponse adjustments served to lower the sum of April 2020 state employment estimates by 461,000 in leisure and hospitality, 413,000 in retail trade, and 73,000 in other services. As jobs returned, the differential nonresponse problem presented in the opposite direction, and correcting for it increased employment estimates.

Small-area estimation

The CES program explored an approach similar to the hurricane variant of the Fay-Herriot model in March 2020. The program considered a scenario in which certain states and metropolitan areas in the Northeast and Pacific Northwest that had early cases of COVID-19 might have substantially larger employment drops in March, in which case it could have been beneficial to pool those areas together and model them separately. This was not the case, however, as job losses that month presented along a continuum, with no clearly identifiable division, and were only loosely related to early case counts. The ordinary Fay-Herriot models were also problematic. The wide range of job losses among states resulted in very high model variance and subsequently near-total reliance on the direct estimates. Although the direct estimates are approximately unbiased, they tend to have high variability when sample sizes are small, and the poor performance of direct estimates following hurricanes in modeled cells indicated the potential for low accuracy.

Instead, BLS generated and in many cases used a small-area model that generalizes the Fay-Herriot model and relaxes many of its assumptions by jointly modeling variance and point estimates and clustering the data.[27] This model outperformed the existing Fay-Herriot model in simulations, in terms of benchmark revisions, during both the steep downturn of the 2007–09 recession and the subsequent recovery and expansion. When applied during the COVID-19 recession, metropolitan area estimates were more consistent with statewide values and showed a similar story: compared with the Fay-Herriot estimates, the new model reduced the root-mean-square difference between metropolitan and statewide estimates in the same state or industry by 29 percent in the April 2020 preliminary estimates. The combination of lessened reliance on volatile direct estimates (because of better model fit) and state-specific effects being captured in the synthetic component of the clustered model resulted in the tighter relationship among metropolitan area estimates and corresponding state-level estimates.

Conclusion

Timely economic data is needed to capture rapid shifts in business conditions shortly after they occur, and payroll employment estimates from the CES program are among the timeliest economic indicators available each month for states and metropolitan areas. Natural disasters often cause sudden, steep job losses, but the measurement of employment change following disasters presents challenges. The CES survey must accurately capture the relationship between business openings and closings, account for differences between respondents and nonrespondents, and use robust models to accurately estimate employment in small domains. Five major hurricanes that occurred in 2017 and 2018 brought these concerns to light and resulted in the development of potential solutions. Using reported zeros proved beneficial to the estimation process after the survey showed sharp

increases in their number. Modeled estimates could be improved by refining the pool of observations that are processed together.

When the COVID-19 pandemic caused the steepest job losses in U.S. history, the CES program applied the lessons learned from producing estimates following major hurricanes to better capture business deaths, properly represent industries experiencing the most severe declines, and incorporate models that capture important differences between, and commonalities among, states. Using reported zeros proved beneficial following Hurricanes Irma and Maria, and the CES program generalized their use with the wave of business closures that began in March 2020. Although nonresponse was not a major problem after the 2017–18 hurricanes, monitoring processes set up in the wake of those hurricanes helped BLS identify industry-based differential nonresponse adjustments when the steepest job losses in history occurred. Techniques pooling similar observations in Fay-Herriot models showed promise, and the CES program applied a model that more formally clustered the data to produce small-area estimates during the pandemic.

Although job losses during the COVID-19 recession have been far steeper and more sudden than those occurring in typical downturns, the associated measurement challenges highlight areas of potential improvement that could help the CES survey better capture future business-cycle turning points and sudden changes in state and area employment that result from disasters.

ACKNOWLEDGMENTS: Julie Gershunskaya, Greg Erkens, Chris Grieves, and Dan Zhao were essential in solving many of the methodological problems we encountered following recent hurricanes and, in particular, during the COVID-19 pandemic. Paige Schroeder, Brad Rhein, Greg Erkens, and Alba Báez all provided comments that noticeably improved this article. I want to thank them, as well as the CES State and Area program office staff more broadly, who showed a great deal of ingenuity, flexibility, and hard work in producing the estimates.

SUGGESTED CITATION

Steven M. Mance, "Estimating state and local employment in recent disasters—from Hurricane Harvey to the COVID-19 pandemic," Monthly Labor Review, U.S. Bureau of Labor Statistics, April 2021, https://doi.org/10.21916/mlr.2021.9.

NOTES

1 For more information on the design of the U.S. Bureau of Labor Statistics (BLS) Current Employment Statistics (CES) survey and its evolution, see Laura A. Kelter, “One hundred years of Current Employment Statistics—the history of CES sample design,” Monthly Labor Review, August 2016, https://doi.org/10.21916/mlr.2016.35.

2 For more information on the process for benchmarking state and local CES employment data, see Kirk Mueller, “Benchmarking the Current Employment Statistics state and area estimates,” Monthly Labor Review, November 2017, https://doi.org/10.21916/mlr.2017.26.

3 This formula is simplified to remove components that are not relevant to this article. A robust estimation technique is used to identify "atypical" reporters, which are removed from the link and only represent themselves, and reduce the weight on other influential reporters. Employees of religious organizations, which are in scope for CES but not on the sampling frame, are addressed by removing their benchmark level from the prior month's employment before applying the weighted link relative and then added back to the current month's level.

4 Decompositions of benchmark revisions have indicated nonresponse to not be a principal driver of total survey error in the CES survey. See, for example, Larry L. Huff and Julie G. Gershunskaya, "Components of error analysis in the Current Employment Statistics survey," Proceedings of the Survey Research Methods Section, American Statistical Association, October 2009, http://www.asasrms.org/Proceedings/y2009f.html; the paper is also available on the BLS website at https://www.bls.gov/osmr/research-papers/2009/st090050.htm. Although the implicit imputation of the weighted link-relative estimator is generally used, there is some explicit imputation in state and area estimates for large nonrespondents that exhibit a stable, seasonal difference from the rest of the universe using historical QCEW data. These explicit imputations are often not made during disasters.

5 For more information about the CES net birth–death model, see Kirk Mueller, "Impact of business births and deaths in the payroll survey," Monthly Labor Review, May 2006, https://www.bls.gov/opub/mlr/2006/05/art4full.pdf.

6 Fay-Herriot models are commonly used in producing small-area estimates and were introduced by Robert E. Fay III and Roger A. Herriot in "Estimates of income for small places: an application of James-Stein procedures to census data," Journal of the American Statistical Association, vol. 74, no. 366, June 1979, pp. 269–277, https://www.jstor.org/stable/pdf/2286322.pdf.

7 More formally, this involves distributional assumptions linking the direct estimates, historical trend projections, and actual values from a high-level model to more detailed domains. For more detail, see Julie Gershunskaya, "Estimation for detailed publication levels in the Current Employment Statistics survey," Proceedings of the Survey Research Methods Section, American Statistical Association, October 2012, https://www.bls.gov/osmr/research-papers/2012/st120190.htm.

8 Puerto Rico transitioned from a quota-based design to the current probability-based design with the January 2014 estimates. Although the U.S. Virgin Islands were severely affected by Hurricane Maria, employment estimates for the Virgin Islands are not examined in this article because they employ a quota-based sample with an estimation methodology that differs from that of the rest of the CES program.

9 The handling of recent disasters was built upon past experiences, primarily Hurricane Katrina, a thorough examination of which can be found in Molly Barth Garber, Linda Unger, James White, and John Wohlford, "Hurricane Katrina's effects on industry employment and wages," Monthly Labor Review, August 2006, https://www.bls.gov/opub/mlr/2006/08/art3full.pdf.

10 Information on the track and development of these storms and estimates of the damage they caused are from the National Hurricane Center's Tropical Cyclone Reports; for more information, see https://www.nhc.noaa.gov/data/tcr/.

11 Devastation from Hurricanes Irma and Maria was severe enough that officials in the U.S. Virgin Islands were unable to collect establishment data for several months, resulting in a delay in the release of preliminary September, October, and November 2017 estimates for the territory. Unlike the 50 states and the District of Columbia, the workforce agencies in the U.S. Virgin Islands and Puerto Rico collect the majority of the microdata used in their CES estimates. More information is available at https://www.bls.gov/sae/notices/2017/hurricanes-irma-maria-september-october-november-december-2017-payroll-data-for-puerto-rico-and-the-us-virgin-islands.htm.

12 An analysis of credit card data by researchers at the Federal Reserve Board indicated that retail trade spending in the areas affected by Hurricanes Harvey and Irma dropped steeply but returned to normal within 2 weeks of the storms making landfall, which helps explain the comparatively smaller effect of Harvey on CES estimates. See Aditya Aladangady Shifrah, Aron-Dine, Wendy Dunn, Laura Feiveson, Paul Lengermann, and Claudia Sahm, "From transactions data to economic statistics: constructing real-time, high-frequency, geographic measures of consumer spending," Finance and Economics Discussion Series 2019-057 (Board of Governors of the Federal Reserve System, 2019), https://doi.org/10.17016/FEDS.2019.057.

13 Some large business deaths were accounted for in Florida following Hurricane Irma, but they solely represented themselves.

14 Fay-Herriot models are also used in some statewide estimation supersectors, mostly in smaller industries such as mining and logging. Another type of small-domain model is also used by the CES program, primarily in detailed industries.

15 Coronavirus disease 2019 (COVID-19) is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). For more information, see "COVID-19 science update" (Centers for Disease Control and Prevention, January 15, 2021), https://www.cdc.gov/library/covid19/01152021_covidupdate.html.

16 Lena H. Sun and Lenny Bernstein, “First U.S. case of potentially deadly Chinese coronavirus confirmed in Washington state,” The Washington Post, January 21, 2020, https://www.washingtonpost.com/health/2020/01/21/coronavirus-us-case/.

17 For example, researchers at the Federal Reserve Bank of Minneapolis used smartphone data to create indexes that measure changes in travel and social encounters, which showed broad declines through March and into April 2020. See Victor Couture, Jessie Handbury, Jonathan I. Dingel, Kevin R. Williams, and Allison Green, “Measuring movement and social contact with smartphone data: a real-time application to COVID-19,” Institute Working Paper 35 (Federal Reserve Bank of Minneapolis, Opportunity and Inclusive Growth Institute, July 2020), https://doi.org/10.21034/iwp.35.

18 There is evidence that the formal shutdown orders only explain a small proportion of the decline in business activity. See Austan Goolsbee and Chad Syverson, “Fear, lockdown, and diversion: comparing drivers of pandemic economic decline 2020,” Working Paper 27432 (Cambridge, MA: National Bureau of Economic Research, June 2020), https://doi.org/10.3386/w27432.

19 For more information on restaurant reservation data, see the “State of the Industry” page on the OpenTable website at https://www.opentable.com/state-of-industry.

20 Ohio became the first state to close schools on March 12, and 27 states and territories had done so by March 16. By March 25, all U.S. public schools were closed. See “The coronavirus spring: the historic closing of U.S. schools,” Education Week, July 1, 2020, https://www.edweek.org/ew/section/multimedia/the-coronavirus-spring-the-historic-closing-of.html.

21 Data on passenger throughput during the COVID-19 pandemic from the Transportation Security Administration are available at https://www.tsa.gov/coronavirus/passenger-throughput.

22 The Business Cycle Dating Committee of the National Bureau of Economic Research determined that a peak in economic activity occurred in February 2020, marking the end of the economic expansion that began in June 2009 and the beginning of a recession. For more information, see “Determination of the February 2020 peak in U.S. economic activity” (Cambridge, MA: National Bureau of Economic Research, June 8, 2020), https://www.nber.org/cycles/june2020.html.

23 For more information on regression models with autoregressive integrated moving average (regARIMA), see Kathleen M. McDonald-Johnson and Catherine C. Hood, “Outlier selection for RegARIMA models” (U.S. Census Bureau, 2001), https://www.census.gov/ts/papers/asa2001kmm.pdf.

24 For more information on the regression model used to modify birth–death forecasts, see Victoria Battista, “Back to the future: using current regression variables to forecast forward from historical net birth/death employment,” Proceedings of the Government Statistics Section, American Statistical Association, October 2013, https://www.bls.gov/osmr/research-papers/2013/st130140.htm.

25 See Huff and Gershunskaya, “Components of error analysis in the Current Employment Statistics survey.”

26 In retail trade and other services, the post-stratified estimates were produced at the three-digit NAICS subsector level. In leisure and hospitality, the estimates became the sum of arts, entertainment, and recreation; accommodation; full-service restaurants; and the remainder of food services and drinking places. In some cases, QCEW ratios were applied to the March leisure and hospitality estimates to create a prior-month employment level from which to apply the weighted link relative.

27 For more details on the generalized small-area model, see Julie Gershunskaya and Terrance D. Savitsky, “Bayesian nonparametric joint model for point estimates and variances under biased domain variances,” Proceedings of the Survey Research Methods Section, American Statistical Association, November 2019, https://www.bls.gov/osmr/research-papers/2019/st190020.htm.

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PRODUCTIVITY AND COSTS

Second Quarter 2025, Revised

Nonfarm business sector labor productivity increased 3.3 percent in the second quarter of 2025, the U.S. Bureau of Labor Statistics reported today, as output increased 4.4 percent and hours worked increased 1.1 percent. (All quarterly percent changes in this release are seasonally adjusted annualized rates.) From the same quarter a year ago, nonfarm business sector labor productivity increased 1.5 percent in the second quarter of 2025. (See chart 1 and tables A1 and 2.)

Chart 1. Labor productivity, nonfarm business, 2021Q1 – 2025Q2

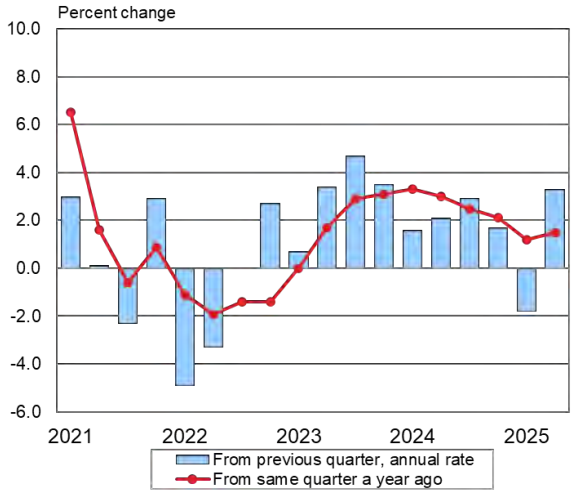
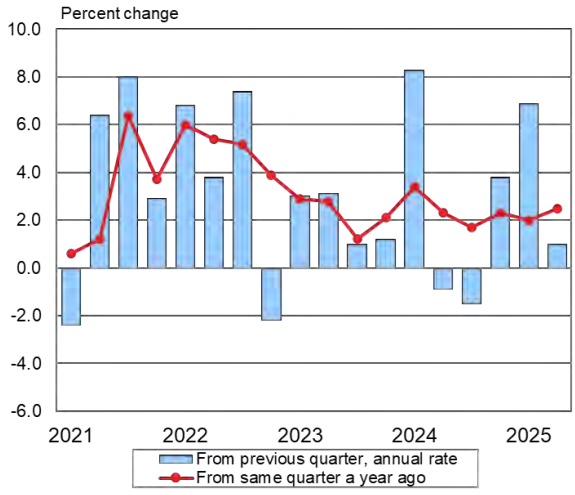


Chart 2. Unit labor costs, nonfarm business, 2021Q1 – 2025Q2



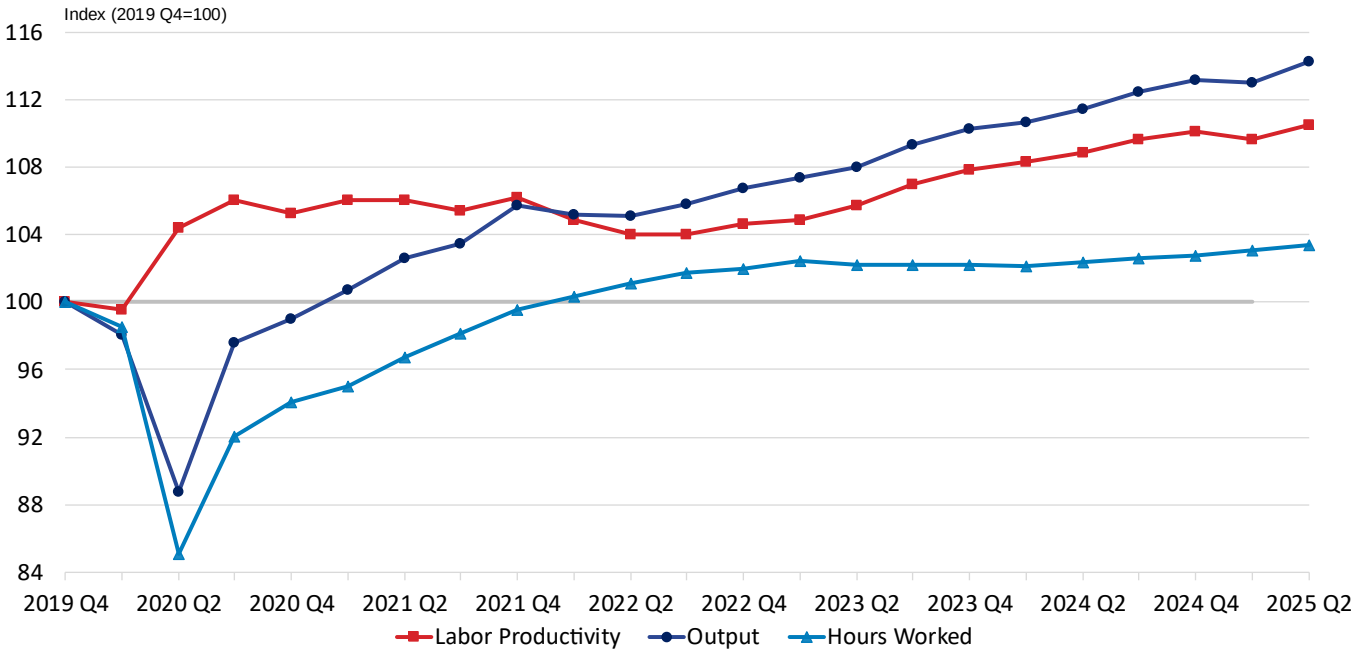
Unit labor costs in the nonfarm business sector increased 1.0 percent in the second quarter of 2025, reflecting a 4.3-percent increase in hourly compensation and a 3.3-percent increase in productivity. Unit labor costs increased 2.5 percent over the last four quarters. (See chart 2 and tables A1 and 2.)

BLS calculates unit labor costs as the ratio of hourly compensation to labor productivity. Increases in hourly compensation tend to increase unit labor costs and increases in productivity tend to reduce them. Real hourly compensation, which takes into account consumer prices, increased 2.6 percent in the second quarter of 2025, and increased 1.5 percent over the last four quarters.

Labor productivity, or output per hour, is calculated by dividing an index of real output by an index of hours worked by all workers, including employees, proprietors, and unpaid family workers. During the current business cycle, starting in the fourth quarter of 2019, labor productivity has grown at an annualized rate of 1.8 percent, reflecting a 2.4-percent rate of growth in output and a 0.6-percent rate of growth in hours worked. (See chart 3.) The 1.8-percent annualized rate of productivity growth in the current business cycle thus far is higher than the 1.5-percent rate of the previous business cycle from the

fourth quarter of 2007 through the fourth quarter of 2019, and is below the long-term rate of 2.1 percent since the first quarter of 1947.

Chart 3. Labor Productivity, Output, and Hours Worked index series, nonfarm business, 2019 Q4 – 2025 Q2

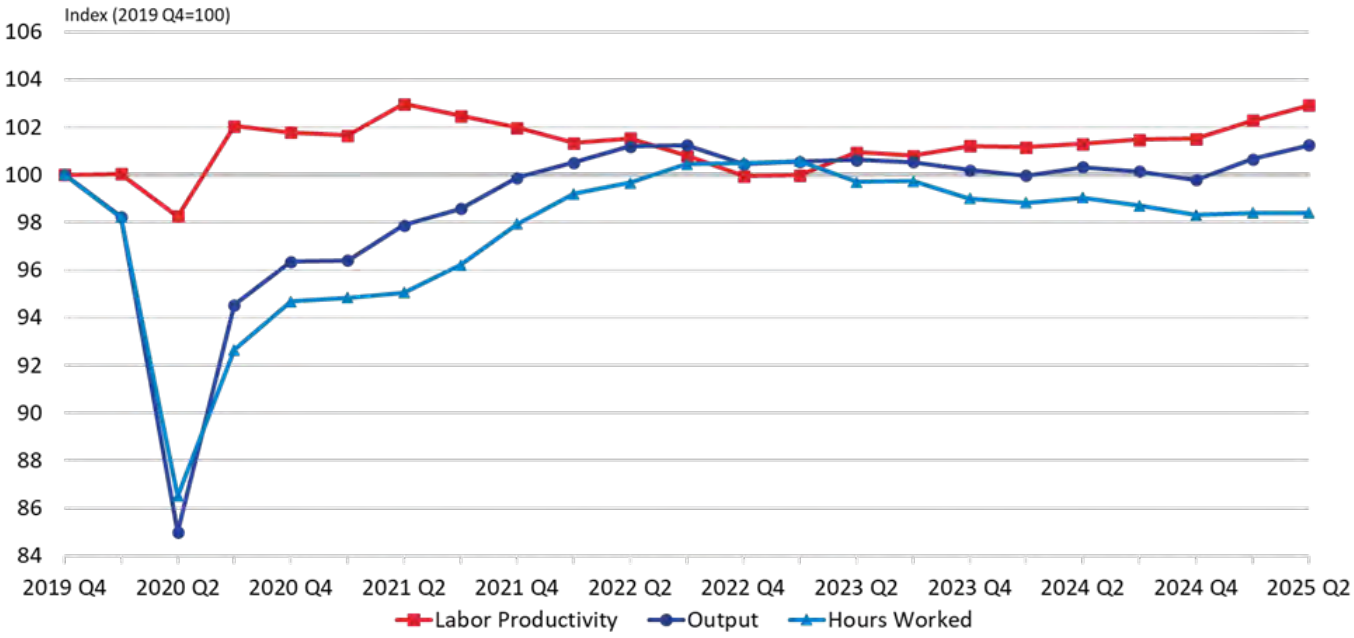


Manufacturing sector labor productivity increased 2.5 percent in the second quarter of 2025, as output increased 2.4 percent and hours worked decreased 0.1 percent. In the durable manufacturing sector, productivity increased 3.2 percent, reflecting a 3.5-percent increase in output and a 0.3-percent increase in hours worked. Nondurable manufacturing sector productivity increased 1.9 percent, as output increased 1.3 percent and hours worked decreased 0.6 percent. Total manufacturing sector productivity increased 1.6 percent from the same quarter a year ago. This is the largest four-quarter gain in manufacturing productivity since the second quarter of 2021, when it increased 4.8 percent. (See tables A1, 3, 4, and 5.)

Unit labor costs in the total manufacturing sector increased 2.0 percent in the second quarter of 2025, reflecting a 4.5-percent increase in hourly compensation and a 2.5-percent increase in productivity. Unit labor costs increased 0.9 percent in the durable goods sector and increased 3.1 percent in nondurable goods industries. Manufacturing unit labor costs increased 2.6 percent from the same quarter a year ago. (See tables A1 and 3.)

Manufacturing sector labor productivity has grown at an annualized rate of 0.5 percent during the current business cycle, as output has increased 0.2 percent and hours have declined 0.3 percent. (See chart 4.) The 0.5-percent annualized rate of productivity growth in the current business cycle thus far is above the 0.1-percent rate of the previous business cycle from the fourth quarter of 2007 through the fourth quarter of 2019 and is below the long-term rate of 2.1 percent since the first quarter of 1987.

Chart 4. Labor Productivity, Output, and Hours Worked index series, manufacturing, 2019 Q4 – 2025 Q2



The concepts, sources, and methods used for the manufacturing output series differ from those used in the business and nonfarm business output series; these output measures are not directly comparable. See the Technical Notes for a more detailed explanation. (See page 7.)

Preliminary measures for the second quarter of 2025 were announced today for the **nonfinancial corporate sector**. Productivity increased 5.7 percent in the second quarter of 2025 as output increased 7.0 percent and hours worked increased 1.2 percent. Productivity increased 3.4 percent over the last four quarters. Unit profits of nonfinancial corporations increased at a 1.9-percent annual rate in the second quarter of 2025 and decreased 1.6 percent over the last four quarters. (See table 6.)

Revised measures

Measures released today are based on more recent source data than were available for the preliminary report; they reflect regular updates of source data from the BLS, the Bureau of Economic Analysis (BEA), and the Board of Governors of the Federal Reserve System. These measures do not reflect labor data to be released September 5, 2025, by the BLS Current Employment Statistics program.

Table B1 presents previous and revised productivity and related measures for the business, nonfarm business, and manufacturing sectors for the second quarter of 2025.

In the second quarter of 2025, nonfarm business sector productivity increased 3.3 percent—a 0.9-percentage point upward revision from the preliminary estimate of a 2.4-percent increase—reflecting a 0.7-percentage point upward revision to output and a 0.2-percentage point downward revision to hours worked. From the same quarter a year ago, nonfarm business sector labor productivity was revised up by 0.2 percentage point, to an increase of 1.5 percent. Unit labor costs increased 1.0 percent in the second quarter of 2025 rather than increasing 1.6 percent as previously reported, reflecting a 0.3-percentage point upward revision to hourly compensation and a 0.9-percentage point upward revision to productivity.

Manufacturing sector productivity for the second quarter of 2025 was revised up to an increase of 2.5 percent from a previously reported increase of 2.1 percent, reflecting a 0.1-percentage point upward revision to output and a 0.4-percentage point downward revision to hours worked. Durable manufacturing sector productivity was revised down 0.1 percentage point to an increase of 3.2 percent; nondurable manufacturing sector productivity had a 0.7-percentage point upward revision to an increase of 1.9 percent. Total manufacturing unit labor costs increased 2.0 percent in the second quarter of 2025, reflecting a 0.3-percentage point upward revision.

Table B2 presents previous and revised productivity and related measures for the business, nonfarm business, manufacturing, and nonfinancial corporate sectors for the first quarter of 2024.

In the first quarter of 2025, nonfarm business sector productivity and unit labor costs were not revised. Manufacturing sector productivity was revised down 0.2 percentage point to an increase of 3.1 percent. As a result, unit labor costs were revised up 0.2 percentage point to an increase of 3.1 percent. In the nonfinancial corporate sector, first-quarter 2025 productivity declined 0.2 percent, as previously reported. Unit labor costs and unit profits in the nonfinancial corporate sector were not revised. (See table 6.)

Quarterly and annual data for all sectors from 2023 forward appear in tables 1-6. Full historical measures can be found on the Productivity and Costs home page: www.bls.gov/productivity/tables/.

The preliminary Productivity and Costs news release for third-quarter 2025 is scheduled to be released on Thursday, November 6, 2025, at 8:30 a.m. (ET).

Table A1. Labor productivity growth and related measures - revised second-quarter 2025
(percent change from previous quarter at annual rate and from same quarter a year ago)

Sector	Percent change from:	Labor productivity	Output	Hours worked	Hourly compensation	Real hourly compensation	Unit labor costs
Nonfarm business	**Previous quarter**	**3.3**	**4.4**	**1.1**	**4.3**	**2.6**	**1.0**
	A year ago	1.5	2.5	1.0	4.0	1.5	2.5
Business	**Previous quarter**	**3.6**	**4.4**	**0.7**	**4.6**	**2.9**	**1.0**
	A year ago	1.5	2.3	0.8	4.2	1.7	2.6
Manufacturing	**Previous quarter**	**2.5**	**2.4**	**-0.1**	**4.5**	**2.8**	**2.0**
	A year ago	1.6	0.9	-0.7	4.3	1.7	2.6
Durable manufacturing	**Previous quarter**	**3.2**	**3.5**	**0.3**	**4.1**	**2.5**	**0.9**
	A year ago	2.1	0.9	-1.2	4.6	2.1	2.5
Nondurable manufacturing	**Previous quarter**	**1.9**	**1.3**	**-0.6**	**5.1**	**3.4**	**3.1**
	A year ago	0.8	1.0	0.2	3.7	1.2	2.9

Table A2. Labor productivity growth and related measures - preliminary second-quarter 2025
(percent change from previous quarter at annual rate and from same quarter a year ago)

Sector	Percent change from:	Labor productivity	Output	Hours worked	Hourly compensation	Real hourly compensation	Unit labor costs
Nonfinancial corporate	**Previous quarter**	**5.7**	**7.0**	**1.2**	**3.5**	**1.8**	**-2.1**
	A year ago	3.4	4.2	0.7	3.8	1.3	0.4

Table B1. Labor productivity growth and related measures - revised and previously published second-quarter 2025
(percent change from previous quarter at annual rate)

Sector		Labor productivity	Output	Hours worked	Hourly compensation	Real hourly compensation	Unit labor costs
Nonfarm business	**Revised**	**3.3**	**4.4**	**1.1**	**4.3**	**2.6**	**1.0**
	Previously published	2.4	3.7	1.3	4.0	2.3	1.6
Business	**Revised**	**3.6**	**4.4**	**0.7**	**4.6**	**2.9**	**1.0**
	Previously published	2.8	3.8	1.0	4.3	2.6	1.5
Manufacturing	**Revised**	**2.5**	**2.4**	**-0.1**	**4.5**	**2.8**	**2.0**
	Previously published	2.1	2.3	0.3	3.8	2.1	1.7
Durable manufacturing	**Revised**	**3.2**	**3.5**	**0.3**	**4.1**	**2.5**	**0.9**
	Previously published	3.3	4.1	0.8	3.0	1.4	-0.2
Nondurable manufacturing	**Revised**	**1.9**	**1.3**	**-0.6**	**5.1**	**3.4**	**3.1**
	Previously published	1.2	0.5	-0.7	5.1	3.4	3.8

Table B2. Labor productivity growth and related measures - revised and previously published first-quarter 2025
(percent change from previous quarter at annual rate)

Sector		Labor productivity	Output	Hours worked	Hourly compensation	Real hourly compensation	Unit labor costs
Nonfarm business	**Revised**	**-1.8**	**-0.6**	**1.2**	**5.0**	**1.2**	**6.9**
	Previously published	-1.8	-0.6	1.2	5.0	1.2	6.9
Business	**Revised**	**-2.0**	**-0.9**	**1.1**	**5.1**	**1.3**	**7.3**
	Previously published	-2.0	-0.9	1.1	5.1	1.3	7.3
Nonfinancial corporate	**Revised**	**-0.2**	**0.6**	**0.8**	**4.3**	**0.5**	**4.6**
	Previously published	-0.2	0.6	0.8	4.3	0.5	4.6
Manufacturing	**Revised**	**3.1**	**3.5**	**0.4**	**6.3**	**2.4**	**3.1**
	Previously published	3.3	3.7	0.4	6.3	2.4	2.9
Durable manufacturing	**Revised**	**6.6**	**7.2**	**0.6**	**7.1**	**3.2**	**0.5**
	Previously published	6.8	7.5	0.6	7.1	3.2	0.2
Nondurable manufacturing	**Revised**	**-0.2**	**-0.2**	**0.0**	**4.8**	**1.0**	**5.0**
	Previously published	0.0	0.0	0.0	4.8	1.0	4.8

TECHNICAL NOTES

Labor Hours

Hours worked data for the labor productivity and cost measures include hours worked for all persons working in the sector—wage and salary workers, the self-employed and unpaid family workers. The primary source of hours and employment data is the BLS Current Employment Statistics (CES) program, which provides monthly survey data on the number of jobs held by and hours paid to wage and salary workers in nonfarm establishments, counting a person who is employed by two or more establishments at each place of employment. As of the February 3, 2023 Employment Situation release, the CES program has updated the national nonfarm payroll series to the 2022 North American Industry Classification System (NAICS). The BLS Major Sector Productivity program will be remaining on a NAICS 2017 basis for the time being by converting NAICS 2022 data from CES back to a NAICS 2017 basis using ratios published on the CES website and based on the Quarterly Census of Employment and Wages (QCEW). Hours of paid time off are removed from hours paid using data from the National Compensation Survey (NCS) for 1996 forward and data from the BLS Hours at Work survey, conducted for this purpose, prior to 1990. Between 1990 and 1995, hours of paid time off are removed using a combination of NCS and Hours at Work survey data. Off-the-clock hours are added, yielding hours worked, using data from the Current Population Survey (CPS).

Data from the CPS are used to estimate hours worked for farm labor, nonfarm proprietors, and nonfarm unpaid family workers. Using CPS information on employment and hours worked at primary jobs and all other jobs, separately, the BLS productivity measures assign all hours worked to the appropriate industrial sector. Hours for government enterprises are derived from the CPS, the CES, and the National Income and Product Accounts (NIPA) prepared by the Bureau of Economic Analysis (BEA) of the Department of Commerce.

Detailed hours data are presented in the table “Hours Worked in Total U.S. Economy and Subsectors” on the BLS website (www.bls.gov/productivity/tables/total-economy-hours-employment.xlsx).

Output

Business sector output is a chain-type, current-weighted index constructed after excluding from gross domestic product (GDP) the following outputs: general government, nonprofit institutions, and households (including owner-occupied housing). Corresponding exclusions also are made in labor hours worked. Businesses accounted for about 77 percent of the value of nominal GDP in 2024. Nonfarm businesses, which exclude farming, accounted for about 76 percent of nominal GDP in 2024.

Annual indexes for manufacturing and its durable and nondurable goods components are constructed by deflating current-dollar industry value of production data from the U.S. Bureau of the Census with deflators from the BLS. These deflators are based on data from the BLS Producer Price Index program and other sources. The industry shipments are aggregated using annual weights, and intrasectoral transactions are removed. Quarterly manufacturing output measures are based on the indexes of industrial production prepared monthly by the Board of Governors of the Federal Reserve System, adjusted to be consistent with annual indexes of manufacturing sector output prepared by BLS.

Nonfinancial corporate output is a chain-type, current-weighted index calculated on the basis of the costs incurred and the incomes earned from production. The output measure excludes the following outputs from GDP: general government; nonprofit institutions; households; unincorporated business; and those corporations classified as offices of bank holding companies, offices of other holding companies, or offices in the finance and insurance sector. Nonfinancial corporations accounted for about 51 percent of the value of nominal GDP in 2024.

Labor Productivity

The measure describes the relationship between real output and the labor time involved in its production. Measures of labor productivity growth show the changes from period to period in the amount of goods and services produced per hour worked. They reflect the joint effects of many influences, including changes in technology; capital investment; level of output; utilization of capacity, energy, and materials; the organization of production; managerial skill; and the characteristics and effort of the work force.

Labor Compensation

The measure includes accrued wages and salaries, supplements, employer contributions to employee benefit plans, and taxes. Estimates of labor compensation by major sector, required for measures of hourly compensation and unit labor costs, are based primarily on employee compensation data from the NIPA, prepared by the BEA. The compensation of employees in general government, nonprofit institutions and households are subtracted from compensation of employees in domestic industries to derive employee compensation for the business sector. The labor compensation of proprietors cannot be explicitly identified and must be estimated. This is done by assuming that proprietors have the same hourly compensation as employees in the same sector. The quarterly labor productivity and cost measures do not contain estimates of compensation for unpaid family workers.

Unit Labor Costs

These measures describe the relationship between compensation per hour and labor productivity, or real output per hour, and can be used as an indicator of inflationary pressure on producers. Increases in hourly compensation increase unit labor costs; labor productivity increases offset compensation increases and lower unit labor costs.

Presentation of the data

The quarterly data in this release are presented in three ways: as percent changes from the previous quarter presented at a compound annual rate, as percent changes from the corresponding quarter of the previous year, and as index number series where 2017=100. Annual data are presented both as index number series and percent changes from the previous year.

The index numbers and rates of change reported in the productivity and costs news release are rounded to one decimal place. All percent changes in this release and on the BLS web site are calculated using index numbers to three decimal places. A complete historical series of these index numbers are available at the BLS productivity web site, https://www.bls.gov/productivity/data.htm, or by contacting the BLS Division of Major Sector Productivity (Telephone 202-691-5606 or email productivity@bls.gov).

For a more detailed explanation of methods see the Handbook of Methods at www.bls.gov/opub/hom/msp/home.htm.

If you are deaf, hard of hearing, or have a speech disability, please dial 7-1-1 to access telecommunications relay services.

Table 1. Business sector: Labor productivity, hourly compensation, unit labor costs, and prices, seasonally adjusted.

Year and quarter	Labor productivity	Output	Hours worked	Hourly compensation (1)	Real hourly compensation (2)	Unit labor costs	Unit nonlabor payments (3)	Value-added output price deflator (4)
				Percent change from previous quarter at annual rate (5)				
2025 II	3.6 r	4.4 r	0.7 r	4.6 r	2.9 r	1.0 r	1.6 r	1.3
I	-2.0	-0.9	1.1	5.1	1.3	7.3	-0.6	3.7
2024 ANNUAL	2.8	3.0	0.1	5.2	2.2	2.4	1.2	1.9
2024 IV	2.2	2.5	0.3	6.1	2.9	3.8	-0.2	2.0
III	2.4	3.5	1.1	0.9	-0.5	-1.4	4.8	1.4
II	2.3	3.3	1.0	1.1	-1.6	-1.1	6.4	2.2
I	1.7	1.4	-0.3	10.0	6.1	8.2	-4.5	2.2
2023 ANNUAL	1.9	2.9	1.0	4.1	0.0	2.2	4.9	3.4
2023 IV	3.6	3.4	-0.2	4.8	2.0	1.2	0.3	0.8
III	4.7	4.9	0.2	5.9	2.3	1.2	4.8	2.8
II	3.3	2.5	-0.7	6.1	3.0	2.7	-0.3	1.3
I	0.7	2.5	1.8	3.8	0.1	3.1	4.4	3.7
				Percent change from corresponding quarter of previous year				
2025 II	1.5 r	2.3 r	0.8 r	4.2 r	1.7 r	2.6 r	1.4 r	2.1
I	1.2	2.1	0.9	3.3	0.5	2.1	2.6	2.3
2024 ANNUAL	2.8	3.0	0.1	5.2	2.2	2.4	1.2	1.9
2024 IV	2.1	2.7	0.5	4.5	1.7	2.3	1.6	2.0
III	2.5	2.9	0.4	4.2	1.5	1.6	1.7	1.7
II	3.1	3.2	0.2	5.4	2.2	2.3	1.7	2.0
I	3.3	3.0	-0.3	6.7	3.3	3.3	0.0	1.8
2023 ANNUAL	1.9	2.9	1.0	4.1	0.0	2.2	4.9	3.4
2023 IV	3.0	3.3	0.3	5.2	1.9	2.0	2.3	2.1
III	2.9	3.4	0.5	4.1	0.5	1.2	4.9	2.9
II	1.7	2.8	1.1	4.5	0.4	2.7	3.9	3.2
I	0.1	2.1	1.9	3.1	-2.5	3.0	8.8	5.6
				Indexes 2017=100				
2025 II	116.4 r	123.4 r	106.0 r	143.8 r	109.6 r	123.5 r	130.2 r	126.4 r
I	115.4	122.1	105.8	142.2	108.8	123.2	129.6	126.0
2024 ANNUAL	115.0	121.1	105.2	138.6	108.0	120.5	128.6	124.1
2024 IV	116.0	122.4	105.5	140.4	108.4	121.1	129.8	124.9
III	115.4	121.6	105.4	138.4	107.6	119.9	129.9	124.3
II	114.7	120.6	105.1	138.1	107.8	120.4	128.4	123.9
I	114.1	119.6	104.8	137.7	108.2	120.7	126.4	123.2
2023 ANNUAL	111.9	117.6	105.1	131.7	105.6	117.7	127.1	121.8
2023 IV	113.6	119.2	104.9	134.4	106.6	118.4	127.8	122.5
III	112.6	118.2	105.0	132.9	106.1	118.0	127.7	122.3
II	111.3	116.8	104.9	131.0	105.5	117.7	126.2	121.4
I	110.4	116.1	105.1	129.0	104.7	116.9	126.4	121.0

See footnotes following Table 6.
September 4, 2025
r=revised
Source: Bureau of Labor Statistics

Table 2. Nonfarm business sector: Labor productivity, hourly compensation, unit labor costs, and prices, seasonally adjusted.

Year and quarter	Labor productivity	Output	Hours worked	Hourly compensation (1)	Real hourly compensation (2)	Unit labor costs	Unit nonlabor payments (3)	Value-added output price deflator (4)
				Percent change from previous quarter at annual rate (5)				
2025 II	3.3 r	4.4 r	1.1 r	4.3 r	2.6 r	1.0 r	2.5 r	1.7 r
I	-1.8	-0.6	1.2	5.0	1.2	6.9	-0.3	3.6
2024 ANNUAL	2.8	2.9	0.1	5.3	2.3	2.4	1.6	2.1
2024 IV	1.7	2.5	0.8	5.5	2.4	3.8	-0.5	1.8
III	2.9	3.6	0.7	1.3	-0.1	-1.5	4.4	1.1
II	2.1	3.0	1.0	1.1	-1.6	-0.9	6.4	2.3
I	1.6	1.3	-0.3	10.1	6.1	8.3	-4.1	2.6
2023 ANNUAL	1.8	2.9	1.1	4.1	0.0	2.2	5.3	3.6
2023 IV	3.5	3.4	-0.1	4.7	1.9	1.2	1.3	1.3
III	4.7	5.0	0.3	5.8	2.2	1.0	5.4	3.0
II	3.4	2.4	-1.0	6.5	3.5	3.1	0.6	1.9
I	0.7	2.5	1.8	3.7	0.1	3.0	5.2	4.0
				Percent change from corresponding quarter of previous year				
2025 II	1.5 r	2.5 r	1.0	4.0 r	1.5 r	2.5 r	1.5 r	2.0 r
I	1.2	2.1	0.9	3.2	0.5	2.0	2.5	2.2
2024 ANNUAL	2.8	2.9	0.1	5.3	2.3	2.4	1.6	2.1
2024 IV	2.1	2.6	0.6	4.4	1.7	2.3	1.5	1.9
III	2.5	2.8	0.3	4.2	1.5	1.7	1.9	1.8
II	3.0	3.2	0.2	5.4	2.1	2.3	2.2	2.3
I	3.3	3.0	-0.3	6.8	3.4	3.4	0.7	2.2
2023 ANNUAL	1.8	2.9	1.1	4.1	0.0	2.2	5.3	3.6
2023 IV	3.1	3.3	0.2	5.2	1.9	2.1	3.1	2.5
III	2.9	3.4	0.5	4.1	0.5	1.2	5.5	3.1
II	1.7	2.8	1.1	4.5	0.4	2.8	4.2	3.4
I	0.0	2.1	2.1	2.9	-2.7	2.9	8.7	5.5
				Indexes 2017=100				
2025 II	116.1 r	123.6 r	106.4 r	143.4 r	109.2 r	123.4 r	130.3 r	126.4 r
I	115.2	122.3	106.1	141.9	108.5	123.1	129.5	125.9
2024 ANNUAL	114.8	121.1	105.5	138.4	107.8	120.6	128.6	124.1
2024 IV	115.7	122.4	105.8	140.1	108.2	121.1	129.6	124.8
III	115.2	121.7	105.6	138.3	107.5	120.0	129.8	124.3
II	114.4	120.6	105.4	137.8	107.6	120.4	128.4	123.9
I	113.8	119.7	105.1	137.4	108.0	120.7	126.4	123.2
2023 ANNUAL	111.7	117.7	105.4	131.4	105.4	117.7	126.6	121.6
2023 IV	113.4	119.3	105.2	134.2	106.4	118.3	127.8	122.4
III	112.4	118.3	105.2	132.6	105.9	118.0	127.3	122.1
II	111.1	116.9	105.2	130.8	105.3	117.7	125.7	121.2
I	110.2	116.2	105.4	128.7	104.4	116.8	125.5	120.6

See footnotes following Table 6.
September 4, 2025
r=revised
Source: Bureau of Labor Statistics

Table 3. Manufacturing sector: Labor productivity, hourly compensation, and unit labor costs, seasonally adjusted.

Year and quarter	Labor productivity	Output	Hours worked	Hourly compensation (1)	Real hourly compensation (2)	Unit labor costs
			Percent change from previous quarter at annual rate (5)			
2025 II	2.5 r	2.4 r	-0.1 r	4.5 r	2.8 r	2.0 r
I	3.1 r	3.5 r	0.4	6.3	2.4	3.1 r
2024 ANNUAL	0.6	-0.4	-1.0	3.8	0.8	3.2
2024 IV	0.1	-1.4	-1.6	2.1	-0.9	2.0
III	0.7	-0.7	-1.4	4.2	2.7	3.4
II	0.5	1.4	0.9	-5.2	-7.8	-5.7
I	-0.2	-0.9	-0.7	6.8	2.9	7.0
2023 ANNUAL	-0.4	-0.4	0.0	4.7	0.6	5.1
2023 IV	1.6	-1.4	-2.9	6.3	3.4	4.6
III	-0.5	-0.4	0.1	6.7	3.1	7.2
II	3.8	0.3	-3.4	10.0	6.8	5.9
I	0.2	0.5	0.3	3.1	-0.5	2.9
			Percent change from corresponding quarter of previous year			
2025 II	1.6 r	0.9 r	-0.7 r	4.3 r	1.7 r	2.6 r
I	1.1 r	0.7	-0.4	1.7	-1.0	0.6
2024 ANNUAL	0.6	-0.4	-1.0	3.8	0.8	3.2
2024 IV	0.3	-0.4	-0.7	1.8	-0.9	1.5
III	0.7	-0.4	-1.0	2.9	0.2	2.2
II	0.4	-0.3	-0.7	3.5	0.3	3.1
I	1.2	-0.6	-1.7	7.4	4.0	6.2
2023 ANNUAL	-0.4	-0.4	0.0	4.7	0.6	5.1
2023 IV	1.3	-0.3	-1.5	6.5	3.1	5.1
III	0.0	-0.7	-0.7	4.8	1.2	4.8
II	-0.6	-0.6	0.0	5.1	1.1	5.8
I	-1.3	0.0	1.4	3.2	-2.4	4.6
			Indexes 2017=100			
2025 II	100.1 r	100.0 r	99.9 r	133.2 r	101.5 r	133.0 r
I	99.5 r	99.4 r	99.9	131.7	100.8	132.4 r
2024 ANNUAL	98.5	98.9	100.4	128.9	100.4	130.8
2024 IV	98.7	98.6	99.8	129.7	100.2	131.4
III	98.7	99.0	100.2	129.1	100.4	130.7
II	98.5	99.1	100.6	127.8	99.7	129.7
I	98.4	98.8	100.4	129.5	101.7	131.6
2023 ANNUAL	97.9	99.3	101.4	124.1	99.6	126.8
2023 IV	98.5	99.0	100.5	127.4	101.0	129.4
III	98.1	99.3	101.3	125.5	100.2	128.0
II	98.2	99.4	101.3	123.5	99.4	125.7
I	97.3	99.4	102.1	120.6	97.8	123.9

See footnotes following Table 6.
September 4, 2025
r=revised
Source: Bureau of Labor Statistics

Table 4. Durable manufacturing sector: Labor productivity, hourly compensation, and unit labor costs, seasonally adjusted.

Year and quarter	Labor productivity	Output	Hours worked	Hourly compensation (1)	Real hourly compensation (2)	Unit labor costs
			Percent change from previous quarter at annual rate (5)			
2025 II	3.2 r	3.5 r	0.3 r	4.1 r	2.5 r	0.9 r
I	6.6 r	7.2 r	0.6	7.1	3.2	0.5 r
2024 ANNUAL	0.4	-1.0	-1.5	4.4	1.4	3.9
2024 IV	-1.7	-3.7	-2.0	1.2	-1.8	3.0
III	0.5	-3.1	-3.6	6.1	4.7	5.6
II	-0.5	0.3	0.8	-8.4	-10.9	-8.0
I	2.3	0.0	-2.3	9.6	5.7	7.1
2023 ANNUAL	-0.7	0.2	0.9	4.9	0.7	5.7
2023 IV	-0.1	-3.0	-2.9	8.4	5.4	8.5
III	-2.3	-0.1	2.3	5.8	2.2	8.2
II	6.2	1.8	-4.2	12.5	9.3	6.0
I	-1.9	-0.4	1.6	3.3	-0.4	5.2
			Percent change from corresponding quarter of previous year			
2025 II	2.1 r	0.9 r	-1.2 r	4.6 r	2.1 r	2.5 r
I	1.2	0.1 r	-1.1	1.3	-1.4	0.1
2024 ANNUAL	0.4	-1.0	-1.5	4.4	1.4	3.9
2024 IV	0.1	-1.6	-1.8	1.9	-0.8	1.7
III	0.6	-1.5	-2.0	3.6	1.0	3.1
II	-0.1	-0.7	-0.6	3.6	0.4	3.7
I	1.5	-0.3	-1.8	9.0	5.6	7.4
2023 ANNUAL	-0.7	0.2	0.9	4.9	0.7	5.7
2023 IV	0.4	-0.4	-0.8	7.4	4.1	7.0
III	-0.5	-0.3	0.2	4.8	1.2	5.3
II	-0.5	0.2	0.7	5.3	1.3	5.9
I	-1.4	1.1	2.6	3.0	-2.7	4.5
			Indexes 2017=100			
2025 II	98.4 r	97.8 r	99.4 r	134.0 r	102.1 r	136.2 r
I	97.6 r	97.0 r	99.3	132.7	101.5	135.9 r
2024 ANNUAL	96.2	96.3	100.1	129.7	101.1	134.8
2024 IV	96.1	95.3	99.2	130.4	100.7	135.8
III	96.5	96.2	99.7	130.1	101.2	134.8
II	96.4	96.9	100.6	128.1	100.0	132.9
I	96.5	96.9	100.4	131.0	102.9	135.8
2023 ANNUAL	95.8	97.3	101.6	124.3	99.6	129.7
2023 IV	96.0	96.9	101.0	128.0	101.5	133.4
III	96.0	97.6	101.7	125.5	100.2	130.8
II	96.5	97.6	101.1	123.7	99.7	128.2
I	95.1	97.2	102.2	120.1	97.5	126.3

See footnotes following Table 6.
September 4, 2025
r=revised
Source: Bureau of Labor Statistics

Table 5. Nondurable manufacturing sector: Labor productivity, hourly compensation, and unit labor costs, seasonally adjusted.

Year and quarter	Labor productivity	Output	Hours worked	Hourly compensation (1)	Real hourly compensation (2)	Unit labor costs
			Percent change from previous quarter at annual rate (5)			
2025 II	1.9 r	1.3 r	-0.6 r	5.1	3.4	3.1 r
I	-0.2 r	-0.2 r	0.0	4.8	1.0	5.0 r
2024 ANNUAL	0.4	0.2	-0.1	2.8	-0.2	2.4
2024 IV	1.8	0.9	-0.9	4.0	0.9	2.2
III	-0.6	1.9	2.4	1.1	-0.3	1.6
II	1.5	2.6	1.1	1.4	-1.3	-0.1
I	-3.7	-1.7	2.0	1.9	-1.7	5.8
2023 ANNUAL	0.6	-0.9	-1.5	4.1	0.0	3.5
2023 IV	3.4	0.3	-2.9	2.2	-0.6	-1.1
III	2.7	-0.7	-3.4	7.8	4.2	4.9
II	1.0	-1.2	-2.2	5.3	2.3	4.3
I	3.2	1.3	-1.8	2.5	-1.1	-0.6
			Percent change from corresponding quarter of previous year			
2025 II	0.8 r	1.0 r	0.2	3.7	1.2	2.9 r
I	0.6 r	1.3	0.7	2.8	0.1	2.2 r
2024 ANNUAL	0.4	0.2	-0.1	2.8	-0.2	2.4
2024 IV	-0.3	0.9	1.2	2.1	-0.6	2.4
III	0.1	0.7	0.6	1.6	-1.0	1.5
II	0.9	0.1	-0.8	3.3	0.1	2.3
I	0.8	-0.8	-1.6	4.3	1.0	3.4
2023 ANNUAL	0.6	-0.9	-1.5	4.1	0.0	3.5
2023 IV	2.6	-0.1	-2.6	4.5	1.2	1.8
III	1.1	-1.2	-2.3	4.7	1.1	3.5
II	-0.2	-1.3	-1.1	4.6	0.5	4.8
I	-0.5	-1.0	-0.5	3.4	-2.2	3.9
			Indexes 2017=100			
2025 II	100.5 r	101.3 r	100.9 r	131.7 r	100.3 r	131.1 r
I	100.0 r	101.0 r	101.0	130.1	99.5	130.1 r
2024 ANNUAL	99.6	100.5	100.9	127.3	99.2	127.8
2024 IV	100.0	101.0	101.0	128.6	99.3	128.6
III	99.6	100.8	101.2	127.3	99.0	127.9
II	99.7	100.3	100.6	127.0	99.1	127.4
I	99.3	99.7	100.4	126.6	99.4	127.4
2023 ANNUAL	99.2	100.2	101.0	123.9	99.3	124.8
2023 IV	100.3	100.1	99.9	126.0	99.9	125.6
III	99.4	100.0	100.6	125.3	100.0	126.0
II	98.8	100.2	101.5	122.9	99.0	124.5
I	98.5	100.5	102.0	121.3	98.4	123.2

See footnotes following Table 6.
September 4, 2025
r=revised
Source: Bureau of Labor Statistics

Table 6. Nonfinancial corporate sector: Labor productivity, hourly compensation, unit labor costs, unit profits, and prices, seasonally adjusted.

Year and quarter	Labor productivity	Output	Hours worked	Hourly compensation (1)	Real hourly compensation (2)	Unit labor costs	Value-added output price deflator (4)	Unit nonlabor costs (6)	Unit combined input costs (7)	Unit profits (8)
				Percent change from previous quarter at annual rate (5)						
2025 II	5.7	7.0	1.2	3.5	1.8	-2.1	0.9	7.2	0.7	1.9
I	-0.2	0.6	0.8	4.3	0.5	4.6	2.6	7.8	5.6	-10.2
2024 ANNUAL	4.3	4.5	0.2	5.6	2.6	1.3	1.1	0.4	1.0	1.6
2024 IV	5.9	6.4	0.4	6.3	3.1	0.3	0.5	0.3	0.3	1.6
III	2.5	2.9	0.4	1.3	-0.1	-1.2	0.3	3.2	0.2	0.8
II	1.1	2.5	1.4	0.8	-1.8	-0.2	1.4	-3.7	-1.3	15.1
I	6.5	6.4	-0.1	12.4	8.4	5.5	0.0	6.0	5.7	-22.2
2023 ANNUAL	0.2	1.5	1.3	4.3	0.1	4.1	3.5	-0.3	2.7	7.3
2023 IV	6.3	6.0	-0.3	4.6	1.7	-1.6	1.3	-2.0	-1.7	15.9
III	2.9	2.9	0.0	5.0	1.4	2.0	3.5	-1.6	0.9	16.9
II	3.3	2.5	-0.7	6.1	3.0	2.7	1.9	-2.5	1.1	6.0
I	-2.9	-0.6	2.4	5.7	2.0	8.9	4.2	-1.5	5.5	-1.6
				Percent change from corresponding quarter of previous year						
2025 II	3.4	4.2	0.7	3.8	1.3	0.4	1.1	4.6	1.7	-1.6
I	2.3	3.1	0.8	3.2	0.4	0.8	1.2	1.8	1.1	1.4
2024 ANNUAL	4.3	4.5	0.2	5.6	2.6	1.3	1.1	0.4	1.0	1.6
2024 IV	4.0	4.5	0.5	5.1	2.3	1.1	0.6	1.4	1.2	-2.1
III	4.1	4.4	0.4	4.7	2.0	0.6	0.7	0.8	0.7	1.1
II	4.2	4.4	0.3	5.6	2.4	1.4	1.6	-0.4	0.8	5.0
I	4.7	4.5	-0.3	7.0	3.6	2.1	1.7	-0.1	1.4	2.8
2023 ANNUAL	0.2	1.5	1.3	4.3	0.1	4.1	3.5	-0.3	2.7	7.3
2023 IV	2.3	2.7	0.3	5.3	2.0	2.9	2.7	-1.9	1.4	9.0
III	0.2	0.8	0.6	4.2	0.6	3.9	3.0	-1.0	2.3	6.0
II	-0.2	1.2	1.4	4.5	0.5	4.7	3.1	-0.6	3.0	3.7
I	-1.3	1.1	2.4	3.4	-2.3	4.8	5.1	2.3	4.0	10.8
				Indexes 2017=100						
2025 II	120.0	128.0	106.7	144.4	110.0	120.4	125.2	114.5	118.5	170.5
I	118.3	125.9	106.4	143.2	109.5	121.1	124.9	112.5	118.3	169.7
2024 ANNUAL	116.6	123.6	106.0	139.8	108.9	119.8	123.9	110.2	116.7	172.2
2024 IV	118.4	125.7	106.2	141.7	109.4	119.7	124.1	110.4	116.7	174.3
III	116.7	123.8	106.1	139.6	108.5	119.6	124.0	110.3	116.6	173.7
II	116.0	122.9	106.0	139.1	108.6	120.0	123.9	109.5	116.5	173.3
I	115.6	122.1	105.6	138.8	109.1	120.0	123.5	110.5	116.9	167.3
2023 ANNUAL	111.8	118.3	105.8	132.3	106.1	118.3	122.5	109.7	115.5	169.5
2023 IV	113.8	120.2	105.6	134.8	106.9	118.4	123.5	108.9	115.3	178.2
III	112.1	118.5	105.7	133.3	106.5	118.9	123.1	109.5	115.8	171.7
II	111.3	117.6	105.7	131.7	106.1	118.3	122.0	109.9	115.6	165.1
I	110.4	116.9	105.9	129.8	105.3	117.5	121.4	110.6	115.3	162.7

See footnotes following Table 6.
September 4, 2025
r=revised
Source: Bureau of Labor Statistics

SOURCES: Output data are from the Bureau of Economic Analysis and the Census Bureau of the U.S. Department of Commerce; the Bureau of Labor Statistics, U.S. Department of Labor; and the Federal Reserve Board. Hours and compensation data are from the Bureau of Labor Statistics and the Bureau of Economic Analysis.

SIZE OF REVISIONS: Productivity and cost measures are revised on a regular schedule as more complete data become available. The first estimate is published within 40 days of the close of the reference quarter, the second estimate approximately 30 days later, and the third estimate approximately 60 days after the second estimate. Based on past revisions, the third estimate of nonfarm business sector quarterly labor productivity growth has differed from the first estimate by -1.0 to +1.3 percentage point about 80 percent of the time. This interval is based on estimates for reference quarters from the first quarter of 2001 to the first quarter of 2025. For more about revisions to labor productivity growth see "Revisions to BLS quarterly labor productivity estimates: How large are they?" at www.bls.gov/opub/mlr/2022/article/revisions-to-bls-quarterly-labor-productivity-estimates-how-large-are-they.htm.

Table Footnotes

(1) Wages and salaries of employees plus employers' contributions for social insurance and private benefit plans. Except for nonfinancial corporations, where there are no self-employed, data also include an estimate of wages, salaries, and supplemental payments for the self-employed.

(2) The change for recent quarters is based on the Consumer Price Index for all urban consumers (CPI-U). The trend from 1978-2024 is based on the Consumer Price Index Retroactive series (CPI-U-RS).

(3) Unit nonlabor payments include profits, consumption of fixed capital, taxes on production and imports less subsidies, net interest and miscellaneous payments, business current transfer payments, rental income of persons, and the current surplus of government enterprises.

(4) Current dollar output divided by the output index.

(5) Quarterly changes: Percent change compounded at annual rate is calculated using index numbers to three decimal places. Indexes published in the news release are rounded to one decimal place for convenience. Annual changes: Percent change is calculated using annual indexes to three decimal places.

(6) Unit nonlabor costs include consumption of fixed capital, taxes on production and imports less subsidies, net interest and miscellaneous payments, and business current transfer payments.

(7) Total unit costs are the sum of unit labor and nonlabor costs.

(8) Unit profits include corporate profits before tax with inventory valuation and capital consumption adjustment.

Oregon Office of Economic Analysis

Oregon Economic News, Analysis and Outlook

State Productivity and Labor Growth (Graph of the Week)

Posted by: **Josh Lehner** | August 25, 2023

Our office's next forecast is coming out next Wednesday, August 30th. We spent time last forecast talking about how this current cycle is different. Oregon is growing faster due to capital investment and productivity gains, while lagging or at least being in the middle of the pack in terms of population and labor growth. That is not the historical patterns we have seen in the state. We will have more on the potential for better productivity in the years ahead in our upcoming forecast as well. The focus will be on the increase in start-ups, the increase in federal investment, including semiconductors, and the potential of generative AI. But one thing that is getting left on the cutting room floor for the report is this state comparison, which is now the latest edition of the Graph of the Week.

On the horizontal x axis is each state's employment growth from pre-pandemic through this spring. On the vertical y axis is each state's productivity growth from pre-pandemic (2019) the most recently available data from BLS (2022). The color coding of the states reflects simple cluster analysis of which states are closest to each other (distance from the centroid).

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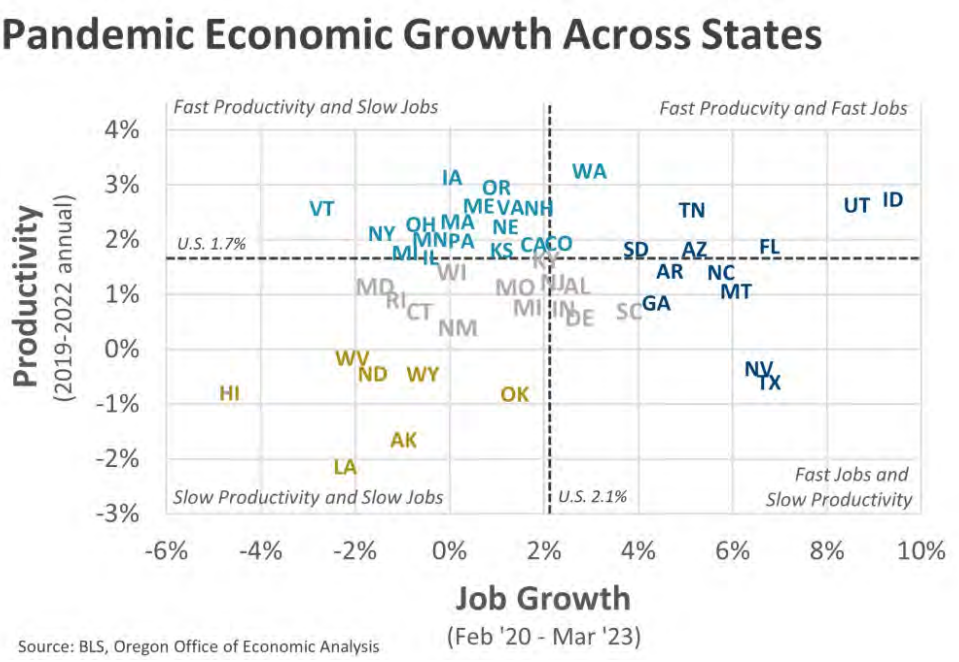

Broadly speaking there are 4 clusters. Oregon and Washington are in the top teal colored cluster. These states have seen labor growth around the national average, or below average, but have seen strong productivity gains. In fact, Washington ranks first, and Oregon third for productivity gains so far this cycle. The gray states are right around the national average, more or less. The yellow states lag both in terms of job growth and productivity gains. Clearly there is an impact seen in our resource states (and Hawaii), where the lack of a strong rebound in mining activity during the pandemic even as oil prices went up, weighs on the statewide data. Finally, the blue group on the right has seen strong labor (and population more broadly) gains in recent years. Productivity changes are more of a mixed bag, likely with the oil and gas impacts weighing on Texas. In terms of strong growth for both labor and capital during this cycle, Idaho and Utah stand out as national leaders.

Have a good weekend everybody.

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« Update on Population Growth in 2023

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Mark McMullen

- **Josh Lehner**

Blog at WordPress.com.

State of Oregon
Employment Department
Quality Information, Informed Choices

Made in Oregon: A Profile of the State's Manufacturing Sector

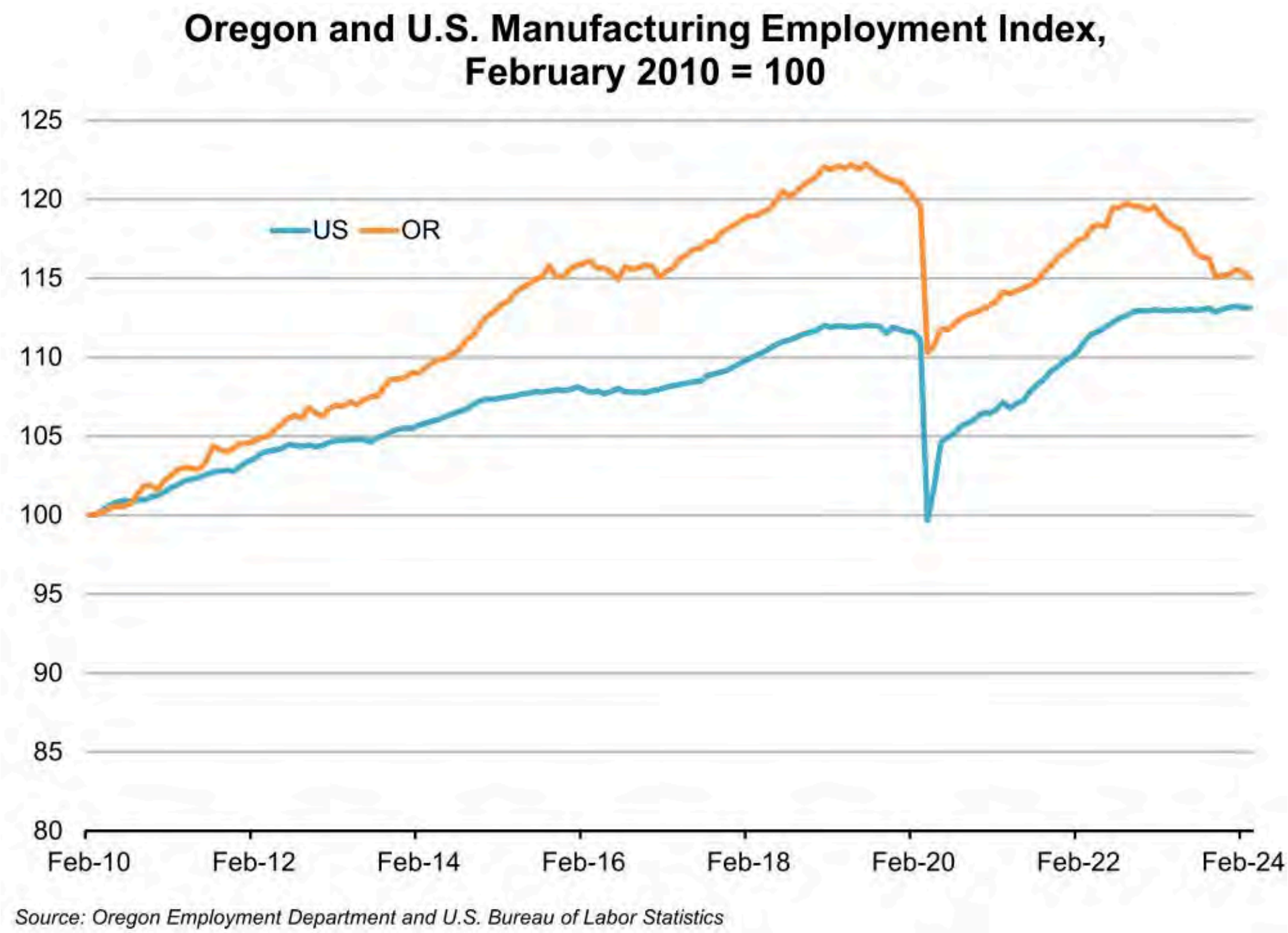
May 03, 2024

by Molly Hendrickson

Oregon-made products have secured a spot on store shelves around the country, and even the world. Some of these products have obvious Oregon roots, tasty things like marionberry jam, cheese, fine wines, and beers that say 'Oregon' right on the label. Some Oregon-made products remain out of view, however. For example, components in the device you're reading this article with might have been made right here in Oregon. Whether you can see it on the label or not, Oregon's manufacturing sector produces products ranging from basic wood pellets to precise aerospace parts. The diverse sector is a fundamental component of the state's identity.

A manufacturing establishment is defined as an establishment that mechanically, physically, or chemically transforms material, substances, or components into new products. In 2022, Oregon was home to 6,786 manufacturing establishments, providing the state with 192,100 jobs or 9.9% of total payroll employment.

Manufacturing has a slightly larger than average footprint in Oregon (9.9% of employment compared with 8.4% nationally) and is growing more quickly over the long term than the nation. Manufacturing, like other industries, was negatively impacted by the pandemic recession. While Oregon had gained back most of the manufacturing jobs lost due to the recession, employment is still below its 2019 peak and declined for much of 2023. Since its lowest employment level in February 2010 (which the United States reached again in April 2020), manufacturing employment in Oregon has grown by 15% compared with the nation's 13%.



Source: Oregon Employment Department and U.S. Bureau of Labor Statistics

Despite outperforming the U.S. in terms of long-term growth, Oregon has recently suffered relatively sharper declines in manufacturing employment since January 2019 that continued during the COVID-19 pandemic. Though there had been substantial recovery through 2022, employment in Oregon's manufacturing sector declined by 6% while U.S. manufacturing has grown by 1% compared with the January 2019 level.

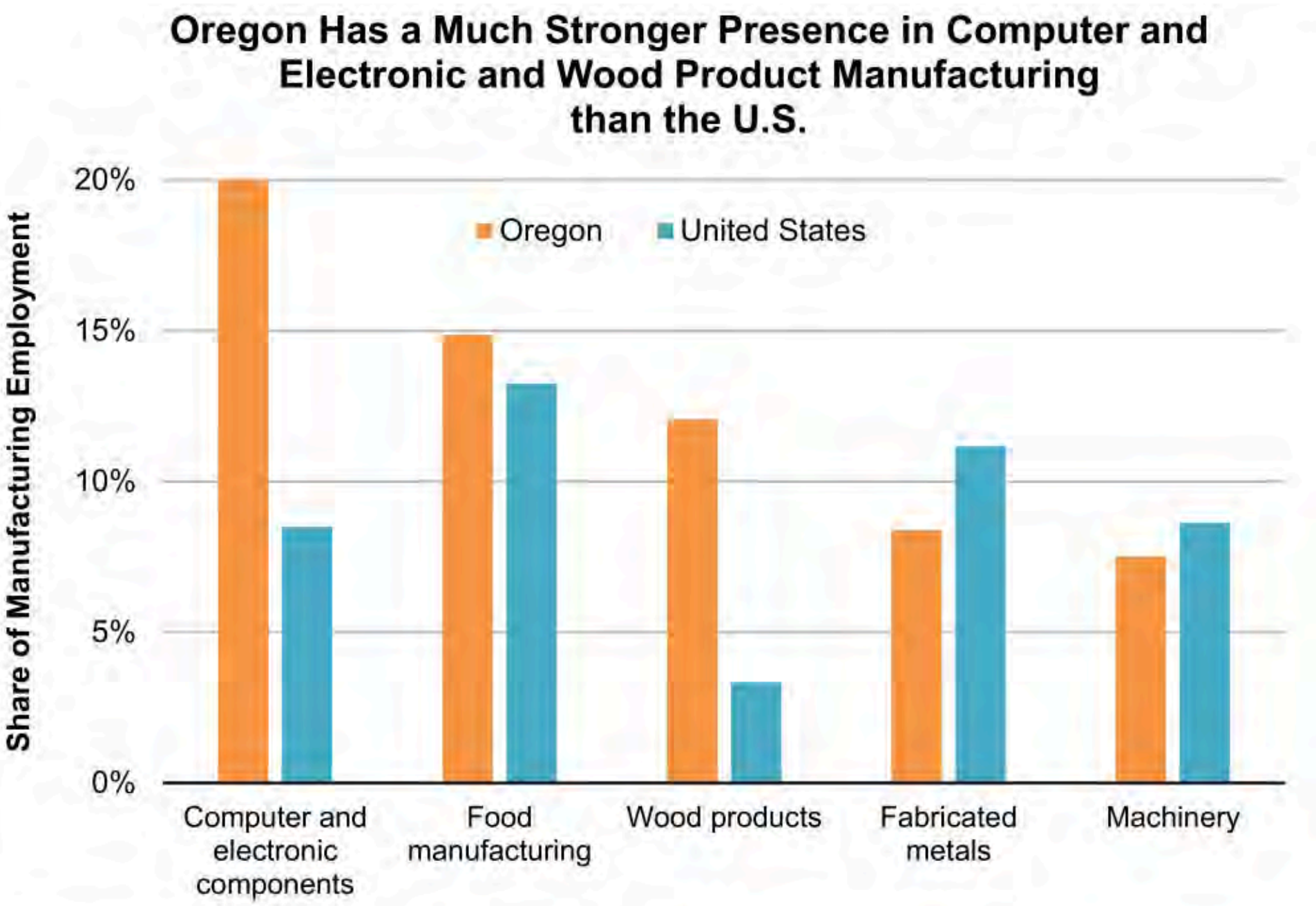
Average wages in Oregon's manufacturing sector have climbed steadily over the past two decades as the state made the shift from a more natural resource-based manufacturing sector to a center for high-tech manufacturing. In 2022, the average annual wage for manufacturing in Oregon was about $83,300. This far exceeded the state's average wage of $66,300.

Looking deeper into Oregon's manufacturing wages, this difference is largely attributable to wages in the computer and

electronic product manufacturing industry, which paid an annual average of about $150,400 in 2022. Excluding computer and electronic product manufacturing, Oregon's average wage across manufacturing industries was about $65,500, slightly below the state's average.

Oregon's Specialties

Oregon's manufacturing sector looks very different than it does nationally. Computer and electronic components manufacturing comprises 21% of the sector statewide compared with about 9% of national manufacturing employment. Wood product manufacturing also has a strong presence in Oregon, making up 12% of sector employment compared with 3% of the sector nationally.



Source: Oregon Employment Department and U.S. Bureau of Labor Statistics

A more detailed industry analysis shows just how diverse the manufacturing sector is. The largest detailed industry by far is the semiconductor and electronic components industry (33,800 jobs in 2022). It also pays far more on average than any other manufacturing industry at $161,600 compared with $83,300 across all manufacturing sectors.

Top Manufacturing Industries in Oregon, 2022

Industry	Employment	Annual Average Wage
Top 10		
Semiconductor and electronic components	33,839	$161,585
Veneer and engineered wood products	8,554	$64,895
Frozen food manufacturing	6,968	$53,386
Sawmills and wood preservation	6,415	$73,802
Industrial machinery manufacturing	6,345	$110,537
Millwork	5,205	$57,469
Navigational, measuring, electromedical, and control instruments	4,797	$103,359
Bread and bakery product manufacturing	4,676	$42,129
Medical equipment and supplies manufacturing	4,338	$65,145
Printing	3,818	$54,979
Other notable industries		
Aerospace product and parts manufacturing	3,050	$90,989
Motor vehicle body and trailer manufacturing	2,991	$52,743
Fruit and vegetable canning, pickling, and drying	2,900	$56,627
Cutlery and handtool manufacturing	2,293	$77,221
Ship and boat building	1,385	$78,886

Source: Oregon Employment Department, QCEW

True to Oregon's long history in forestry, three of Oregon's top industries are tied to our natural resources: veneer and engineered wood products (8,600 jobs), sawmills and wood preservation (6,400 jobs), and millwork (5,200 jobs). While employment in wood product manufacturing is but a fraction of what it was a few decades ago, these three industries combined play an influential role in Oregon's manufacturing sector.

Two relatively low-paying industries in the top 10 largest manufacturing industries are frozen food manufacturing ($53,400), and bread and bakery product manufacturing ($42,100). While these industries make up a large chunk of Oregon's manufacturing sector, the jobs paid average annual wages considerably lower than the statewide average wage of $66,300.

Oregon is well-known across the country for its fresh produce. The number of food preservation businesses, specifically the canning, pickling, and drying of fruits and vegetables, has grown across the state substantially over the years. Employment has risen steadily over the years, and is highly seasonal due to employment spikes around harvest time, though there has been less fluctuation in the past seven years. The annual average wage for fruit and vegetable canning, pickling, and drying is $56,600.

Another notable industry in Oregon is the motor vehicle body and trailer manufacturing industry. This industry includes recreational vehicle manufacturers. Prior to the recession in 2007, this industry peaked at 4,800 jobs. After suffering massive losses during the recession, the industry was left with less than 2,000 jobs. Since then, employment has rebounded and steadily climbed to around 3,000 jobs.

For more information on detailed industries, visit QualityInfo.org where information is published on 125 detailed Oregon manufacturing industries.

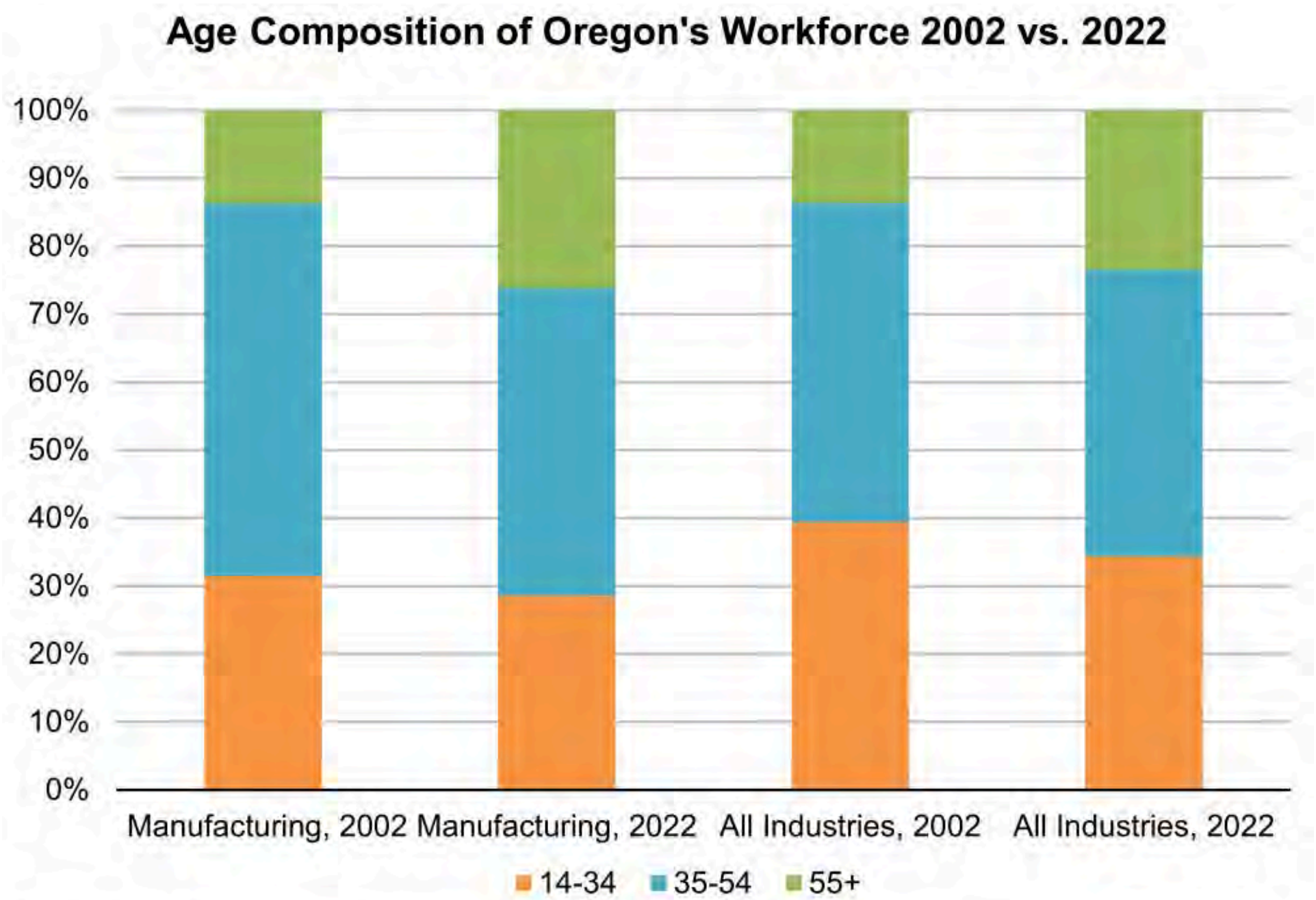
Long-Term Aging of the Mostly Male Workforce

The share of manufacturing workers by gender has remained unchanged for the past 20 years, at about 73% men and 27% women. Overall in 2022, women accounted for 47% of Oregon's private-sector workers; that share also hasn't changed much since 2001, but it is of course more balanced with women's share of the population.

The manufacturing workforce in Oregon is older and aging slightly quicker than the workforce as a whole. Twenty years ago in 2002, 39% of Oregon's workforce was between 14 and 34 years old. In manufacturing, about 32% of workers were between 14 and 34 years of age. In 2022, only 34% of the workforce was between 14 to 34 years old, while in manufacturing just 29% of workers were in this age group.

The share of workers ages 35 to 54 in manufacturing has declined by 10 percentage points compared with 20 years ago. In the overall workforce, this group's share has declined by 5 percentage points over the past 20 years.

In both the overall workforce and the manufacturing workforce, workers in the 55 and over age group continue to make up a larger share now that the youngest baby boomers are turning 60. However, the manufacturing workforce has not had as many young workers enter the industry, as is the case for the overall workforce.



Source: Oregon Employment Department and U.S. Census Bureau, Quarterly Workforce Indicators

As workers retire, these positions will need to be filled by workers who have less experience in the field. This is true for both the overall workforce and the manufacturing workforce but is more pronounced for the manufacturing workforce as fewer young workers have joined.

Projections Show Many Future Openings

The Oregon Employment Department projects that the state's manufacturing sector will grow by 7% between 2022 and 2032. Within manufacturing, primary metals manufacturing is expected to grow quickest at 19%. The only broad manufacturing industry expected to lose employment is paper manufacturing.

Projections for Oregon's Manufacturing Sector, 2022-2032

Industry	2022 Employment	Projected Employment Change	Percent Change
Manufacturing	191,700	14,100	7%
Primary metals	7,200	1,400	19%
Machinery	14,600	2,100	14%
Transportation equipment	10,700	1,300	12%
Fabricated metal products	16,100	1,500	9%
Computer and electronic products	41,000	2,700	7%
Food manufacturing	28,500	1,700	6%
Wood products	23,200	700	3%
Paper and paper products	4,200	-600	-14%

Source: Oregon Employment Department

Manufacturing is expected to grow by 14,100 jobs between 2022 and 2032. In addition to these job gains, there will be many more job openings due to the need to replace workers who leave manufacturing jobs, most of them ending their careers and retiring. Manufacturing may be anticipated to grow at a slower rate than the overall economy in coming years, but as the workforce continues to age there will be lots of job opportunities in the manufacturing industry of the future.

Production occupations with the most projected annual job openings include assemblers and fabricators (1,250); inspectors, testers, sorters, samplers, and weighers (820); packaging and filling machine operators and tenders (810); and first-line supervisors (780). Many high-demand manufacturing occupations typically require a high school education at the entry level. Postsecondary training can make job seekers more competitive for today's manufacturing jobs.

Conclusion

Oregon's manufacturing sector has experienced faster long-term growth than manufacturing across the nation. The state's

manufacturing sector has suffered relatively heavier losses leading up to and during the initial months of the COVID-19 pandemic and has yet to recover all jobs lost. However, 7% growth is projected from 2022 to 2032, and many job opportunities will be available as new jobs are created and workers leaving their current occupations are replaced.

OREGON EMPLOYMENT DEPARTMENT

Mass Timber: Better Buildings, Resilient Forests, Brighter Future

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We're creating equitable economic development and family-wage rural and urban jobs from sustainable wood products that are grown and manufactured in Oregon.

The U.S. Economic Development Administration (EDA) has awarded Oregon Mass Timber Coalition a $41.4 million Build Back Better grant to advance Oregon's sustainable mass

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sector. This investment will drive jobs, sustainable forestry, and mass timber housing.

Why Mass Timber

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Housing Solutions: The Mass Plywood Home

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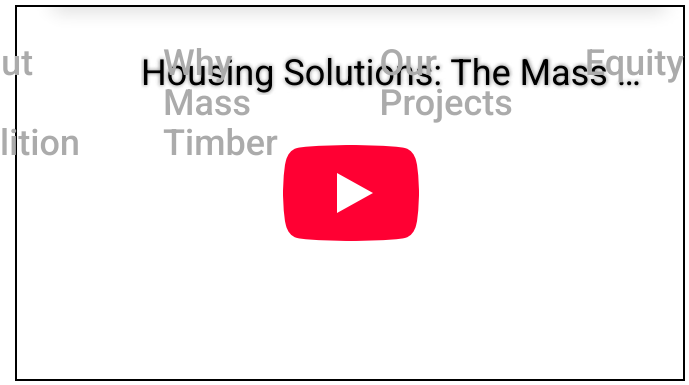
It's not a science project. We're addressing real-world problems for real people. The mass plywood house lays the foundation for the future of housing construction. By embracing cutting-edge innovative materials like mass plywood and systematizing modular design, we can accelerate housing production to meet our growing needs.



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The Coalition is a partnership between Oregon's leading research

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universities and government agencies.

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Featured Project

Mass Timber and Housing Innovation Hub at T2

The Mass Timber and Housing Innovation Hub at T2 is a signature project of the Oregon Mass Timber Coalition, led by the Port of Portland.

Located on the 53-acre

What's New

the facility will build and supply mass timber panels for modular homes, which will be barged and trucked from Terminal 2 to communities in need around Oregon.

Learn More

cheduled.

Oregon State Legislature

What's New

Building Material

Cross-laminated timber, or CLT, is composed of layers of wood glued together at 90º angles and is more fire-resistant than traditional timber.

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HB 3145

Governor Kotek has signed House Bill 3145, a $25M pilot program to deliver high-quality, energy-efficient homes for families earning up to 80% of Area Median Income (AMI). The bill prioritizes modular, off-site, and mass timber construction; supports Oregon-based builders and sustainable design; focuses on rural, coastal & Eastern Oregon; and expands affordable rental and homeownership options. Originating from a convening with the OMTC and championed by Representative Pam Marsh, this bill helps bring housing to more people, faster and more affordably.

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The Oregon Mass Timber Coalition (OMTC) is a partnership of state government and leading academic institutions to support and develop Oregon's mass timber industry.

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What's New

Article

July 2022

Growth trends for selected occupations considered at risk from automation

Breakthroughs in artificial intelligence (AI) and robotics have led to substantial concern that large-scale job losses are imminent. Selected occupations are often cited as illustrations of technological displacement that is or will become a more general problem, but these discussions are often impressionistic. This article compiles a list of specific occupations cited in the automation literature and examines the occupations' employment trends since 1999 and projected employment to 2029. There is little support in U.S. Bureau of Labor Statistics data or projections for the idea of a general acceleration of job loss or a structural break with trends pre-dating the AI revolution with respect to the occupations cited as examples. Offsetting factors and other limitations of the automation thesis are discussed.

Technological change has always attracted attention because of its potential effects on employment. Recent advances in robotics and artificial intelligence (AI) have attracted even more interest than usual, and the breadth and speed of these advances have raised the possibility of widespread job displacement in the near future. Many observers consider these new technologies fundamentally different from previous waves of computing technology. New computing capacities—in areas such as image recognition, robotic manipulation, text processing, natural-language processing, and pattern recognition, and, more generally, the ability to learn and improve rapidly in relatively autonomous ways—represent a break from the hand-coded, rules-based programs of the past. In this view, newer robots and AI represent a clear departure from previous waves of computing, one that accelerates the pace of technological change and job displacement.

Recent writings on automation and employment often refer to certain occupations in passing as examples of jobs that are currently affected by advanced robots and AI or are likely to be affected in the near future. These occupations may be intended as representative examples of general processes or the leading edge of trends that will eventually affect other occupations. Because the occupations are not examined in depth, a natural question is whether the expectations expressed in the automation literature are consistent with U.S. Bureau of Labor Statistics (BLS) projections and recent employment trends for these occupations. There are also potential problems with representativeness in using individual occupations as exemplars. Because part of the workforce is being used as a stand-in for the whole, it is natural to ask whether these particular occupations are actually shrinking rapidly, as well as whether the general practice of citing individual examples has some inherent limitations that are worth bearing in mind.

This article assembles the individual occupations that widely cited recent works on automation consider highly vulnerable to substitution by robots and AI and examines their projected growth from 2019 to 2029. For context, the growth of these occupations over 2008–18 is compared with both the 2019–29 projections and the 2008–18 projections published a decade earlier. Finally, actual and projected growth in these occupations is compared with their growth over 1999–2009. In addition to providing trend data for the past 20 years and projections for the following 10 years, these data permit some consideration of the accuracy of the 2029 projections against the performance of the 2008–18 projections. This article does not examine overall trends by major occupational group, which is covered in a companion paper.[1] Rather, it examines how well recent discussions of automation describe developments in the specific occupations that have been selected to illustrate general trends. The article also examines limitations surrounding any use of occupational examples to understand general employment trends.

Current automation discourse

Since the emergence of information and communications technology (ICT) in the late 1940s, the development of this technology has been uniquely dynamic. Both the power and breadth of applications of ICTs have grown rapidly. Milestones include mainframe computing, early manufacturing automation, minicomputers, microcomputers, the internet, and mobile computing, among others. From their inception, ICTs were understood as a watershed in the development of technology, with great potential for both abundance and displacement. Repeating periodic concerns raised earlier regarding mechanical technology, some observers in the 1950s and 1960s argued computers and industrial automation could lead to massive job losses.[2] Responding to these concerns, congressional hearings, a series of studies by the U.S. Bureau of Labor Statistics, and a multivolume report by a special presidential commission investigated the employment implications of computers and automation.[3] However, when economic growth picked up in the late 1960s and unemployment fell to 3.5 percent, the issue faded into the background.

Concern regarding the impact of computers on jobs reemerged in the late 1980s. Economists became aware of a trend toward greater earnings inequality, which included increasing wage differentials between education groups. The dominant explanation was that new technology increasingly favored more educated workers. This concept of skill-biased technological change (SBTC) pointed to the spread of microcomputers as reducing the demand for less-skilled workers.[4] When wage gaps between the middle and lower percentiles of the wage distribution stopped widening in the late 1990s, attention turned toward the possibility that declining labor demand affected middle-skilled jobs more than low-skilled jobs because their tasks were more codifiable and programmable. It was argued this made middle-skilled jobs more susceptible to automation than low-skill service jobs because service jobs require sensory perception, common sense, and other tacit skills that are difficult to replicate with algorithmic, if–then programming logic.[5]

A new wave of computing has led to further revision regarding the effects of automation. Beginning in 2005 with the successful demonstration of self-driving vehicles, views of the capabilities of ICTs have expanded. A series of often unexpected and dramatic breakthroughs in AI and robotics have expanded the kinds of tasks that information technology can perform. Now robots clean floors, deliver packages, perform warehouse work, check inventory on supermarket shelves, patrol malls, and assist surgery. Other robots lay bricks and sew garments. After 2010, corporate research and development on self-driving vehicles and other AI rose significantly. Breakthroughs in complex game-playing raised the possibility of more general automated intelligence that might replace numerous cognitively complex jobs.[6] By 2015, image recognition, speech recognition, natural-language processing and speech synthesis, machine translation, automated captioning and subtitling, automated text generation, and business analytics made remarkable advances powered by improved hardware, big data, and advances in neural networks and other machine learning techniques. Even experts in the field of AI were often surprised by the rapid rate of improvement and the milestones reached in such a compressed timeframe.[7]

This sudden burst of progress led some researchers and commentators to change their views regarding the kinds of jobs that might be subject to widespread automation in the near future. Complex perceptual and cognitive tasks, like driving vehicles, composing news articles, extracting information from legal documents, and reading radiological images, as well as all kinds of manual and service tasks previously performed by humans, came to be seen as vulnerable to large-scale substitution by machines. Widely cited writings on automation have argued strongly that the new wave of computing technology is fundamentally different from previous waves in terms of its capabilities and speed, and that it may produce massive job displacement in the near future.[8] One widely cited and emulated study claimed 47 percent of U.S. jobs were at risk of automation between 2010 and 2030.[9] This and similar highly publicized claims generated their own congressional hearings and government reports.[10]

One common feature of recent writing on automation is the use of particular occupations as illustrations of the rapid encroachment of robots and AI on jobs previously restricted to human workers. BLS projects 10-year occupational employment trends on a regular basis, so it is natural to ask whether the BLS projections also consider these particular occupations highly vulnerable to automation and whether recent employment trends also suggest reasons for concern. Given the overall size of the U.S. workforce, there are also questions regarding the total number of jobs that are in these potentially vulnerable occupations. If the projections and recent trends suggest these occupations are vulnerable and the occupations are large, either individually or collectively, then recent automation concerns receive support. By contrast, if their growth follows relatively consistent or moderate trends over time or the number of jobs involved is not outsized relative to the overall labor force, then the experience of these occupations would not support current levels of concern regarding automation.

How AI can affect employment

Several considerations are worth noting in investigating this question because they potentially qualify the view that AI and robots will have outsize employment impacts, some of which apply to technological change more generally.

Technological vintage

The current literature on automation considers recent robots and AI much more powerful and consequential for employment than previous ICTs, representing a break with previous computing technology. Therefore, the employment effects of the current wave of computing should be distinguished from the effects of previous waves of computing, such as older automation technologies, conventional office software, the internet, and mobile technology. It is the new functions of leading technologies, their wider applicability, and faster development that has generated especial concern for the future of work. If the new technology simply represents a "handoff" of productivity leadership from maturing ICTs to a new generation of ICTs, without a break or discontinuity in employment trends, then one would not expect to see the current, heightened levels of concern. Therefore, the specific employment effects of newer robots and AI need to be distinguished from the effects of well-established computing technologies, such as digitization, ICT-enabled self-service, ICT-enabled offshoring, e-commerce, and office automation, whose employment effects began earlier and have not necessarily been exhausted. None of these older technologies uses or is dependent on machine learning or advanced robotics. This article focuses on the potential effects of robotics and AI, which have generated the greatest attention and concern recently, but, as will be seen, it is not always easy to maintain the distinction between newer and older computing technologies in practice when examining occupational growth trends.

Scale effects

In addition, the automation literature tends to focus on job destruction due to technological substitution without much consideration of the possibility that innovations could increase demand for a good or service and thus require more workers to meet that demand (a scale effect). The most common scale effect mentioned in discussions of automation generally refers to firm or industry growth resulting from automation-related price decreases and accompanying growth in product demand. It is possible, for example, that partial automation of warehouses may lower retail prices and expand the use of e-commerce so that the total number of warehouse workers might grow even as staffing patterns within each warehouse become leaner. However, if e-commerce demand eventually stops growing and automation continues to progress, employment levels will no longer be buoyed by growth in the size of the product market.

Perhaps more importantly, embedded in the BLS projection models is the understanding that a growing population generally increases total demand for goods and services, which usually increases the total demand for labor, even when productivity is rising.[11] Likewise, a growing labor force provides the means for satisfying growing demand for final goods and services and is typically associated with job growth. The automation literature tends to focus on the jobs that technology eliminates or may eliminate, usually omitting effects of population growth and growth in the total size of the economy, which are reflected in both employment growth and BLS projections.

Task and job variation within occupations

Firms have often responded to the introduction of new labor-saving technology by redefining the tasks involved in existing jobs. Economists often point to the "lump of labor" fallacy in discussing previous waves of technological innovation.[12] According to this view, there is no fixed amount of work to be done in an economy, as an economy not only grows over time but becomes more diversified. Even though machines may reduce the number of jobs in some occupations, historically the workforce has shifted to other, often new occupations. This principle can be extended to the tasks within occupations, as well. Automation of some tasks, such as document review within legal occupations, may result in more time spent on other, perhaps new, tasks without necessarily a reduction in the number of jobs. Although this is certainly not inevitable, observers need to be aware that there is a potential lump of labor fallacy *within* occupations that may inhibit occupational decline, as well as the more familiar application of the concept across occupations. When technology substitutes for some tasks within an occupation, it is possible that workers will be shifted to other, sometimes new, tasks, rather than simply losing their jobs. The extent to which technology augments organizational capacities rather than simply saving labor is an empirical question that tends to be overlooked in discussions of automation, perhaps because it represents continuity rather than a break with existing practices. To the extent jobs are lost, firms may rely on attrition rather than layoffs, which will moderate the pace of occupational decline.

Another issue is that occupational titles in the Standard Occupational Classification (SOC) system may cover a wider range of jobs than may be immediately apparent, and not all of these jobs may be equally susceptible to automation. For example, some estimates of jobs at risk from automation mention the three million jobs in the broad occupation driver/sales workers and truck drivers (SOC 53-3030) as vulnerable to displacement by self-driving trucks, rather than the 1.7 million jobs in the detailed occupation heavy and tractor-trailer truck drivers (SOC 53-3032), some of which, like cement truck drivers, also do not drive long-haul highway routes considered most suitable for autonomous vehicles.[13] Likewise, software may replace accountants who mainly prepare tax filings, but accounting jobs are varied, and those focused on other tasks may remain completely unaffected. Even when jobs within an occupation correspond more closely to assumptions, those jobs may contain more tasks that are difficult to automate than is commonly recognized, which may slow the replacement of human workers by machines.[14] Underestimating the variety of jobs covered by an occupational title and their varying susceptibility to automation is distinct from situations in which the task content of jobs *changes* in response to the introduction of technology. However, in both cases there is a risk of overestimating the importance of a particular technology for a given occupation because of underestimating the variety of their task content, either in the cross-section or over time.

Omitting considerations like scale effects, job redefinition, and job variety, or mentioning them only in passing, assumes by default that the effects of technological substitution are stronger than the effects of economic growth and other offsetting variables that operate to maintain or increase jobs in affected occupations.[15] As will be seen, this is not necessarily a safe assumption. Nevertheless, it should be noted that nothing in this article should be interpreted as minimizing the number of jobs lost, the hardships experienced by workers affected by job loss, or the implications of the changing occupational composition for inequality and economic opportunity more generally.

Data

This article uses data from two BLS sources. Projections data are from the Employment Projections program and historical employment data are from the Occupational Employment and Wage Statistics (OEWS) program.

Employment Projections

BLS conducts research on job trends on an ongoing basis as part of its Employment Projections program. This research is used to make 10-year projections of occupational growth to help members of the public, such as jobseekers, counselors, and education planners, understand labor market trends. As part of the projections process, staff economists conduct detailed research on recent and emerging technologies used in the workplace, as well as prior trends in employment by occupation. This article uses projections files for 2008–18 and 2019–29. These projections cover a 20-year period frequently used as a projection interval in the recent automation literature.[16] The 2019–29 projections permit direct comparison between BLS research and recent work on automation, while avoiding distortions that would arise in the 2020–30 projections because of the effect of the coronavirus disease 2019 (COVID-19) pandemic on employment in 2020.[17] The 2019–29 projections file also includes brief explanations of the technological and other drivers of occupational trends that emerged from BLS research, which are cited at points below.[18]

The 2008–18 projections file contains actual occupational employment for 2008 and both projected and actual occupational employment for 2018. These data provide employment trends for the first decade of the current wave of ICTs and a benchmark for evaluating how well the projections methodology anticipated trends in occupational employment. Although there is no way to evaluate the projections for 2029, the performance of the 2008–18 projections provide a useful point of comparison when considering the likely performance of the 2019–29 projections.

Using the performance of the 2008–18 projections to provide perspective on the likely performance of the projections to 2029 is complicated by several factors. Projections aim to provide a general guide to the course of future occupational employment but recognize there will likely be some divergence between projected and actual figures in the target year, given previous experience and the intrinsic uncertainties involved. Therefore, modest differences between projected and actual values for 2018 should not be given great weight. However, the implications of any large divergences for projections to 2029 may be ambiguous because the later projection may take the earlier discrepancies into account and try to address the problems that caused them. Nevertheless, Carl Benedikt Frey and Michael Osborne argue the BLS projections lag technological developments, so it is important to note cases in which the projections underestimated change during the first decade of the AI era and continue to project gradual change in the next decade.[19]

Occupational Employment and Wage Statistics

Because some occupations identified as vulnerable to substitution by robotics and AI may have been affected by previous waves of computing technology, and may continue to experience these effects, this article also examines growth trends for the 1999–2009 period by using the Occupational Employment and Wage Statistics (OEWS) database. The OEWS database covers a somewhat narrower range of industries than the projections data. This difference will produce some discrepancies in the absolute levels of employment between the OEWS and projections files. However, the growth rates for 1999 to 2009 should be a useful benchmark for judging whether subsequent changes in occupational employment represent a qualitative break with prior rates of change, as suggested by recent work on automation. A discussion of occupational growth rates (in the next section) also uses the OEWS database for 1999 to 2018 to show typical rates of occupational growth and decline to provide context. Readers should bear in mind that two different data series, Employment Projections and OEWS database, are used to derive the main results for occupations considered highly susceptible to automation because the data series cover different years, which produces some noncomparabilities noted below.[20]

Both the projections and the OEWS database use the Standard Occupational Classification (SOC) system, which is a hierarchical system for coding occupations. For example, the 2000 SOC has 821 detailed occupations, which are nested within approximately 450 broad occupations, 96 minor occupation groups, and 23 major occupation groups. The writings consulted for this article generally use the equivalent of detailed occupations when discussing jobs at risk of automation, but those writings sometimes use the equivalent of broad or even minor occupations, which is reflected in the tables that follow. The relationship between automation and major occupation groups is covered in a companion paper.[21] The SOC system was revised significantly beginning in 2010 and, again, beginning with data collected in 2019, which can introduce some comparability issues across periods.

Occupational size and growth: general considerations

Because discussion of automation often uses particular occupations to illustrate general employment trends, it is useful to have some perspective on the varying sizes of occupations. BLS projections data report 163 million jobs in the United States in 2019, which are classified into 790 detailed occupations. Therefore, the average occupation had 206,072 jobs and accounted for about one-tenth of 1 percent (0.13 percent) of all jobs. However, the highly skewed nature of the distribution means that the share of the largest occupation accounted for more than 20 times the average (2.7 percent). Occupational size declines fairly rapidly thereafter, such that the share of the smallest occupation in the top decile of the occupational employment distribution accounted for about twice the average (0.29 percent). The median occupation had only about 54,000 jobs, accounting for just 0.03 percent of all jobs, and the nearly 400

occupations below the median each accounted for 0.01 percent of all jobs on average. Clearly, occupational size is an important consideration when focusing on particular cases given that most occupations are small in absolute terms and even large occupations account for relatively small shares of all jobs. (For further information on the occupational size distribution, see the appendix). Even very large percent declines imply limited overall job losses in the case of most occupations, and very large percent declines in occupational employment are themselves not very common.

Between 1999 and 2018, the total number of jobs grew 17 percent for the 669 occupations in the OEWS database that can be followed consistently. This represents average 10-year and 20-year growth rates of 8.6 percent and 18.0 percent, respectively. Given the general increase in jobs, which partly reflects growth in the population and labor force, one would expect most occupation-specific growth rates to be positive. However, while many occupations experienced below-average growth, others experienced absolute declines. An occupation must decline by 25 percent per decade to shrink by 44 percent over two decades, equivalent to 0.56 of its base-year level. This is comparable to the rate of change implied by Frey and Osborne's widely cited forecast of a 47-percent decline in the total number of jobs over 20 years.[22]

Such steep declines are unusual. Table 1 shows the actual distribution of growth rates in the OEWS database for 1999–2018. The top data row shows that only about 15 percent of occupations (column 1), accounting for 9 percent of jobs in 1999 (column 2), declined by 25 percent or more per decade over the full period. Clearly, current views of automation imply a sharp break with the recent past in terms of the scale of occupational employment decline. Table 1 also shows that about half of all jobs in 1999 were in occupations that grew or shrank by up to 10 percent per decade over the next 19 years (row 2), two-thirds were in occupations that changed within 20 percent per decade (row 3), and 83 percent of jobs were in occupations that changed within 30 percent per decade (row 4).

A more detailed breakdown in panel B of table 1 shows that, as one moves away from the central, slowest growth category (0- to 10-percent growth) and toward categories representing larger shifts, the shares of occupations and jobs involved grow smaller. This is especially the case for declining occupations. Only 21 occupations, representing 1 percent of jobs in 1999, declined by 50 percent or more per decade from 1999 to 2018. By contrast, 55 occupations, representing 2.7 percent of jobs in 1999, grew by 50 percent or more per decade over the same period.

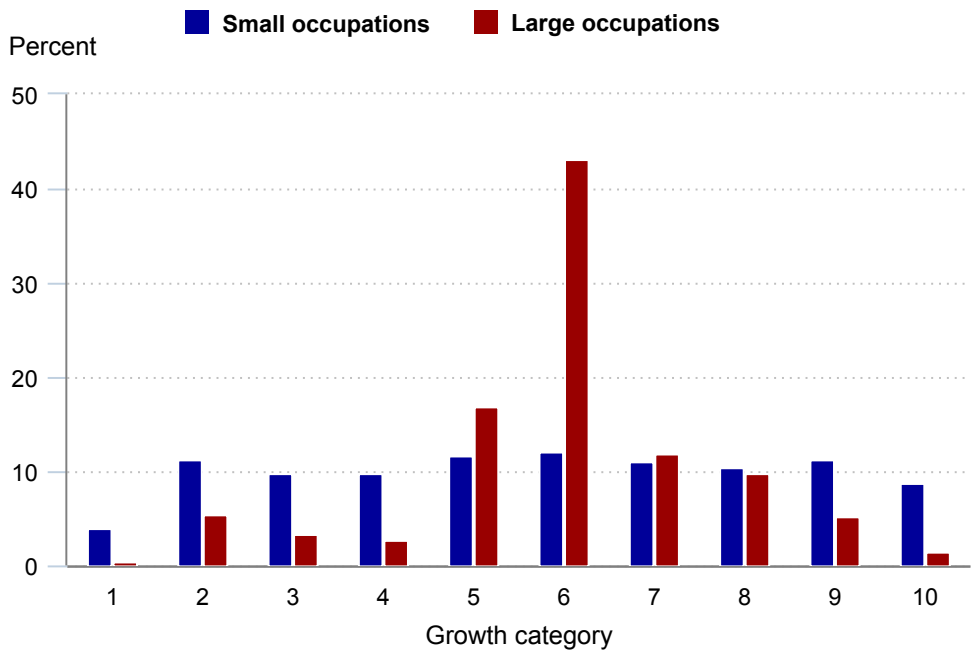
Table 1. Distribution of occupations' 10-year growth rates, 1999–2018

10-year growth	Percent of all occupations	Percent of all jobs	Number of occupations	Percent of jobs, small occupations (*N* = 338)	Percent of jobs, large occupations (*N* = 104)
A. Select growth rates					
Declined by 25 percent or more	15.1	9.0	101	13.1	4.9
Changed ± 10 percent	30.9	51.2	207	23.8	59.9
Changed ± 20 percent	51.7	67.8	345	44.7	74.5
Changed ± 30 percent	69.3	83.0	463	64.8	87.5
B. All growth rates					
$G \leq 0.5$	3.1	1.0	21	4.00	0.3
$0.5 < G \leq 0.7$	8.7	6.3	58	11.30	5.5
$0.7 < G \leq 0.8$	7.3	4.7	49	9.70	3.3
$0.8 < G \leq 0.9$	9.3	5.3	62	9.80	2.7
$0.9 < G < 1.0$	13.8	16.0	92	11.60	16.9
$1.0 \leq G \leq 1.1$	17.2	35.2	115	12.20	43
$1.1 < G \leq 1.2$	11.4	11.3	76	11.10	11.9
$1.2 < G \leq 1.3$	10.3	10.5	69	10.40	9.7
$1.3 < G < 1.5$	10.8	7.1	72	11.30	5.2
$1.5 \leq G$	8.2	2.7	55	8.70	1.4
Total [1]	**100.1**	**100.1**	**669**	**100.1**	**99.9**

Note:
[1] Totals do not sum to 100 because of rounding.
G = growth rate, and *N* = number of observations. Small occupations are defined as those with fewer than 50,000 jobs, and large occupations are defined as those with greater than 250,000 jobs.
Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics 1999–2018.

It would not be surprising to find that rates of change were larger for smaller occupations, because absolute changes imply larger percent changes. This is confirmed by comparing the employment-weighted distribution of occupational growth rates for occupations with less than 50,000 jobs in 1999 (see table 1, column 4) with the distribution for occupations with more than 250,000 jobs in 1999 (column 5), which together account for two-thirds of all occupations included in the table (442 of 669). The differences are even more apparent when the two distributions are compared graphically **(**see chart 1**)**. In sum, very large declines in occupational employment were relatively uncommon between 1999 and 2018, and they tended to be concentrated among smaller occupations, limiting their effect on overall employment. The pattern of occupational decline implied by automation futurists would represent a dramatic departure from recent trends.

Chart 1. Distribution of 1999 jobs across growth categories, by occupation size



Click legend items to change data display. Hover over chart to view data.
Notes: Small occupations are defined as those with fewer than 50,000 jobs, and large occupations are defined as those with greater than 250,000. G = 2018 occupational size relative to 1999 occupational size.
Growth category
1: $G \leq 0.5$;
2: $0.5 < G \leq 0.7$;
3: $0.7 < G \leq 0.8$;
4: $0.8 < G \leq 0.9$;
5: $0.9 < G < 1.0$;
6: $1.0 \leq G \leq 1.1$;
7: $1.1 < G \leq 1.2$;
8: $1.2 < G \leq 1.3$;
9: $1.3 < G < 1.5$;
10: $1.5 \leq G$.
Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics 1999–2018.

View Chart Data

Occupations considered highly susceptible to automation

Tables 2 and 3 show recent and projected trends for 27 occupations that have been used as illustrations in widely cited works on the effects of robotics and AI on employment.[23] Most of the discussion will focus on the percent growth figures in the percent change columns of table 3, but the absolute number of jobs in table 2 and the changes in absolute levels in the absolute change columns of table 3 are relevant to the question of magnitudes and provided for reference. In both tables, occupations in the top panel are closer to "pure" cases in which technological drivers of employment are more likely to be exclusively robotics and AI. Occupations cited in the automation literature that appear in the bottom panel are more mixed and are likely to have been affected significantly by previous waves of computing technologies, in addition to any effects of more advanced information and communications technologies (ICTs). Nevertheless, the distinction is not clear, if only because the magnitudes of the various technological effects on different occupations are not well understood. All figures for 1999 to 2009 are derived from the OEWS database, while figures for 2008 to 2018 and 2019 to 2029 are derived from the Employment Projections database, which adds the self-employed and certain other groups to the OEWS totals.

Table 2. Job trends for detailed occupations considered high risk for automation, 1999–2029 (number of jobs in thousands)

SOC code	Title	OEWS		BLS projections database				
		1999	2009	2008	2018p	2018	2019	2029p
00-0000	All occupations	118,201	130,580	150,930	166,204	160,959	162,797	168,835
A. Potential AI-affected occupations								
13-2052	Personal financial advisors	80.0	149.5	208.4	271.2	271.7	263.0	274.6
27-3091	Interpreters and translators	13.6	40.0	50.9	62.2	76.1	77.4	92.9
29-1067	Surgeons, except ophthalmologists	48.5	44.6	54.5	63.8	38.2	39.6	38.8
35-3021	Fast food and counter workers	2,358.9	3,186.7	3,227.1	3,670.4	4,184.4	4,047.7	4,508.6
37-2011	Janitors and cleaners	2,090.6	2,090.4	2,375.3	2,479.4	2,404.4	2,374.2	2,479.8
37-2012	Maids and housekeeping cleaners	913.5	887.9	1,498.2	1,583.7	1,494.4	1,474.9	1,470.7
37-3011	Landscaping and groundskeeping workers	739.5	860.0	1,205.8	1,422.9	1,205.2	1,188.0	1,307.9
53-3032	Heavy and tractor-trailer truck drivers	1,558.4	1,550.9	1,798.4	2,031.3	1,958.8	2,029.9	2,060.5
53-7051	Industrial truck and tractor operators	590.7	568.3	610.3	627.0	615.0	634.7	652.3
53-7062	Laborers and freight, stock, material moving	2,035.6	2,135.8	2,317.3	2,298.6	2,953.8	2,986.0	3,111.7
1	**Subtotal**	**10,429.3**	**11,514.1**	**13,346.2**	**14,510.5**	**15,202.0**	**15,115.4**	**15,997.8**
1	**Percent of all jobs**	**8.8**	**8.8**	**8.8**	**8.7**	**9.4**	**9.3**	**9.5**
B. Occupations with pre-AI potential effects								
13-2072	Loan officers	200.2	298.2	327.8	360.9	316.2	316.9	327.0
13-2082	Tax preparers	58.1	61.1	95.8	98.6	86.6	88.4	87.9
15-1131	Computer programmers	528.6	367.9	426.7	414.4	250.3	213.9	193.8
23-1011	Lawyers	464.3	556.8	759.2	857.7	823.9	813.9	846.3
23-2011	Paralegals and legal assistants	175.9	246.8	301.5	380.8	342.9	337.8	373.1
27-3022	News analysts, reporters, journalists	64.6	52.0	69.3	64.9	49.7	52.0	46.2
27-3031	Public relations specialists	118.3	242.7	1	1	1	274.6	294.3
41-1011	First-line supervisors of retail sales workers	1,237.1	1,163.0	1,685.5	1,773.9	1,548.3	1,476.4	1,395.3
41-2011	Cashiers	3,162.1	3,439.4	3,550.0	3,675.5	3,648.5	3,600.9	3,335.5
41-2021	Counter and rental clerks	392.6	417.0	448.2	461.9	436.1	420.4	424.9
41-2031	Retail salespersons	3,729.0	4,209.5	4,489.2	4,863.9	4,510.9	4,371.4	4,346.3
43-4051	Customer service representatives	1,789.6	2,195.9	2,252.4	2,651.9	2,972.6	3,018.8	2,959.8
41-9041	Telemarketers	485.7	307.7	341.6	303.8	167.7	136.9	117.5
43-5081	Stockers and order fillers	1,800.8	1,864.4	1,858.8	1,993.3	2,056.6	2,135.8	2,151.3
43-4181	Reservation/transportation ticket agents	222.3	142.5	168.3	181.9	133.7	126.3	122.7
45-2091, 45-2092, 45-2093	Farmworkers and agricultural equipment operators	267.2	291.1	782.6	763.9	855.0	882.2	891.3
51-4120 [2]	Welders	478.7	399.3	466.4	455.9	462.4	476.1	487.2
1	**Subtotal**	**15,123.0**	**16,197.9**	**17,852.1**	**19,128.5**	**18,338.7**	**18,427.0**	**18,097.0**
1	**Percent of all jobs**	**12.8**	**12.4**	**11.8**	**11.5**	**11.4**	**11.3**	**10.7**
C. All potentially affected occupations								
1	**Total, all specific occupations**	**25,552.3**	**27,712.0**	**31,198.3**	**33,639.0**	**33,540.7**	**33,542.4**	**34,094.8**
1	**Percent of all jobs**	**21.6**	**21.2**	**20.7**	**20.2**	**20.8**	**20.6**	**20.2**

Note:

1 Not applicable.

2 Broad occupation.

SOC = Standard Occupational Classification system, OEWS = Occupational Employment and Wage Statistics, BLS = Bureau of Labor Statistics, and p = projected value. All occupation codes are from SOC 2010, but the SOC 2000 codes used for the 1999–2009 OEWS and the 2008–18 BLS projections and the SOC 2018 codes used for 2019–29 may differ. Public relations specialists (SOC 27-3031) cannot be identified uniquely in the projections database prior to 2019.

Source: U.S. Bureau of Labor Statistics, OEWS database 1999–2009 and BLS occupational projections files for 2008–18 and 2019–29.

Table 3. Job trends for detailed occupations considered high risk for automation 1999–2029, absolute and percent change

SOC code	Title	Absolute change (in thousands)				Percent change			
		1999–2009	2008–18p	2008–18	2019–29p	1999–2009	2008–18p	2008–18	2019–29p
00-0000	All occupations	12,378	15,274	10,028	6,038	10.5	10.1	6.6	3.7
A. Potential AI-affected occupations									
13-2052	Personal financial advisors	69.5	62.8	63.3	11.6	86.9	30.1	30.4	4.4
27-3091	Interpreters and translators	26.4	11.3	25.2	15.5	193.3	22.2	49.4	20.0
29-1067	Surgeons, except ophthalmologists	-3.9	9.3	-16.3	-0.8	-8.0	17.0	-30.0	-2.0
35-3021	Fast food and counter workers	827.8	443.3	957.3	460.9	35.1	13.7	29.7	11.4
37-2011	Janitors and cleaners	-0.2	104.1	29.1	105.6	0.0	4.4	1.2	4.4
37-2012	Maids and housekeeping cleaners	-25.6	85.5	-3.8	-4.2	-2.8	5.7	-0.3	-0.3
37-3011	Landscaping and groundskeeping workers	120.5	217.1	-0.6	119.9	16.3	18.0	0.0	10.1
53-3032	Heavy and tractor-trailer truck drivers	-7.5	232.9	160.4	30.6	-0.5	12.9	8.9	1.5
53-7051	Industrial truck and tractor operators	-22.4	16.7	4.6	17.6	-3.8	2.7	0.8	2.8
53-7062	Laborers and freight/stock/material moving	100.2	-18.7	636.5	125.7	4.9	-0.8	27.5	4.2
1	**Subtotal or percent change**	**1,084.8**	**1,164.3**	**1,855.7**	**882.4**	**10.4**	**8.7**	**13.9**	**5.8**
B. Occupations with pre-AI potential effects									
13-2072	Loan officers	98.0	33.0	-11.6	10.1	49.0	10.1	-3.5	3.2
13-2082	Tax preparers	3.0	2.8	-9.3	-0.5	5.2	2.9	-9.7	-0.6
15-1131	Computer programmers	-160.7	-12.3	-176.4	-20.1	-30.4	-2.9	-41.3	-9.4
23-1011	Lawyers	92.5	98.5	64.7	32.4	19.9	13.0	8.5	4.0
23-2011	Paralegals and legal assistants	70.9	79.3	41.4	35.3	40.3	26.3	13.7	10.4
27-3022	News analysts, reporters, journalists	-12.6	-4.4	-19.6	-5.8	-19.6	-6.3	-28.3	-11.2
27-3031	Public relations specialists	124.4	1	1	19.7	105.2	1	1	7.2
41-1011	First-line supervisors, retail sales	-74.0	88.4	-137.2	-81.1	-6.0	5.2	-8.1	-5.5
41-2011	Cashiers	277.3	125.5	98.5	-265.4	8.8	3.5	2.8	-7.4
41-2021	Counter and rental clerks	24.4	13.7	-12.1	4.5	6.2	3.1	-2.7	1.1
41-2031	Retail salespersons	480.5	374.7	21.7	-25.1	12.9	8.3	0.5	-0.6
43-4051	Customer service representatives	406.2	399.5	720.2	-59.0	22.7	17.7	32.0	-2.0
41-9041	Telemarketers	-177.9	-37.8	-174.0	-19.4	-36.6	-11.1	-50.9	-14.2
43-5081	Stockers and order fillers	63.6	134.4	197.8	15.5	3.5	7.2	10.6	0.7
43-4181	Reservation/transportation ticket agents	-79.8	13.6	-34.5	-3.6	-35.9	8.1	-20.5	-2.9
45-2091, 45-2092, 45-2093	Farmworkers and agricultural equipment operators	23.9	-18.7	72.4	9.1	8.9	-2.4	9.3	1.0
51-4120 2	Welders	-79.4	-10.5	-4.1	11.1	-16.6	-2.3	-0.9	2.3
1	**Subtotal or percent change**	**1,075.0**	**1,276.2**	**486.4**	**-330.0**	**7.1**	**7.1**	**2.7**	**-1.8**
1	**All specific occupations**	**2,159.8**	**2,440.5**	**2,342.1**	**552.4**	**8.5**	**7.8**	**7.5**	**1.6**

Note:
1 Not applicable.
2 Broad occupation.
SOC = Standard Occupational Classification system, OEWS = Occupational Employment and Wage Statistics, BLS = Bureau of Labor Statistics, and p = projected value. All occupation codes are from SOC 2010, but the SOC 2000 codes used for the 1999–2009 OEWS and the 2008–18 BLS projections and the SOC 2018 codes used for 2019–29 may differ. Public relations specialists (SOC 27-3031) cannot be identified uniquely in the projections database prior to 2019.
Source: U.S. Bureau of Labor Statistics, OEWS database 1999–2009 and BLS occupational projections files for 2008–18 and 2019–29.

At the most basic level, concerns regarding automation are supported if occupations in panel A of table 3 are projected to decline sharply in the 2019–29 period and, secondarily, if they also shrank in the 2008–18 period with the birth of the modern AI industry. Nevertheless, with continued population and labor force growth, one might also focus on occupations whose growth was far below average for a given period.

The AI literatures leads one to expect faster rates of employment decline for the 2019–29 period compared with previous periods. In table2, one would also expect rates of decline in panel A to be faster after 2008 than rates of decline for occupations in panel B for 1999 to 2009, when those occupations were affected only by prior waves of computing technology. Finally, if occupations in panel B are affected by both prior and new waves of computing technology after 2008, their rates of decline would be expected to be the most rapid of any group or period in table 3. Unfortunately, these kinds of comparisons across panels are complicated by the fact that job growth has been decelerating because of the decline in the growth of the working-age population over time, which exerts an independent drag on the growth of jobs overall.[24] For example, the total number of jobs grew 10.5 percent from 1999 to 2009 and then slowed to 6.5 percent from 2008 to 2018 according to the OEWS database, while the projections anticipate further deceleration to 3.7-percent growth from 2019 to 2029. Under these circumstances, one would expect slower job creation in more recent years regardless of technological advances.

Aggregate results

Panel A of table 2 shows occupations used in the literature as examples of occupations susceptible to job loss from AI and robots and classified here as unaffected by earlier ICTs. The number of jobs in this group rose from 13.3 million (2008) to 15.1 million (2019) and is projected to grow further, to nearly

16.0 million (2029). This group's share of all jobs rose from 8.8 to 9.3 percent (2008–19) and is projected to rise more slowly to 9.5 percent by 2029. In other words, these occupations grew in both absolute and relative terms since 2008 and are expected to continue to do so. According to the OEWS database, these occupations also grew in absolute size from 1999 to 2009, but their relative share remained flat at 8.8 percent of jobs during this period. Table 3 shows this group grew somewhat faster than projected from 2008 to 2018 (13.9 percent real growth versus 8.7 percent expected growth) and is projected to continue to grow faster than average for 2019 to 2029. Therefore, neither recent data nor BLS projections suggest automation is a serious issue for this group overall, though individual occupations may face greater risks.

Occupations in panel B of table 2, potentially affected by both current and previous waves of computing, account for somewhat more jobs. Jobs in this group grew from 17.9 million (2008) to 18.4 million (2019) but are projected to fall to 18.1 million by 2029. This group's share of all jobs fell from 11.8 percent (2008) to 11.3 percent (2019) and is projected to fall by a similar amount to 10.7 percent by 2029. It is worth noting that the 2008–18 projections anticipated these occupations would account for 11.5 percent of jobs in 2018, and their actual share was very close, 11.4 percent in 2018. These occupations grew more slowly than average over both the 1999–2009 and 2008–18 periods. (See table 3.) The projections anticipate their growth will turn negative for 2019 to 2029, declining by 1.8 percent. For this group, negative forces are expected to dominate offsetting forces like general growth in the population, labor force, and economy. However, the magnitude of the decline is expected to be much less than anticipated in the automation literature, even though growth in these occupations may be affected by both preexisting and newer varieties of computing technologies.

Panel C of table 2 shows jobs in the two groups of occupations, taken together, grew from 31.2 million (2008) to 33.5 million (2019) and are projected to grow to 34.1 million (2029). Their share of all jobs remained essentially flat at 20.7 percent for 2008 and 2019, and the share is projected to decline by 0.4 percentage points by 2029. The similarity between their projected and actual share of jobs in 2018 (20.2 percent versus 20.8 percent) increases one's confidence in the general magnitudes of the projections for 2029 at the aggregate level. The bottom row of table 3 shows the combined group grew 7.5 percent over 2008–18, nearly identical to the projected rate (7.8 percent). This rate is comparable to the 8.5 percent recorded in the OEWS database for the 1999–2009 period and more rapid than the 1.6 percent projected for 2029, which would be somewhat below average relative to projected job growth overall. The next two sections discuss the 27 occupations in these two groups in more detail.

Detailed occupations newly affected by robotics and AI

Reading four key works on automation, one finds 11 occupations used as illustrations whose employment levels were likely to be relatively unaffected by previous waves of computing.[25] Therefore, one can have somewhat greater confidence that recent or projected employment declines for these occupations reflect newer technology, like robotics and AI, exclusively. In contrast to these "pure cases," the next section ("Occupations also affected by previous waves of computing technology") discusses occupations cited by the recent automation literature whose employment levels have likely been affected by prior waves of computing, as well as any effects of robots and AI. For none of the occupations in this section do the employment projections to 2029 or observed changes for the 2008–18 period fit the pattern of large-scale job loss suggested by the automation literature. The only occupation with actual or projected employment declines after 2008 is surgeons. The trend for this occupation–and for others growing at a below-average rate since 2008–is evident in the 1999–2009 period, as well, predating the AI breakthroughs of the early 2010s and therefore likely reflecting other forces (see table 3).

Personal financial advisors

Recent works on automation note that algorithms can provide personalized financial advice.[26] Indeed, BLS projections for 2029 anticipate greater use of "robo-advisors," which have existed since the early 2000s.[27] However, the projections anticipate that the demand for personal financial advisors will continue to increase, more than offsetting the anticipated labor-saving effects of AI-driven advising systems. Indeed, AI may be widening the market by reducing cost of personal financial advice for people who may have been unable to afford human advisors. In this case, AI will augment rather than replace labor, as human workers would not have been hired to serve these clients in the absence of AI.[28] The projected 10-year growth will remain slightly above average (4.4 percent) but will not be close to the rapid 30-percent growth in both projections and reality for the 2008–18 period and the 87-percent growth recorded in the OEWS database for 1999 to 2009. Part of the growth in prior years reflected increases in the population engaging in retirement planning. Further research would be required to understand whether robo-advisors and other information technology account for a significant portion of the slowdown in growth since 2009.[29]

Interpreters and translators

The development of machine translation is one of the most remarkable achievements of AI in the past 20 years. Combined with speech recognition and speech generation capabilities, translation software may substitute for human translators of both written text and real-time conversations and presentations.[30] Nevertheless, projections to 2029 anticipate a 20-percent increase in jobs within this occupation as many businesses increasingly need translation services because of globalization. This would still represent deceleration compared with the 49.4-percent growth from 2008 to 2018, which itself was underestimated in the projections (22.2 percent), and the tripling recorded by the OEWS database in this small occupation from 1999 to 2009.

Surgeons, except ophthalmologists

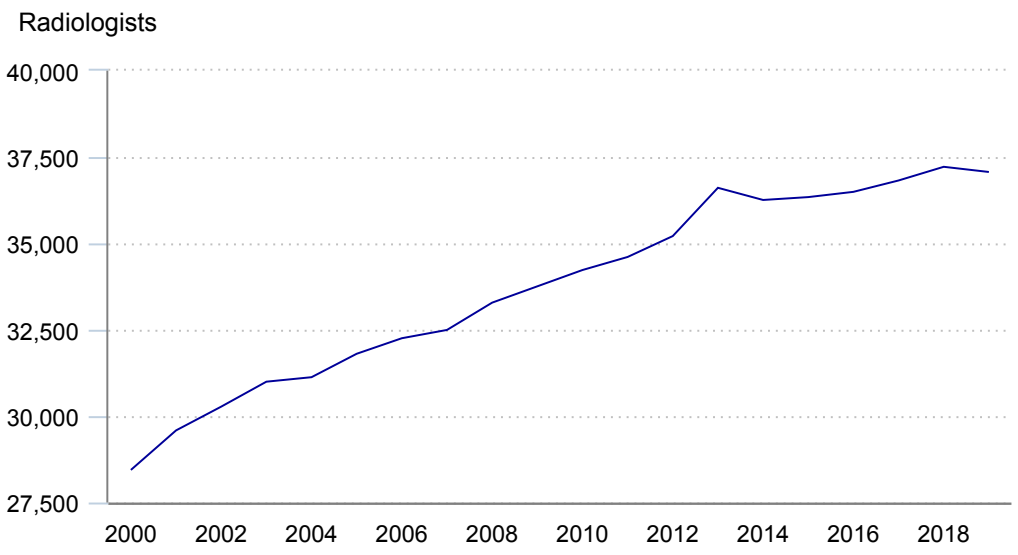
Surgical robots have received significant attention.[31] Although some discuss them in the same context as industrial robots, suggesting they will substitute for nonroutine manual tasks performed by humans , others concede they are more likely to augment rather than replace human surgeons.[32] A recent systematic review did not find clear advantages of robotic over conventional surgery despite greater cost and length of operations, though the technology may improve in the future.[33] BLS projects the number of surgeon jobs will decline by 2 percent between 2019 and 2029, a significant moderation compared with the 30-percent decline from 2008 to 2018, which was probably not due to robot adoption, and a marked departure from the 17-percent increase that had been projected for the 2008–18 period. The OEWS also recorded a decline from 1999 to 2009 (−8.0 percent) despite the robust increase in jobs overall during this period.

Radiologists

Many consider radiology to be a clear case of a highly skilled white-collar occupation facing serious competition from deep-learning-based AI because of breakthroughs in image recognition after 2010 .[34] Numerous research papers show AI performance in automated image interpretation meets or exceeds those of radiologists and other medical professionals, generating considerable anxiety within these specialties.[35] Some believe automated medical image reading will change the task content of radiology jobs but not greatly reduce employment.[36] However, in 2016, Geoffrey Hinton, considered the father of deep learning and modern AI, said he thought the outlook for radiology jobs in the next 5 to 10 years was quite negative.[37] Likewise, a paper in a leading radiology publication agreed that "machine learning will become a powerful force in radiology in the next 5 to 10 years [2021–26], not in multiple decades…. Indeed, in a few years there may be no specialty called radiology."[38]

BLS does not track the number of radiology jobs specifically, but the American Medical Association has tracked employment and major professional activity for all physicians and numerous medical specialties over time. According to these data, the total number of physicians whose main activity was patient care increased from 647,430 in 2000 to 870,264 in 2019, nearly 16.8-percent growth per decade. The number of radiologists whose main activity was patient care increased from 28,444 in 2000 to 37,068 in 2019, or by 15.0 percent per decade, as shown in chart 2. This makes radiologists a small occupation by the standards of the previous section. Radiologists as a share of all physicians fluctuated between 4.40 and 4.50 percent for almost all years between 2000 and 2014, then decreased to 4.26 percent by 2019, shown in chart 3. Understanding the reasons for the relative decline would require further study, but it is both rather gradual and offset by the overall expansion in healthcare such that the absolute number of radiologists has not declined appreciably.[39] Clearly, predictions of rapid labor substitution by AI are unlikely to be realized. Nevertheless, projections prepared for the Association of American Medical Colleges make passing reference to model predictions of a declining demand for radiologists between 2019 and 2034, without mentioning any estimated magnitude.[40] Those projections are based on demographic changes and current treatment rates by group and do not take technological change into account.

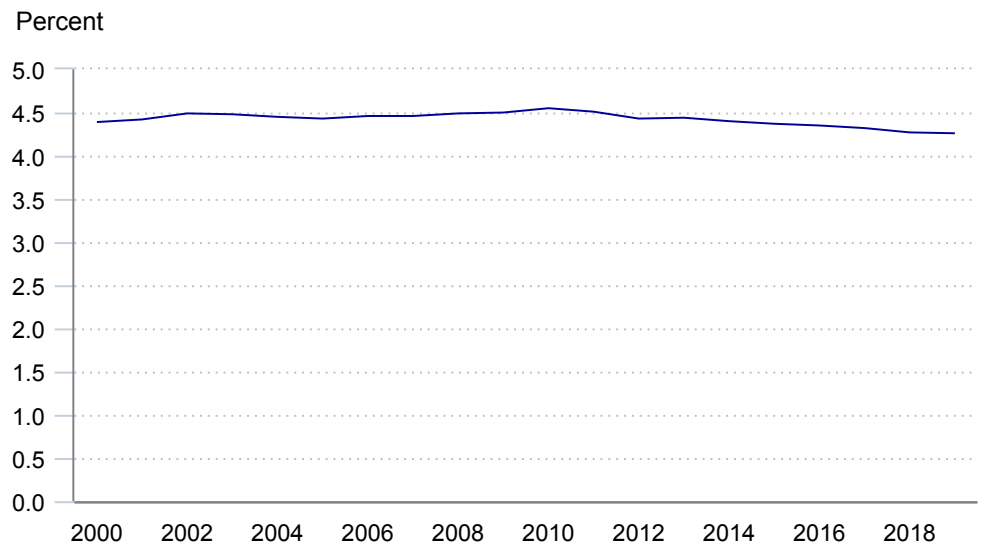
Chart 2. Total number of radiologists mainly providing patient care, 2000–19



Hover over chart to view data.
Source: American Medical Association.

View Chart Data

Chart 3. Radiologists as a percentage of all physicians, 2000–19



Hover over chart to view data.
Source: American Medical Association.

View Chart Data

It is important to recognize that trends in demand for radiologists are strongly affected by imaging reimbursement policies, population aging, and radiologists' retirement rates.[41] In addition, the practice of radiology involves a wide variety of complex diagnostic and related tasks. How rapidly AI can scale to substitute for an appreciable number of those myriad tasks and any new ones that result from medical progress is an empirical question, but the process is likely to be gradual and far from realized by 2026.[42]

Fast food and counter workers

In 2012, a San Francisco startup demonstrated a fully automatic machine for making hamburgers that purportedly produced 350 complete burgers per hour and would pay for itself in under 1 year of operation. These and similar robotic food preparation machines prompted some to consider that fast food employment could be cut by 25–50 percent by 2030, or some similar date.[43] However, BLS projections to 2029 foresee 11.4-percent growth in this occupation, following nearly 30-percent increase for the 2008–18 period and 35-percent growth for the 1999–2009 period. The projections for the 2008–18 period (13.7 percent) underestimated actual growth considerably, so it will be interesting to see whether this occupation also grows faster than projected for the 2019–29 period.

Janitors and cleaners, and maids and housekeeping cleaners

The first robot vacuum cleaners were introduced in 2002, and their mapping and navigation software has grown much more sophisticated over time. Their early introduction provides a long timeframe to test the idea that even automation substituting for only some of an occupation's component tasks will reduce the size of the occupation proportionately. More recently, robotic commercial floor cleaners have appeared, and such cleaning tasks are considered ripe for further substitution by robots.[44] Both janitors and maids and housekeepers are quite large occupations. (See table 2 and chart A-1 in the appendix.) However, janitor jobs are projected to increase by 4.4 percent from 2019 to 2029, roughly in line with their modest growth rates since 1999. The number of maids and housekeepers have contracted modestly over time. The OEWS series used for the 1999–2009 period includes only wage and salary workers, while projections and observed data for the 2008–18 period and the 2019–29 period also include the self-employed, which increases the number of maids and housekeepers by more than two-thirds when comparing figures for 2008 and 2009. As such, comparisons across data series should not be made for this occupation. However, the projections show the total number of maids and housekeepers declined by less than 0.3 percent between 2008 and 2018, despite 16 years of robot vacuum sales, and a similar decline is projected for the 2019–29 period. Although private households have long sought relief from the task of vacuuming, which accounts for a meaningful share of work time for maids and housekeepers, the availability of robot vacuums does not seem to have made large inroads into the number of jobs in this occupation and is not expected to do so by 2029.

Landscaping and groundskeeping workers

Robot lawn mowers that work without a human operator have attracted attention for years and have been cited as putting jobs at risk.[45] However, one leading roboticist, the cocreator of the robotic vacuum cleaner, is skeptical that they can be easily adapted for work on commercial properties.[46] BLS projects that jobs in this occupation will increase 10 percent from 2019 to 2029, though employment was flat from 2008 to 2018, when projections anticipated 18-percent growth, in contrast to the 16.3-percent growth recorded in the OEWS database for 1999 to 2009.

Heavy and tractor-trailer truck drivers

Driverless trucks have often been seen as the most likely near-term application of self-driving vehicles , though other writers on automation are more cautious about the ability of the technology to dispense with drivers entirely.[47] Jobs in this occupation are projected to increase 1.5 percent between 2019 and 2029, which, while representing a slowdown from 2008 to 2018 (8.9 percent), is more rapid than the 0.5 percent decrease recorded in the OEWS database for 1999 to 2009.

Industrial truck and tractor operators

Forklifts and other material-moving vehicles and carts represent another application of mobile robotic technology.[48] However, industrial truck and tractor operators jobs are projected to remain stable between 2019 and 2029, continuing a pattern observed at least as far back as 1999, perhaps partly reflecting the growth in e-commerce.

Laborers and freight, stock, and material movers, hand

Increased use of robots in warehouse operations might be expected to reduce the number of stock-handling jobs.[49] However, projections anticipate the occupation will grow 4.2 percent between 2019 and 2029, a slowdown from the remarkable 27.5-percent growth over the 2008–18 period that may have reflected the growth of e-commerce. However, the projections for the 2008–18 period proved much too pessimistic (−0.8 percent), so more robust growth than projected for the 2019–29 period is possible. In any case, the projected growth for 2029 is comparable to the growth recorded in the OEWS database for the 1999–2009 period (4.9 percent).

Occupations also affected by previous waves of computing technology

Seventeen occupations used as examples in the recent automation literature have been affected by prior waves of computing technology, in addition to any effects from innovative robots and AI (see table 3, bottom panel). Therefore, recent and projected trends in employment in these occupations may reflect the continuing effects of previous waves of computing whose ultimate impact is not yet fully realized. Fourteen of these occupations are projected to decline or grow by at least half a percentage point below average from 2019 to 2029. Eleven of these 17 occupations declined between 2008 and 2018, and 7 also declined between 1999 and 2009. Clearly, the occupations exposed to prior waves of computing have more consistently negative employment trends and projected trends than the occupations more plausibly affected only by recent advances in AI and robotics.

Loan officers

Recent research on automation notes that traditional algorithms threaten to automate the mortgage origination tasks of loan officers.[50] Projections anticipate modest growth (3.2 percent) to 2029, though the slight decline during the 2008–18 period (−3.2 percent) was not anticipated by the projections (10.1 percent), so it would not be surprising if future growth were modestly negative, as well. By contrast, the OEWS database registered robust growth (49.0 percent) from 1999 to 2009.

Tax preparers

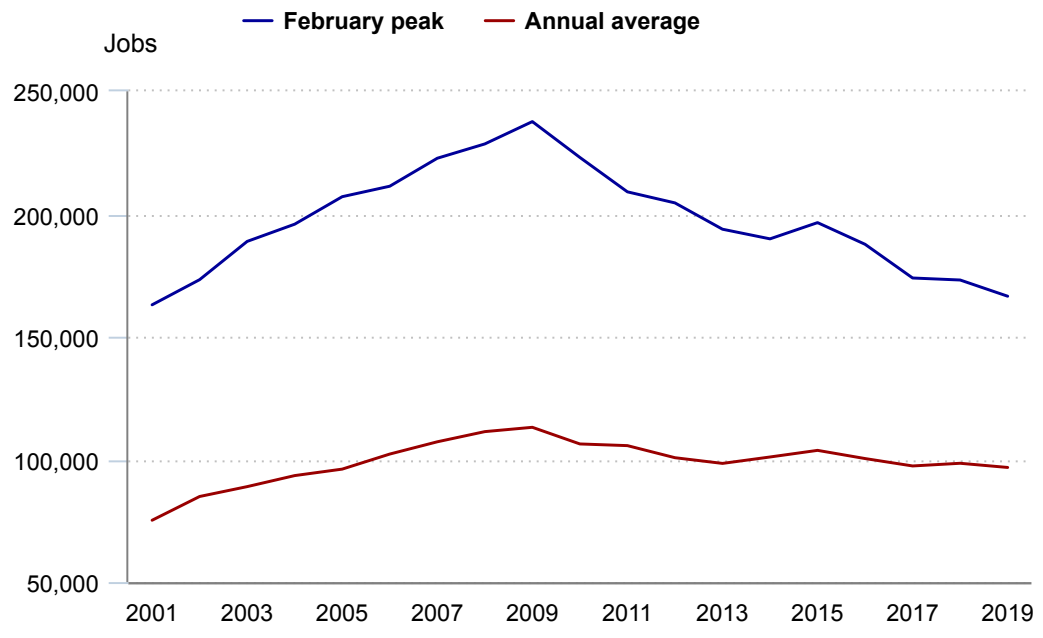
Recent writing cites tax preparers as affected negatively by the ready availability of tax preparation software packages, as well as offshoring.[51] These software packages may use an earlier, rule-based form of AI called expert systems. The BLS projections anticipate this occupation will decline by 0.6 percent by 2029, though the decline for the 2008–18 period (−9.7 percent) was not anticipated by the projections for that period (2.9 percent). Nevertheless, this occupation grew 5.2 percent from 1999 to 2009, despite the general availability of tax software during that period.

One source credits the leading tax program with putting many jobs at risk by "allowing a machine to do the jobs of hundreds of thousands of human tax preparers."[52] However, the total number of dedicated tax preparer jobs never reached 100,000 according to available occupation statistics. The occupation grew from 69,000 in 2000 to 96,000 in 2008, then declined by 9,300 jobs to 87,000 jobs in 2018.[53] (See tables 2 and 3.)

In fact, high rates of part-year and part-time work make determining the exact number of tax preparers rather complicated. Every year, jobs in the tax preparation services industry peak in February and decline 70–80 percent by July or August.[54] The OEWS data will miss the peak because the program gathers data in May and November. The Quarterly Census of Employment and Wages, which is the source of the figures just cited, collects data each month, but only captures jobs by industry, not by occupation. However, if the core occupation were at risk from expert systems software, it may be reasonable to consider much of the rest of the industry vulnerable as well. Chart 4 shows trends in the tax preparation industry's employment for 2001 to 2019 using both February and annual average figures.[55] Both series show jobs growing from 2001 to 2009 before falling back to levels similar to those in 2001 by 2019, though the downward trend is much more modest for the annual average. Whether this decrease is merely a return to prior levels or the first stage of a long-

run decline remains to be seen. Some fraction of accountants also engages in tax preparation, but job and task variety within that occupation would be expected to buffer the employment effects of tax software within the occupation.

Chart 4. Employment trends in tax preparation services (North American Industry Classification System 54-1213), February peak and annual average



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

View Chart Data

Computer programmers

There have been previous efforts to automate aspects of software production, such as the development of computer-aided software engineering tools. Although some current writing on automation believes algorithms are likely to replace human programmers , others consider this to be a more distant prospect or even less likely.[56] Artificial intelligence has been used to create programs that can automatically write computer code in response to plain-language requests, but the code often fails or requires modifications by humans, limiting potential use.[57] Information technology occupations have tended to grow strongly despite the growth of automation and software tools, and current projections anticipate they will continue to do so. One exception is the computer programmer occupation, which is projected to decline by 9.4 percent from 2019 to 2029. However, BLS projections research attributes this mostly to offshoring. The projected magnitude may be an underestimate given the actual decline for the 2008–18 period (−41.3 percent) was far greater than projected (−3 percent), despite a similar decline registered in the OEWS database from 1999 to 2009 (−30.4 percent). Nevertheless, the importance of offshoring complicates any effort to attribute the declining number of jobs in this occupation to automation or AI.

Lawyers and paralegals and legal assistants

Lawyers and paralegals have been affected by a form of offshoring known as legal process outsourcing, as well as by cost-cutting pressures during and after the financial crisis of 2007–08.[58] However, the increased ability of AI software to process troves of electronic documents has led to suggestions that tasks performed by lawyers, paralegals, and related occupations may be under much greater threat from future automation.[59] By contrast, Professors Dana Remus and Frank Levy find lawyers' tasks are much more diverse than recognized in these writings, and only about 4 percent of billed hours are spent on document review, which is the only task strongly susceptible to automation.[60] Consistent with this view of modest task substitution, BLS projects jobs will increase 4.0 percent for lawyers and 10.4 percent for paralegals between 2019 and 2029, though, again, this represents a slowdown for both groups relative to the 2008–18 period (8.5 percent and 13.7 percent) and even more so compared with rates recorded in the OEWS database for the 1999–2009 period (13.0 percent and 26.3 percent). Although the projections anticipate paralegals will take on more of the tasks previously assigned to legal secretaries and entry-level attorneys, BLS research economists do not consider technology to be a major driver of employment growth for these occupations.

News analysts, reporters, journalists and public relations specialists

Even more than legal occupations, journalist jobs have been changed by prior technology, most notably the internet and social media, which have led to declining readership and lower advertising revenue for many long-established news outlets. However, AI is now being used to compose simple news stories, corporate earnings reports, and similar reading matter, potentially reducing the need for journalists and public relations personnel.[61] The projections anticipate news-related jobs will decline by 11.2 percent between 2019 and 2029, although this decline would be more moderate than the declines for the 2008–18 period (−28.3 percent) and recorded in the OEWS database for the 1999–2009 period (−19.6 percent). However, the decline for 2008–18 was much greater than projected (−6.3 percent), so it is possible that the projected decline for 2029 is also an underestimate.

By contrast, the number of public relations specialists is projected to grow more than 7 percent between 2019 and 2029. Comparable figures are not available for 2008 to 2018, but the occupation grew much faster from 1999 to 2009, more than doubling according to the OEWS database. Nevertheless, this occupation is likely an example in which AI may automate certain tasks, like composing certain kinds of press releases, without substituting for enough tasks within the occupation to meaningfully decrease employment.

First-line supervisors of retail sales workers, retail salespersons, counter and rental clerks, and cashiers

Occupations in retail have been cited as vulnerable in recent work on automation.[62] The projections for 2019–29 agree that retail jobs are likely to decline. However, prior technologies, such as e-commerce and mobile apps, are likely to be more important than AI and robotics.[63] Projections research finds cashiers are also likely to decline because of greater use of self-checkout, mobile payments, and the bundling of checkout tasks into retail salespersons' jobs, none of which rely heavily on AI. Cashiers are projected to decline by 7.4 percent between 2019 and 2029 after growing by 2.8 percent (2008–18) and 8.8 percent (1999–2009). Jobs for retail salespersons and counter and rental clerks are projected to be flat, continuing the trend from 2008–18, while the number of first-line retail supervisors is expected to decline modestly (−5.5 percent), continuing a trend visible since 1999.

Customer service representatives and telemarketers

Telemarketers and customer service representatives (CSR) have been replaced or supplemented with interactive voice response systems that can present callers or listeners with a preprogrammed set of options and, in some cases, interpret human speech and respond flexibly to queries in a limited fashion. Some see these jobs as vulnerable to replacement as artificial intelligence improves while others view customer service jobs as less amenable to automation because customer queries make tasks unpredictable .[64] In fact, CSR jobs are projected to remain stable, after growing by 32 percent (2008–18) and 23 percent (1999–2009), despite marked increases in the offshoring of CSR jobs over time. Projections research finds telemarketing jobs are more threatened by increased use of digital marketing than AI. Telemarketing jobs are anticipated to fall 14.2 percent over 2019–29, which may be optimistic given previous declines of 51 percent (2008–18) and 37 percent (1999–2009), which projections research attributed mostly to the increased use of digital marketing than AI. Telemarketing jobs are anticipated to fall 14.2 percent over 2019–29, which may be optimistic given previous declines of 51 percent (2008–18) and 37 percent (1999–2009), which projections research attributed mostly to the increased use of "do not call" registries and caller ID functions on telephones, rather than automation.

Stockers and order fillers

As e-commerce has increased the need for efficient warehouses, efforts to automate warehouse operations have grown. Advances in warehouse robotics have received particular attention, but the focus on technological substitution usually does not account for the scale effects of e-commerce expansion.[65] In addition, only about 20 percent of stockers and order fillers are employed in the warehouse and storage industry, in which the introduction of robots is furthest along. As such, this may be another example in which job diversity within an occupation limits the potential for technological substitution.[66] BLS projects this occupation will grow 0.7 percent between 2019 and 2029, much less than the 10.6-percent growth between 2008 and 2018 (which was close to the projected value of 7.2 percent), and also less than the more modest 3.5-percent growth in the OEWS between 1999 and 2009. The projection of stable employment to 2029 reflects the combined effects of labor substitution due to various technologies (automated order-taking systems and automated storage and retrieval equipment based on sensors, bar codes, and radio frequency identification) and the growth of labor demand for tasks that technology cannot replace, a scale effect. Many of the computing technologies, as well as e-commerce itself, predate the recent wave of mobile robotics and machine learning, so there is some element of technological continuity in this case. Given the continued expansion of e-commerce, occupational employment trends in this sector may be a race between increasing technological capabilities and increasing demand for the industry's output.

Reservation/transportation ticket agents

Many of the functions of this occupation have been replaced by websites.[67] The projections anticipate ticket agent jobs will drop nearly 3 percent from 2019 to 2029, which would represent significant moderation of the 20.5-percent decline from 2008 to 2018. However, the projections for 2008–18 anticipated job growth (8.1 percent), so there may be similar issues with the projections to 2029. Nevertheless, the decline from 2008 to 2018 was more moderate than the decline from 1999 to 2009 (−35.9 percent), so there is no evidence of accelerated job loss either.

Farmworkers and agricultural equipment operators

A number of agricultural robots are dexterous enough to milk cows, apply fertilizers and pesticides, prune grape vines, and harvest oranges, strawberries, and almonds.[68] However, farm jobs have been declining for many decades, so the extension of machines to fine motor tasks such as picking fruits and vegetables would represent a kind of handoff between older and newer technologies, rather than an entirely new area in which technology substitutes for labor. Nevertheless, this group of occupations is projected to grow by 1.0 percent between 2019 and 2029, after having grown more than 9.0 percent from 2008 to 2018, despite projections of 2.4-percent decline. According to the BLS projections research, this is because the effect of further mechanization, which reduces labor demand, is expected to be more than offset by increases in production, a scale effect. For table 2 and table 3, this group also includes agricultural equipment operators, who are projected to grow, in order to capture slightly offsetting job growth due to increased technology use in these work settings. The OEWS database recorded 8.9-percent growth for this occupation from 1999 to 2009, but the OEWS database excludes most agriculture-related industries so comparisons between the two series are inappropriate for this sector.

Welders

Welding was one of the earliest applications of industrial robotics and remains one of the most common uses of commercial robots.[69] However, after declining nearly 17 percent between 1999 and 2009, the number of welders remained relatively flat over 2008–18, consistent with projections. The projections for 2019–29 also anticipate little change.

Occupations losing the most jobs, 2008–18

The previous sections examined employment trends in occupations selected because of their presumed vulnerability to new automation technologies. By contrast, this section begins with the occupations that have experienced the largest job losses and discusses the technologies that may be responsible for their decline.

Table 4 is based on the same 669 occupations in the OEWS database as table 1. The top row shows that employment in these occupations increased 17 percent over the 19-year period, 1999 to 2018. Among 238 occupations that experienced large losses (greater than 5 percent) between 1999 and 2018, the total number of jobs declined by 8.5 million, or 31 percent, over 19 years (row 2). Relative to all jobs in 1999, this represents a loss of 7.4 percent. Because the number of jobs increased overall, retaining the jobs that were lost would have increased the total in 2018 by somewhat less (6.4 percent). Both figures are many times smaller than the widely cited 47-percent job loss envisioned for the 2010–30 period, despite reflecting other forces, such as trade and offshoring, in addition to technological change. In addition, the losses were more than offset by job gains elsewhere, as the total number of jobs increased by more than 19 million between 1999 and 2018, implying the other occupations gained more than 28 million jobs.

Table 4. Top 30 detailed occupations losing jobs, 1999–2018

SOC code	Title	1999	2018	Change	Percent change
[1]	All occupations	114,728,000	134,219,408	19,491,408	17.0
[1]	Occupations losing more than 5 percent of jobs	27,403,670	18,856,440	-8,547,230	-31.2
[1]	Occupations losing more than 45 percent of jobs	7,032,300	2,651,060	-4,381,240	-62.3
43-9021	Data entry keyers	520,220	174,930	-345,290	-66.4
41-9041	Telemarketers	485,650	164,160	-321,490	-66.2
15-1021	Computer programmers	528,600	230,470	-298,130	-56.4
51-6031	Sewing machine operators	403,770	136,450	-267,320	-66.2
43-9022	Word processors and typists	271,310	53,130	-218,180	-80.4
43-4151	Order clerks	376,430	159,210	-217,220	-57.7
43-2011	Switchboard operators	248,570	71,600	-176,970	-71.2
51-4031	Cutting, punching, press machine setters/operators	353,300	186,640	-166,660	-47.2
43-9011	Computer operators	198,500	34,700	-163,800	-82.5
43-4071	File clerks	266,890	110,020	-156,870	-58.8
43-5053	Postal service mail sorters, processors, operators	234,820	103,830	-130,990	-55.8
17-3023	Electrical and electronic engineering technicians	242,160	126,950	-115,210	-47.6
43-9051	Mail clerks and mail machine operators, except postal	198,440	86,150	-112,290	-56.6
53-7063	Machine feeders and offbearers	176,400	66,380	-110,020	-62.4
47-2211	Sheet metal workers	231,690	131,570	-100,120	-43.2
51-5022	Prepress technicians and workers	109,350	29,990	-79,360	-72.6
51-4032	Drilling and boring machine tool setters/operators	75,140	11,400	-63,740	-84.8
51-9151	Photographic process workers/machine operators	76,440	16,680	-59,760	-78.2
51-4111	Tool and die makers	132,350	72,700	-59,650	-45.1
43-5021	Couriers and messengers	134,370	75,720	-58,650	-43.6
51-6063	Textile knitting/weaving machine setters/operators/tenders	79,440	21,190	-58,250	-73.3
51-4033	Grinding/lapping/polishing/buffing machine tool setters/operators/tenders	127,920	71,870	-56,050	-43.8
51-6021	Pressers, textile, garment, and related materials	93,320	38,320	-55,000	-58.9
51-4034	Lathe and turning machine tool setters/operators/tenders	83,940	29,510	-54,430	-64.8
43-4041	Credit authorizers, checkers, and clerks	82,900	29,980	-52,920	-63.8
43-9071	Office machine operators, except computer	101,490	48,580	-52,910	-52.1
51-6064	Textile winding, twisting, and drawing out machine setters/operators/tenders	83,360	31,650	-51,710	-62.0
43-2021	Telephone operators	50,820	5,160	-45,660	-89.8
51-2021	Coil winders, tapers, and finishers	56,350	12,190	-44,160	-78.4
31-9094	Medical transcriptionists	97,260	53,730	-43,530	-44.8
Total	[1]	**6,121,200**	**2,384,860**	**-3,736,340**	[1]

Note:
[1] Not applicable.
SOC = Standard Occupational Classification system. There are 669 occupations that could be tracked consistently over 1999–2018. There were 248 occupations that lost more than 5 percent of jobs and 84 occupations that lost more than 45 percent of jobs. Occupations known or believed to have declined because of changes in coding practices are excluded from the table. The final column is percent change for 1999–2018. All occupation codes are from SOC 2000, except SOC 51-9151 (photographic process workers), which harmonizes occupational categories across classification systems to the SOC 2010 value. Values in the bottom row are column totals. Between 1999 and 2018, the total number of jobs in these 30 occupations declined by 61.0 percent.
Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics 1999–2018.

There is a much smaller group of 81 occupations whose employment declined by more than 45 percent between 1999 and 2018, equivalent to a 47-percent drop over two decades. The total number of jobs in this group decreased by more than 62 percent (table 4, row 3). However, the 4.4 million jobs lost represent only 3.8 percent of all jobs in 1999 and would have added only 3.3 percent to the total in 2018 had they not been lost. Even though the percent losses within these occupations were similar to those foreseen in the recent automation literature, they were quite atypical, so their effect on overall employment was much smaller than the magnitude of their decline might suggest. This is not intended to minimize the number of jobs lost, the hardships experienced by workers affected by them, or the implications of the changing occupational composition for inequality and economic opportunity more generally. However, the incidence of these dramatic declines is more than an order of magnitude smaller than the 47-percent potential job losses commonly cited in the automation literature. One can find particular occupations that experienced dramatic job losses, but they do not generalize to the broader workforce, even during the first decade of the new wave of robotics and AI. The future would have to diverge dramatically from past patterns for job losses overall to reach 47 percent over 20 years.

Table 4 shows the 30 detailed occupations that lost the largest absolute number of jobs between 1999 and 2018, in descending order.[70] Except for four occupations that each declined nearly 45 percent, this group is a subset of the 81 occupations discussed above. This group accounts for 81 percent of jobs in occupations experiencing large percent drops. The total number of jobs in this group decreased 61 percent over 20 years. These occupations are notable for the apparent influence of previous waves of computing technologies (for example, those used for data entry keyers, word processors, file clerks, switchboard operators) and previous waves of mechanical technologies (for example, those used by sewing machine operators, mail sorters), as well as possible effects of trade and offshoring. The large decline in sewing machine operators reflects the continuation of a decades-long trend, while the large decline in word processors and data entry keyers reflects the ongoing effects of the microcomputer revolution beginning in the early 1980s and subsequent growth of digital

data capture. Although the newest technologies attract the greatest attention, most of the major contractions appear to reflect long-run implications of more established technologies, whose full effects unfold over many decades. In terms of overall magnitude, even these reductions represent a 20-year loss of only about 2.5 percent of jobs, whether calculated with 1999 or 2018 totals as the base value.

High-technology occupations

Finally, consideration of the new technology raises the question of the jobs they create, as well as replace. Tables 5 and 6 show trends in science, technology, engineering, and mathematics-related (STEM) jobs. The projections anticipate that computer-related jobs will increase 11.5 percent between 2019 and 2029. However, this may be an underestimate, given growth rates around 30 percent between 1999 and 2018, which were somewhat underprojected for the 2008–18 period. Math-related occupations have grown even faster and are projected to continue to do so for the 2019–29 period, but this group is only about one-twentieth the size of the ICT occupational group. The most notable developments include the near doubling of statistician jobs from 2008 to 2018 and the emergence of data scientist as a recognized occupation. It seems likely that these trends reflect the increasing need for workers in fields like machine learning and data analytics. Some of these jobs produce the software whose potential to replace other kinds of labor have prompted recent concerns. Nevertheless, these two occupations together accounted for only 76,000 jobs in 2019 and were projected to grow to 101,000 jobs by 2029. Other STEM occupations experienced even weaker performance, lagging overall job growth between 2008 and 2018 and projected to continue to do so between 2019 and 2029.

Table 5. Trends in size of STEM occupations (in thousands of jobs)

SOC code	Title	OEWS		Projections database				
		1999	2009	2008	2018p	2018	2019	2029p
ICT occupations								
15-1251	Computer programmers	528.6	367.9	426.7	414.4	250.3	213.9	193.8
15-1232	Computer user support specialists	462.8	540.6	565.7	643.7	671.8	687.2	741.9
15-1221	Computer and information research scientists	26.3	26.1	28.9	35.9	31.7	32.7	37.7
15-1245	Database administrators and architects	101.5	108.1	120.4	144.7	116.9	132.5	145.3
15-1098 [2]	Combination (15-1051, 15-1071, 15-1081)	731.2	1,077.7	1,163.7	1,506.5	1,641.2	[1]	[1]
15-1211	Computer systems analysts	[1]	[1]	[1]	[1]	[1]	632.4	679.0
15-1212	Information security analysts	[1]	[1]	[1]	[1]	[1]	131.0	171.9
15-1231	Computer network support specialists	[1]	[1]	[1]	[1]	[1]	195.1	207.7
15-1241	Computer network architects	[1]	[1]	[1]	[1]	[1]	160.1	168.1
15-1244	Network and computer systems administrators	[1]	[1]	[1]	[1]	[1]	373.9	389.9
15-1031 [2]	Software engineers, applications	287.6	495.5	514.8	689.9	944.2	[1]	[1]
15-1032 [2]	Software engineers, systems software	209.0	385.2	394.8	515.0	421.3	[1]	[1]
15-1256	Software developers and quality assurance	[1]	[1]	[1]	[1]	[1]	1,469.2	1,785.2
15-1257	Web developers and digital interface designers	[1]	[1]	[1]	[1]	[1]	174.3	188.3
15-1299	Computer occupations, all other	[1]	[1]	209.3	236.8	412.8	431.1	455.8
[1]	**Subtotal**	**2,347.0**	**3,001.0**	**3,424.3**	**4,187.0**	**4,490.2**	**4,633.4**	**5,164.6**
Mathematics and statistical occupations								
15-2011	Actuaries	12.6	17.9	19.7	23.9	25.0	27.7	32.6
15-2021	Mathematicians	3.5	2.8	2.9	3.6	2.9	2.9	3.0
15-2031	Operations research analysts	43.8	61.0	63.0	76.9	109.7	105.1	131.3
15-2041	Statisticians	14.6	21.4	22.6	25.5	44.4	42.7	57.5
15-2098	Data scientists and math occupations, all other	[1]	[1]	[1]	[1]	[1]	33.2	43.4
15-2090	Miscellaneous mathematical occupations	[1]	[1]	7.8	9.1	2.3	[1]	[1]
[1]	**Subtotal**	**74.4**	**103.0**	**116.1**	**139.1**	**184.3**	**211.6**	**267.8**
All other STEM (excluding social scientists, 19-3000)								
17, 19	Architecture, engineering, life, physical sciences	2,515.1	2,868.4	3,526.5	3,953.8	3,667.9	3,822.5	3,949.1
[1]	**Total**	**4,936.5**	**5,972.5**	**7,066.9**	**8,279.9**	**8,342.4**	**8,667.5**	**9,381.5**

Note:
[1] Not applicable.
[2] This occupation code is specific to a particular period.
SOC = Standard Occupational Classification system; OEWS = Occupational Employment and Wage Statistics; STEM = science, technology, engineering, and mathematics; ICT = information and communications technology; and p = projected value. All occupation codes are from SOC 2010, except those indicated by note 2. In some cases, identical titles may refer to different occupational definitions across periods (one example is: computer occupations, all other).
Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics 1999-2009 and occupational projections files for 2008-18 and 2019-29.

Table 6. Trends in size of STEM occupations, absolute and percent change

SOC code	Title	Absolute change (in thousands)				Percent change			
		1999–2009	2008–18p	2008–18	2019–29p	1999–2009	2008–18p	2008–18	2019–29p
ICT occupations									
15-1251	Computer programmers	-160.7	-12.3	-176.4	-20.1	-30.4	-2.9	-41.3	-9.4
15-1232	Computer user support specialists	77.7	78.0	106.1	54.7	16.8	13.8	18.8	8.0
15-1221	Computer and information research scientists	-0.2	7.0	2.8	5.0	-0.6	24.2	9.7	15.3
15-1245	Database administrators and architects	6.6	24.4	-3.5	12.8	6.5	20.3	-2.9	9.7
15-1098 [2]	Combination (15-1051, 15-1071, 15-1081)	346.5	342.8	477.5	[1]	47.4	29.5	41.0	[1]
15-1211	Computer systems analysts	[1]	[1]	[1]	46.6	[1]	[1]	[1]	7.4
15-1212	Information security analysts	[1]	[1]	[1]	40.9	[1]	[1]	[1]	31.2
15-1231	Computer network support specialists	[1]	[1]	[1]	12.6	[1]	[1]	[1]	6.5
15-1241	Computer network architects	[1]	[1]	[1]	8.0	[1]	[1]	[1]	5.0
15-1244	Network and computer systems administrators	[1]	[1]	[1]	16.0	[1]	[1]	[1]	4.3
15-1031 [2]	Software engineers, applications	207.9	175.1	429.4	[1]	72.3	34.0	83.4	[1]
15-1032 [2]	Software engineers, systems software	176.2	120.2	26.5	[1]	84.3	30.4	6.7	[1]
15-1256	Software developers and quality assurance	[1]	[1]	[1]	316.0	[1]	[1]	[1]	21.5
15-1257	Web developers and digital interface designers	[1]	[1]	[1]	14.0	[1]	[1]	[1]	8.0
15-1299	Computer occupations, all other	[1]	27.5	203.4	24.7	[1]	13.1	97.2	5.7
[1]	**Subtotal**	**654.0**	**762.7**	**1,065.9**	**531.2**	**27.9**	**22.3**	**31.1**	**11.5**
Mathematics and statistical occupations									
15-2011	Actuaries	5.4	4.2	5.3	4.9	42.8	21.4	26.8	17.7
15-2021	Mathematicians	-0.7	0.7	-0.1	0.1	-19.7	22.5	-1.9	3.4
15-2031	Operations research analysts	17.2	13.9	46.7	26.2	39.3	22.0	74.1	24.9
15-2041	Statisticians	6.8	2.9	21.8	14.8	46.2	13.1	96.7	34.7
15-2098	Data scientists, math occupations, all other	[1]	[1]	[1]	10.2	[1]	[1]	[1]	30.7
15-2090	Miscellaneous mathematical occupations	[1]	1.3	-5.5	[1]	[1]	16.2	-70.7	[1]
[1]	**Subtotal**	**28.7**	**23.0**	**68.2**	**56.2**	**38.5**	**19.8**	**58.7**	**26.6**
All other STEM (excluding social scientists, 19-3000)									
17, 19	Architecture, engineer, life, physical sciences	353.4	427.3	141.4	126.6	14.0	12.1	4.0	3.3
[1]	**Total**	**1,036.0**	**1,213.0**	**1,275.5**	**714.0**	**21.0**	**17.2**	**18.0**	**8.2**

Note:

[1] Not applicable.

[2] This occupation code is specific to a particular period.

SOC = Standard Occupational Classification system; STEM = science, technology, engineering, and math; ICT = information and communications technology; and p = projected value. All occupation codes are from SOC 2010, except those indicated by note 2. In some cases, identical titles may refer to different occupational definitions across periods (one example is: computer occupations, all other).

Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics 1999-2009 and occupational projections files for 2008-18 and 2019-29.

Conclusion

Numerous observers believe recent developments in robotics and AI may cause an unprecedented wave of automation-related job losses. In this view, the new technology is fundamentally different from earlier waves of computing technology because it improves at an accelerating rate and substitutes for a much wider range of job tasks. A widely cited scenario estimates that 47 percent of jobs are susceptible to automation between 2010 and 2030, implying a decisive break with previous rates of occupational growth and decline. As part of this argument, proponents have cited 28 detailed occupations as notably susceptible to job loss due to new technology. However, these occupations did not exhibit any general tendency toward notably rapid job loss in the first half of this period (2008–18) and are not projected to experience such losses in the second half (2019–29). Occupations that did decline were mostly those that were vulnerable to previous waves of computing technology and other trends, such as offshoring, rather than occupations newly susceptible to automation due to AI and advanced robotics. Actual job losses within these occupations for 2008–18 and the losses projected for 2019–29 often exhibit continuity with previous trends dating to 1999–2009 and are generally within the range of typical growth rates observed for all occupations for 1999–2018. This points to the importance of carefully distinguishing the effects of different generations of computing technology in any discussion of individual cases and overall trends. In general, most occupations are small, few decline by 30 percent or more over 10 years, and those that do so account for a small share of the total number of jobs. Although the performance of the 2008–18 projections with respect to these occupations taken individually was varied, the projections' performance was strong for the group overall. The performance of the 2008–18 projections provides no reason to suppose that the projections to 2029, which also foresee gradual changes rather than a break with previous trends, systematically underestimate future job losses.

Even among the occupations cited in the automation literature, rates of actual and projected job loss rarely reached levels that the automation literature suggests are becoming common or soon will be. Although there are large occupations that experienced large percent declines over two decades, those occupations account for much less than 47 percent of jobs, and their losses are more than offset by growth in other occupations, which is to say those jobs are not representative of a broader trend.

Part of the reason new technology does not produce sharper changes in employment is the diversity of jobs within occupations and the diversity of tasks within jobs, not all of which are equally susceptible to technological substitution. Automation of some tasks may also alter the task composition of jobs, rather than simply reducing the number of jobs. The growth of product demand within industries implementing new technology can buffer the employment effects of

technological change. On a broader scale, population growth and economic growth are associated with expanding employment. It is also possible that adoption rates for new production technology are more gradual than commonly assumed. The automation literature implicitly claims that technological substitution will be so great as to dominate any offsetting forces, producing unusually large job losses. However, the total number of jobs grew after the AI breakthroughs of the early 2010s, and BLS projects it will continue to do so, as will most of the specific occupations the automation literature considers to be on the leading edge of this wave of technological displacement.

Fears that automation will cause widespread job losses have been raised repeatedly in the past, which, in retrospect, usually greatly overestimated the scale of actual displacement. Recent experience and projections suggest a similar pattern may be occurring with recent developments in AI and robotics. For various reasons, technological change seems to be generally more gradual than commonly recognized. Prior waves of computing may be too familiar to receive much attention from observers of emerging trends, but their immediate effects are probably smaller than anticipated and their full impact unfolds gradually over a longer timeframe than recognized. None of this is to minimize the hardships experienced by displaced workers. However, rapid leaps in technology in the early 2010s prompted many to envision a future scenario of massive disruption. This article has examined specific occupations that are most favorable to the automation thesis and found little support for this view. It is entirely possible that robotics and AI are simply another in a long line of waves of innovation whose effects on employment will unfold at rates comparable to those in the past.

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Appendix: The distribution of occupational sizes

The automation literature and discussions of changes in the nature of work more generally often use specific occupations as illustrations of what are believed to be general trends. It is useful to have a better understanding of the range of occupational sizes in both absolute and relative terms to have some yardstick for judging whether any given occupation of interest is large or small. The mean occupation, which has approximately 200,000 jobs, could serve as a dividing line between large and small occupations, while the median, which is much smaller (approximately 54,000 jobs), is probably much too small to serve as a useful benchmark, though it does indicate the highly skewed nature of the distribution. In fact, a closer examination shows that there are relatively few occupations that can be considered large by most reasonable standards and many occupations that are small.

Table A-1 shows the distribution of occupations by size decile, with each decile containing about 79 occupations. The largest occupation accounted for 2.7 percent of jobs in 2019 (column 4), but the smallest occupation in the top decile had less than 0.3 percent of all jobs (column 3). The average occupation in the top decile had nearly 1.3 million jobs (column 1) and accounted for about 0.8 percent of all jobs (column 2). By contrast, the average occupation in the median (fifth) decile had only 67,000 jobs and accounted for 0.04 percent of all jobs. The number of jobs per occupation and their percent shares decline further from there. Collectively, the top two deciles, 158 occupations out of 790 total, accounted for over 78.1 percent of all jobs (column 6), while the remaining 632 occupations accounted for the remaining 21.9 percent of jobs. The bottom half of the distribution (395 occupations) accounted for only about 5.3 percent of all jobs. Clearly, any reference to a particular occupation as susceptible to automation will have very different implications depending on whether it is among the few large ones or the many small ones. If the latter, then the portrait of automation's impact can easily be unrepresentative. Even among the largest occupations, there are many that account for only 0.15 percent to 0.30 percent of all jobs.

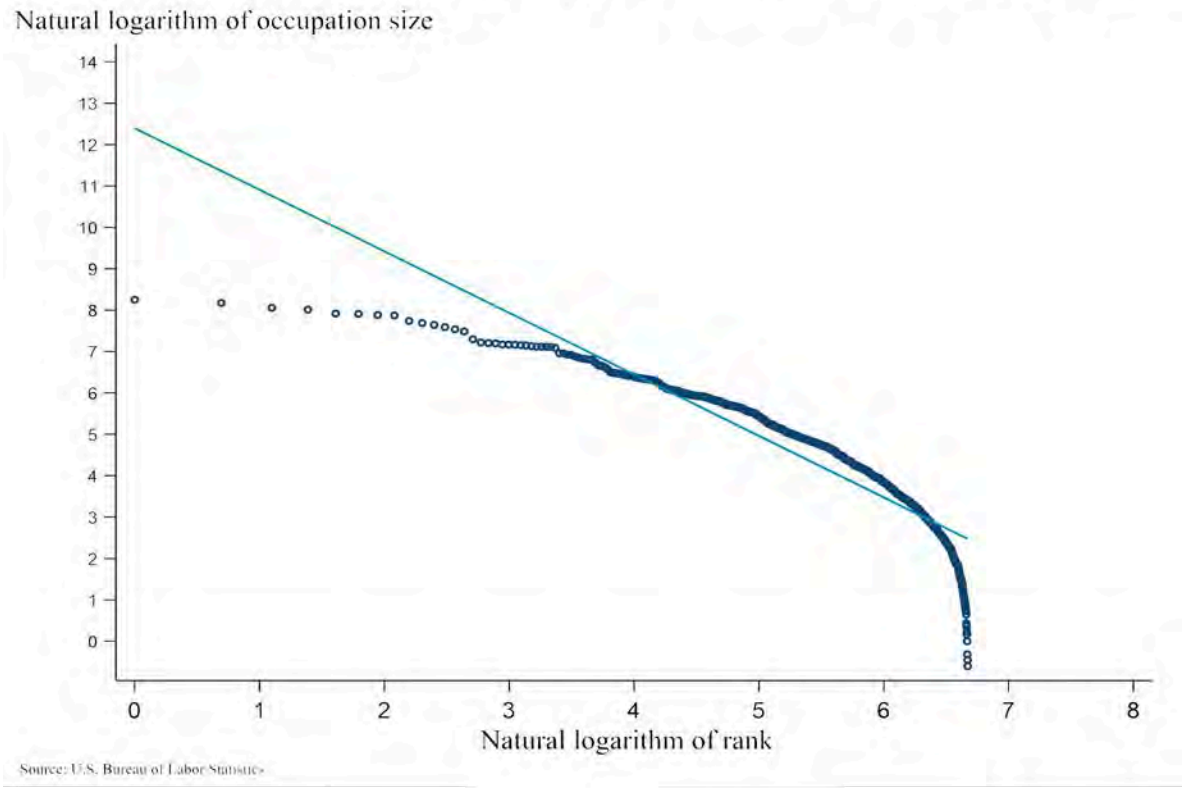
Table A-1. Size distribution of occupations by decile, 2019

Decile	Mean jobs per occupation (thousands)	Percent of all jobs in decile's mean occupation	Percent of jobs in decile's smallest occupation	Percent of jobs in decile's largest occupation	Total jobs in decile	Decile's percent share of all jobs
1	1,267.9	0.78	0.29	2.69	100,167.3	61.53
2	341.7	0.21	0.14	0.28	26,996.7	16.58
3	168.1	0.10	0.08	0.14	13,283.4	8.16
4	106.9	0.07	0.05	0.08	8,445.6	5.19
5	67.3	0.04	0.03	0.05	5,316.5	3.27
6	44.0	0.03	0.02	0.03	3,432.8	2.11
7	29.8	0.02	0.02	0.02	2,382.5	1.46
8	19.0	0.01	0.01	0.01	1,497.2	0.92
9	11.6	0.01	0.01	0.01	894.9	0.55
10	4.7	0.00	<0.001	0.01	379.7	0.23
All deciles	**206.1**	**0.13**	**0.00**	**2.69**	**162,796.6**	**100.00**

Note: Assignment to occupational deciles is based on the number of jobs in an occupation. Deciles are shown from largest to smallest. Each decile contains 79 occupations, aside from ties. Figures in columns refer to (1) average number of jobs per occupation (in thousands), (2) average percent share of jobs per occupation, (3) minimum and (4) maximum percent shares of occupations in decile, (5) total number of jobs in decile (in thousands), and (6) the decile's percent share of all jobs. Figures in the bottom row for all cases are means (columns 1 and 2), minimum and maximum values (columns 3 and 4), and sums (columns 5 and 6).
Source: U.S. Bureau of Labor Statistics, occupational projections file for 2019–29.

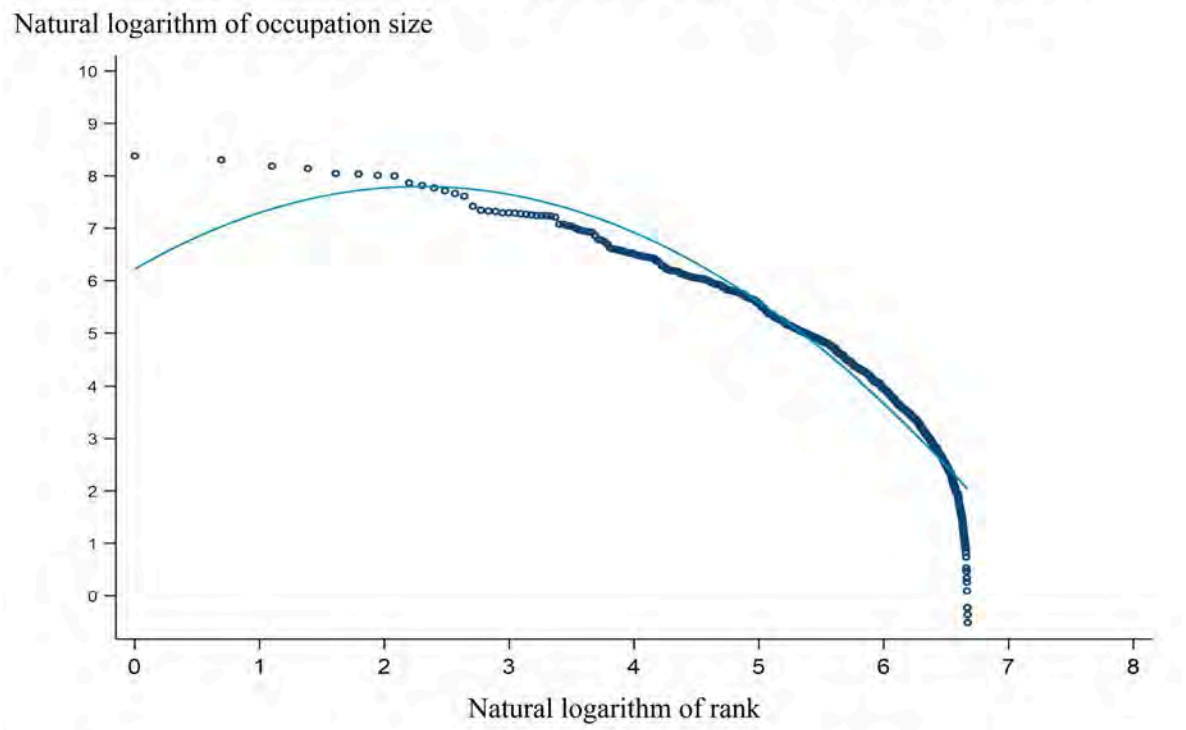
As an aside, because the largest approximately 20 percent of occupations account for nearly 80 percent of all jobs, it is natural to ask whether occupational size follows a power law. According to this mathematical model, the natural log of an occupation's size is related linearly to the natural log of its rank, sorted from largest to smallest.[71] Chart A-1 plots log occupation size against log occupation rank. The relationship is far from linear, and even a quadratic function (see chart A-2) shows significantly poor fit at either end, where actual occupational employment is much lower than predicted. Occupational size does not follow a power law. In fact, the distribution of occupational employment is strikingly close to a lognormal distribution (see chart A-3), which is also consistent with a highly skewed size distribution containing a large mass of relatively small occupations and a long tail containing a small number of large occupations.[72]

Chart A-1. Relationship between occupational size and rank, 2019



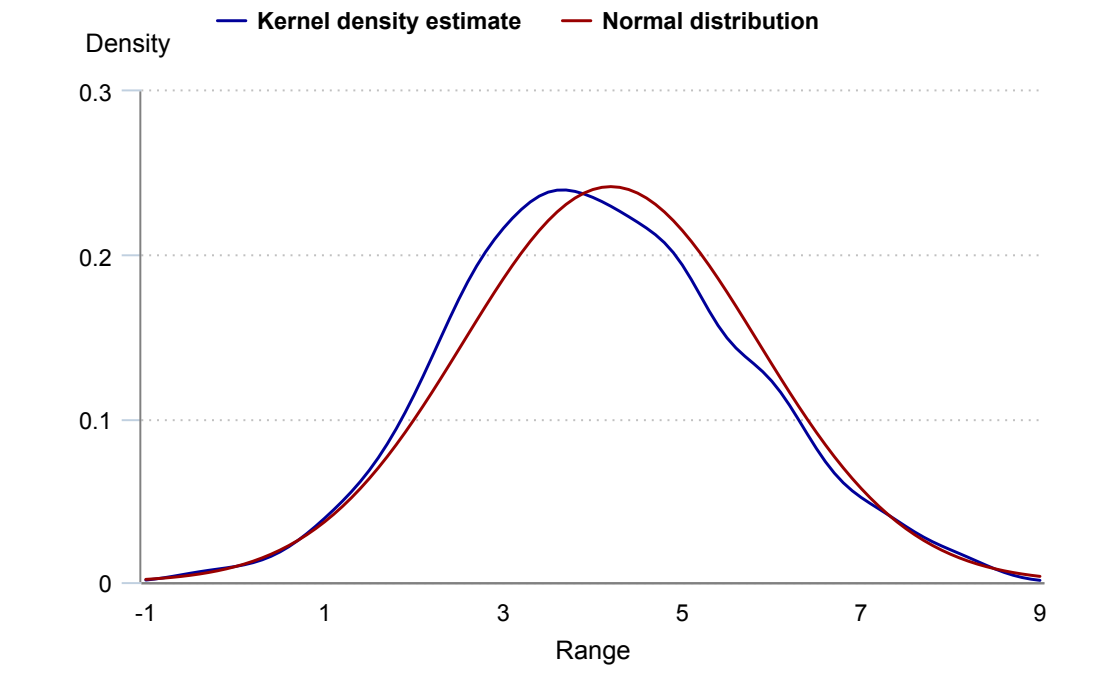
Source: U.S. Bureau of Labor Statistics.

Chart A-2. Quadratic fit of occupational size and rank, 2019



Source: U.S Bureau of Labor Statistics.

Chart A-3. Distribution of the natural logarithm of occupational employment, 2019



Click legend items to change data display. Hover over chart to view data.
Source: U.S. Bureau of Labor Statistics.

View Chart Data

Table A-2 shows occupations at different points of the size distribution and the number of jobs and share of all jobs they represent. In addition to the 20 smallest and 20 largest occupations, the table includes twenty occupations increasing in size from the median. These figures provide another perspective on how rapidly the size of occupations drops and can serve as reference points for the discussion of automation's possible impacts. Some of the large occupations, such as material movers, heavy truck drivers, and household and commercial cleaners, figure prominently in discussions of the increasing power of robots and AI, but others, like those related to nursing and personal care aides, do not. Occupations like retail salespersons, cashiers, and bookkeeping, accounting, and auditing clerks are somewhat more ambiguous, because they have been affected by prior waves of computing technologies, such as microcomputers, e-commerce, and self-checkout, in addition to any effects of newer technology like robots and AI.

Table A-2. Number of jobs and share of jobs in selected detailed occupations, 2019

SOC code	Occupational title	Jobs (thousands)	Percent
	Twenty largest occupations		
41-2031	Retail salespersons	4,371.4	2.685
35-3023	Fast food and counter workers	4,047.7	2.486
41-2011	Cashiers	3,600.9	2.212
31-1120	Home health and personal care aides	3,439.7	2.113
43-9061	Office clerks, general	3,126.3	1.920
29-1141	Registered nurses	3,096.7	1.902
43-4051	Customer service representatives	3,018.8	1.854
53-7062	Laborers and freight, stock, and material movers	2,986.0	1.834
35-3031	Waiters and waitresses	2,613.8	1.606
11-1021	General and operations managers	2,486.4	1.527
37-2011	Janitors and cleaners, except maids and housekeepers	2,374.2	1.458
43-6014	Secretaries and administrative assistants	2,250.2	1.382
53-7065	Stockers and order fillers	2,135.8	1.312
53-3032	Heavy and tractor-trailer truck drivers	2,029.9	1.247
43-3031	Bookkeeping, accounting, and auditing clerks	1,673.6	1.028
43-1011	First-line supervisors of office and administrative support	1,552.4	0.954
31-1131	Nursing assistants	1,528.5	0.939
49-9071	Maintenance and repair workers, general	1,516.4	0.931
41-1011	First-line supervisors of retail sales workers	1,476.4	0.907
37-2012	Maids and housekeeping cleaners	1,474.9	0.906
1	**Total**	**50,800**	**31.203**
	Twenty middle-sized occupations		
51-7041	Sawing machine setters, operators, and tender	54.5	0.033
49-9062	Medical equipment repairers	53.9	0.033
11-1031	Legislators	53.7	0.033
45-1011	First-line supervisors of farming, fishing,	53.2	0.033
49-9012	Control and valve installers and repairers,	53.1	0.033
51-9012	Separating, filtering, clarifying machine setters, operators	53.1	0.033
47-2121	Glaziers	52.8	0.032
43-9022	Word processors and typists	52.7	0.032
11-9039	Education administrators, all other	52.1	0.032
27-3023	News analysts, reporters, and journalists	52.0	0.032
27-1023	Floral designers	51.8	0.032
47-5013	Service unit operators, oil and gas	51.7	0.032
33-9093	Transportation security screeners	51.4	0.032
29-1011	Chiropractors	51.1	0.031
31-2022	Physical therapist aides	50.6	0.031
31-1132	Orderlies	50.6	0.031
23-2099	Legal support workers, all other	50.4	0.031
39-2011	Animal trainers	50.2	0.031
29-1298	Acupuncturists, healthcare diagnosing/treating, all other	49.6	0.030
29-1216	General internal medicine physicians	49.5	0.030
1	**Total**	**1,038.0**	**0.637**
	Twenty smallest occupations		
15-2021	Mathematicians	2.9	0.00178
19-1011	Animal scientists	2.8	0.00172
41-9012	Models	2.7	0.00166
29-9092	Genetic counselors	2.6	0.00160
53-4099	Rail transportation workers, all other	2.5	0.00154
25-1192	Family and consumer sciences teachers, postsecondary	2.5	0.00154

Note:
1 Not applicable.
SOC = Standard Occupational Classification system. Number of jobs is in thousands. This table omits some occupations with larger declines over the period because of known changes in coding practices designed to address title inflation in some occupations (SOC 11-1011, chief executives and other managerial occupations; SOC 43-6011, executive secretaries/administrative assistants). Others are omitted because of presumed changes in coding practices (SOC 47-3012, helpers–carpenters; SOC 49-9098, helpers–installation, maintenance, and repair). Declines in the sizes of these occupations are not believed to reflect actual changes in the economy for the most part.
Source: Source: U.S. Bureau of Labor Statistics, occupational projections file for 2019-29.

SOC code	Occupational title	Jobs (thousands)	Percent
53-5022	Motorboat operators	2.5	0.00154
19-2011	Astronomers	2.3	0.00141
33-2022	Forest fire inspectors and prevention specialists	2.3	0.00141
25-1043	Forestry and conservation science teachers, postsecondary	2.1	0.00129
17-2021	Agricultural engineers	1.7	0.00104
19-3092	Geographers	1.6	0.00098
53-7031	Dredge operators	1.6	0.00098
51-7031	Model makers, wood	1.4	0.00086
51-2061	Timing device assemblers and adjusters	1.3	0.00080
19-3032	Industrial-organizational psychologists	1.1	0.00068
13-1074	Farm labor contractors	0.8	0.00049
49-9045	Refractory materials repairers, except brickmasons	0.8	0.00049
51-7032	Patternmakers, wood	0.7	0.00043
29-1024	Prosthodontists	0.6	0.00037
1	**Total**	**36.8**	**0.02261**

Note:
1 Not applicable.
SOC = Standard Occupational Classification system. Number of jobs is in thousands. This table omits some occupations with larger declines over the period because of known changes in coding practices designed to address title inflation in some occupations (SOC 11-1011, chief executives and other managerial occupations; SOC 43-6011, executive secretaries/administrative assistants). Others are omitted because of presumed changes in coding practices (SOC 47-3012, helpers–carpenters; SOC 49-9098, helpers–installation, maintenance, and repair). Declines in the sizes of these occupations are not believed to reflect actual changes in the economy for the most part.
Source: Source: U.S. Bureau of Labor Statistics, occupational projections file for 2019-29.

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Notes

1 See plenary keynote presentation to the Technequality Conference (https://technequality-project.eu/files/michaelhandelprojectionspresentationbrusselsseminarpdf). For full program, see https://technequality-project.eu/files/scientificconferencetechnequality-finalprogrammlpdf and https://technequality-project.eu/news/technequality-virtual-scientific-conference-25-and-26-november-looking-back-successful-event.

2 Norbert Wiener wrote, “It is perfectly obvious that [“automatic machines”] will produce an unemployment situation, in comparison with which the present recession and even the depression of the thirties will seem a pleasant joke.” See Wiener, *The human use of human beings: cybernetics and society* (Boston: Houghton Mifflin, 1950), p.189. See also Gregory R. Woirol, *The technological unemployment and structural unemployment debates* (Westport, CT: Greenwood Press, 1996); Amy Sue Bix, *Inventing ourselves out of jobs? America’s debate over technological unemployment, 1929–1981* (Baltimore: Johns Hopkins University Press, 2000); and Maxine Berg, *The machinery question and the making of political economy, 1815–1848* (Cambridge University Press, 1980).

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7 Sean Gerrish, *How smart machines think* (Cambridge, MA: MIT Press, 2018).

8 Key works on automation used in this paper include Erik Brynjolfsson and Andrew McAfee, *The second machine age: work, progress, and prosperity in a time of brilliant technologies* (New York: W.W. Norton & Company, 2014); Carl Benedikt Frey and Michael A. Osborne, “The future of employment: how susceptible are jobs to computerization?” *Technological Forecasting and Social Change* vol. 114, issue C, 2017, pp. 254–280; Martin Ford, *Rise of the robots: technology and the threat of a jobless future* (New York: Basic Books, 2015); and *Jobs lost, jobs gained: workforce transitions in a time of automation* (San Francisco, CA: McKinsey Global Institute, December 2017), https://www.mckinsey.com/~/media/mckinsey/featured%20insights/future%20of%20organizations/what%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/mgi%20jobs%20lost-jobs%20gained_report_december%202017.pdf.

9 Frey and Osborne, “The future of employment.”

10 *The transformative impact of robots and automation: hearing before the Joint Economic Committee, Congress of the United States*, 114th Congress (U.S. Government Printing Office, 2016), https://www.jec.senate.gov/public/index.cfm/2016/5/the-transformative-impact-of-robots-and-automation; *and Workforce automation: better data needed to assess and plan for effects of advanced technologies on jobs*, Report GAO-19-257 (Government Accountability Office, 2019).

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12 Scott A. Wolla “Examining the ‘lump of labor’ fallacy using a simple economic model," *Page One Economics* (Federal Reserve Bank of St. Louis, November 2020), https://research.stlouisfed.org/publications/page1-econ/2020/11/02/examining-the-lump-of-labor-fallacy-using-a-simple-economic-model.

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14 Gittleman and Monaco, “Truck-driving jobs: are they headed for rapid elimination?”

15 For an example, see *Jobs lost, jobs gained* (McKinsey Global Institute), p. 6.

16 Prior versions of Brynjolfsson and McAfee’s *The second machine age* and Frey and Osborne’s “The future of employment” appeared in 2011 and 2013, respectively. Both versions of Frey and Osborne’s paper use a 20-year forecast interval with 2010 as the base year. This window aligns well with the occupational data and projections for 2008–18 and 2019–29 used in this article. The 2008–18 projections are used for the previous decade because the program operated on a biennial schedule prior to 2019, so there were no projections for the period 2009–19. The base year employment for 2008–18 is also much less affected by the downturn of the Great Recession than if 2009 were the base year.

17 See Dubina, Morisi, Rieley, and Wagoner, “Projections overview and highlights.” Effects of COVID-19 on recent occupational employment are covered in a separate, companion paper (see note 1 for the presentation on that unpublished paper).

18 For further details on the Employment Projections program, see https://www.bls.gov/emp.

19 Frey and Osborne, “The future of employment.”

20 For further details on the Occupational Employment and Wage Statistics (OEWS) program, see https://www.bls.gov/oes. Note that after the data used in this article were collected, the program’s name changed to the Occupational Employment and Wage Statistics program.

21 See note 1.

22 Frey and Osborne, “The future of employment.” If an occupation shrinks at a rate of 27 percent per decade, after 10 years it will be 0.73 times the base-year value, and after 20 years it will be $(0.73)^2 = 0.53$ times the base-year value, representing a 47-percent loss.

23 Brynjolfsson and McAfee, *The second machine age*; Ford, *Rise of the robots;* Frey and Osborne, “The future of employment”; and *Jobs lost, jobs gained* (McKinsey Global Institute).

24 Dubina, Morisi, Rieley, and Wagoner, “Projections overview and highlights.”

25 These key works are Brynjolfsson and McAfee, *The second machine age*; Ford, *Rise of the robots*; Frey and Osborne, “The future of employment”; and *Jobs lost, jobs gained* (McKinsey Global Institute).

26 See Ford, *Rise of the robots*, p. 103; and Frey and Osborne, “The future of employment,” p. 260.

27 All references to technological and other factors affecting staffing patterns are drawn from the U.S. Bureau of Labor Statistics projections spreadsheet file for 2019–29.

28 I thank Michael Wolf for suggesting this possible explanation.

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38 Chockley and Emanual, "The end of radiology?” p. 1419.

39 All numbers in charts 2 and 3 refer to radiologists whose primary activity was patient care. Values for 2000–05 are from *Physician characteristics and distribution in the [U.S.]* (American Medical Association, various editions). Values for 2006–19 are from the National Center for Health Workforce Analysis analysis of American Medical Association Physician Masterfile data. Values for 2009 are interpolated. Figures are totals for the following American Medical Association defined subspecialties: abdominal radiology, cardiothoracic radiology, diagnostic radiology, hospice and palliative medicine (radiology), musculoskeletal radiology, nuclear radiology, pediatric radiology, radiology, neuroradiology, radiological physics, and vascular and interventional radiology. I thank Stephen Pegula of the Health Resources and Services Administration (U.S. Department of Health and Human Services) for providing the data on radiologist employment for 2006–19.

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49 See Frey and Osborne, "The future of employment," p. 262; and *Jobs lost, jobs gained* (McKinsey Global Institute), p.10.

50 Brynjolfsson and McAfee, *The second machine age*, p. 17; *Jobs lost, jobs gained* (McKinsey Global Institute), pp. 6, 26; and West, *The future of work*, p. 24.

51 Brynjolfsson and McAfee, *The second machine age*, p. 130; and Ford, *Rise of the robots*, p. 115.

52 Brynjolfsson and McAfee, *The second machine age*, p. 150. Note that the same source uses a different figure in a different passage on page 130, saying "tens of thousands of tax preparers now find their jobs and incomes threatened."

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62 Frey and Osborne, "The future of employment," p. 265; *Jobs lost, jobs gained* (McKinsey Global Institute), p. 9.

63 Dubina, Morisi, Rieley, and Wagoner, "Projections overview and highlights."

64 Frey and Osborne, "The future of employment," pp. 259f, 265; Brynjolfsson and McAfee, *The second machine age*, p. 139; and *Jobs lost, jobs gained* (McKinsey Global Institute), p. 26.

65 Frey and Osborne, "The future of employment," p. 262.

66 For the industrial distribution of this occupation, see https://www.bls.gov/oes/current/oes537065.htm.

67 Brynjolfsson and McAfee, *The second machine age*, p. 137.

68 Ford, *Rise of the robots*, p. 23ff.

69 *Jobs lost, jobs gained* (McKinsey Global Institute), p. 26.

70 Table 4 omits some occupations with larger declines over the period because of known changes in coding practices designed to address title inflation in some occupations (Standard Occupational Classification (SOC) system 11-1011, chief executives and other managerial occupations; SOC 43-6011 executive secretaries/administrative assistants). Others are omitted because of presumed changes in coding practices (SOC 47-3012, helpers–carpenters; SOC 49-9098, helpers–installation, maintenance, and repair). Declines in the sizes of these occupations are not believed to reflect actual changes in the economy for the most part.

71 Volker Nitsch, "Zipf zipped," *Journal of Urban Economics* vol. 57, issue 1, 2005, p. 89, https://doi.org/10.1016/j.jue.2004.09.002.

72 Taking the natural logarithm of occupational employment reduces the skewness of the size distribution from 4.9 to 0.1 and reduces the kurtosis from 32.3 to 2.8. The Shapiro-Francia test fails to reject the null hypothesis that the distribution is lognormal ($p > 0.17$), as does Stata's -sktest- command ($p > 0.20$), while the Shapiro-Wilk test is borderline ($p > 0.09$).

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Report to Congressional Committees

August 2022

WORKFORCE AUTOMATION

Insights into Skills and Training Programs for Impacted Workers

GAO-22-105159

August 2022

WORKFORCE AUTOMATION

Insights into Skills and Training Programs for Impacted Workers

GAO Highlights

Highlights of GAO-22-105159, a report to congressional committees

Why GAO Did This Study

Increasingly, technology is automating tasks previously performed by people. Automation has changed some jobs and eliminated others entirely. Thus some workers have had to retrain to learn the skills needed to keep their jobs or obtain new ones. Workers with lower levels of education who perform more routine tasks have tended to experience the greatest disruptions from automation, putting at risk jobs such as cashiers or clerical workers. House Report 116-450 included a provision for GAO to examine challenges and opportunities to provide training to workers at risk of losing their jobs to automation.

GAO examined (1) what available data indicate about which workers are at risk of automation and the skills needed for in-demand jobs; and (2) what insights stakeholders offer for workforce programs to better serve displaced workers and those affected by automation.

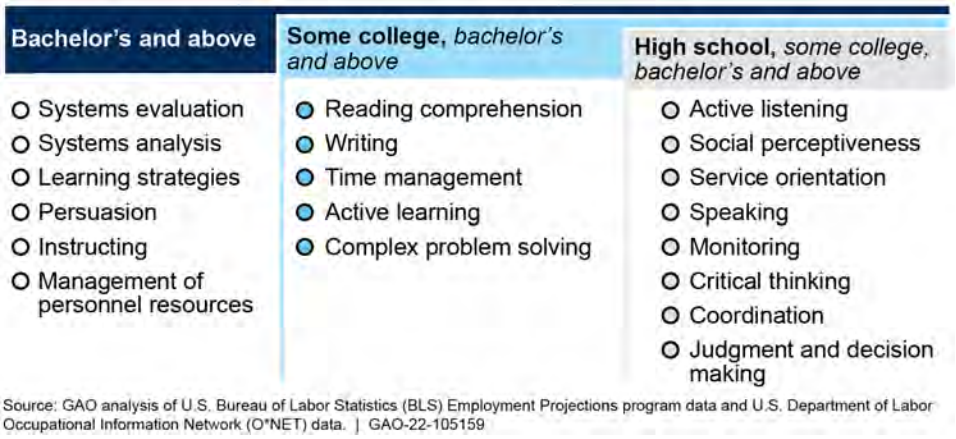
GAO analyzed DOL data to identify occupations projected to grow over the next decade, as well as the skills associated with those growing occupations. GAO also conducted case studies in four states, diverse across jobs and geography that were also recommended by national workforce organizations and others as having promising workforce responses to automation. In those states, GAO collected information related to both objectives. Additionally, GAO interviewed stakeholders from agencies and nine workforce, labor, business, and other organizations. GAO also reviewed relevant federal laws and regulations, prior GAO reports, and literature.

View GAO-22-105159. For more information, contact Dawn G. Locke at (202) 512-7215 or locked@gao.gov.

What GAO Found

Although available data do not explicitly identify workers at risk of losing their jobs to automation, they provide insight into the skills needed for jobs projected to be in high demand over the next decade. For example, Department of Labor (DOL) data show that in-demand jobs require a mix of skills, including soft skills and process skills that help a person acquire knowledge quickly, such as active learning and critical thinking. Federal data also indicate that in-demand jobs having a higher number of skills deemed important also tend to require higher levels of education. Further, research indicates that certain jobs and skills are less likely to be automated, including those involving management and social skills. State and other data can also inform which skills are most important for in-demand jobs in a given geographic area. DOL and the Department of Commerce are seeking additional data on skills that the general worker population will need for in-demand jobs in light of automation.

Skills Deemed Important in the Top 20 In-Demand Occupations, by Education Level Required



Source: GAO analysis of U.S. Bureau of Labor Statistics (BLS) Employment Projections program data and U.S. Department of Labor Occupational Information Network (O*NET) data. | GAO-22-105159

Note: These skills reflect a score of at least 3 in O*NET's 5-point scale of importance.

Officials in four case study states and other stakeholders GAO interviewed offered insights on how existing workforce programs could better serve displaced workers and those at risk of losing their jobs to automation who face challenges obtaining in-demand jobs. For example, several stakeholders suggested that training programs sometimes failed to focus on providing skills for in-demand jobs. Specifically, one state official said that some programs focus on interviewing and resume writing skills, rather than helping workers acquire the actual skills needed to perform the tasks for their next job. Other officials also noted that jobseekers faced barriers to accessing training, such as lack of childcare. Accordingly, stakeholders proposed strategies including (1) focusing training content on in-demand skills, (2) designing programs to maximize their accessibility, (3) increasing investment in training, and (4) collaborating with other workforce stakeholders to better serve workers displaced by automation.

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Abbreviations

BLS	Bureau of Labor Statistics
DOL	Department of Labor
O*NET	Occupational Information Network
SD	standard deviation
WIOA	Workforce Innovation and Opportunity Act

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

August 17, 2022

The Honorable Patty Murray
Chair
The Honorable Roy Blunt
Ranking Member
Subcommittee on Labor, Health and Human Services, Education, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Rosa L. DeLauro
Chair
The Honorable Tom Cole
Ranking Member
Subcommittee on Labor, Health and Human Services, Education, and Related Agencies
Committee on Appropriations
House of Representatives

In recent decades, technological advancements have allowed automation to perform tasks traditionally done by human workers—changing or eliminating some jobs on the one hand, and creating entirely new occupations and industries on the other.[1] In addition, several researchers have argued that the COVID-19 pandemic could have accelerated the adoption of certain technological changes in the nature of work, which could result in more robots in manufacturing and warehouses or more self-service kiosks in stores, for example.[2] These changes may also alter the types of skills needed for current and future jobs.

[1]In this report, we use "automation" to mean modifying processes to become more automatic by reducing human involvement.

[2]See, e.g., McKinsey Global Institute, *The future of work after COVID-19* (Feb. 2021); World Economic Forum, *The Future of Jobs Report 2020* (Switzerland: Oct. 2020); Burning Glass Technologies, *After the Storm: The Jobs and Skills that will Drive the Post-Pandemic Recovery* (Boston, MA: Feb. 2021). Moreover, there are a variety of factors that might affect a firm's decision to automate. For example, Acemoglu, Manera, and Restrepo (2020) argue that the U.S. tax system favors excessive automation. In particular, the study notes that the heavy taxation of labor and low taxes on capital encourage firms to automate more tasks and use less labor than is socially optimal. Daron Acemoglu, Andrea Manera, and Pascual Restrepo, "Does the U.S. Tax Code Favor Automation?" *Brookings Papers on Economic Activity*, Spring, 231-300.

The current U.S. workforce faces challenges to adapt to this evolving labor market. Automation may result in the elimination of certain jobs or require workers to retrain in order to keep their jobs or to obtain new ones. We use the phrase “at-risk workers” to describe those workers whose jobs are at risk of being partially or fully automated.

Federal, state, and local governments play a role in helping to ensure that the workforce is equipped to meet current and future labor market demands. The Department of Labor (DOL) creates projections to anticipate which jobs will grow the fastest—what we term “in-demand jobs”—and the skills needed for those jobs—what we term “in-demand skills.”[3] However, research has highlighted a widening gap between the skills needed for certain jobs and the skills of workers available for these jobs.[4] This gap is especially apparent in industries with high degrees of automation, such as health care, information technology, and manufacturing. Historically low unemployment has increased difficulties for employers looking to fill jobs involving skills needed for in-demand jobs. Additionally, it is unclear whether existing training opportunities can close this skills gap. One survey of warehouse workers found that 35 percent of participants were concerned that inadequate training resources would reduce their ability to succeed in a digital environment.[5]

House Report 116-450 of the Committee on Appropriations, to accompany H.R. 7614, Departments of Labor, Health and Human Services, and Education, and Related Agencies Appropriations Act, 2021

[3]Based on DOL data, we identified “in-demand jobs” as those occupations that were projected to add more than 7,600 jobs over the 2019 through 2029 period—i.e., the average job gain across all occupations over this period. Of these, we selected the 20 fastest-growing occupations. This eliminated occupations that are growing quickly but will add relatively few jobs. For example, the occupation of wind turbine service technicians is projected to grow by about 60 percent from 2019 to 2029, but will add fewer than 5,000 jobs over the period.

[4]See, for example, Boston Consulting Group, *Towards a Reskilling Revolution: A Future of Jobs for All*,” World Economic Forum (Geneva: January 2018) and Craig Giffi et al., 2018 *Deloitte and The Manufacturing Institute Skills Gap and Future of Work in Manufacturing Study* (Washington, D.C.: Deloitte Insights, 2018).

[5]Joe Lui et al., “Research: How Do Warehouse Workers Feel About Automation?” *Harvard Business Review* (Boston, MA: Feb. 11, 2022).

included a provision for GAO to examine challenges and opportunities to provide training to workers at risk of losing their jobs to automation.[6]

This report examines (1) what available data indicate about which workers are at risk of automation and the skills needed for in-demand jobs; and (2) what insights stakeholders offer for workforce programs to better serve displaced workers and those affected by automation.[7]

For our first objective, we analyzed DOL data to identify occupations projected to grow the fastest over the period 2019 through 2029, as well as the 2020 DOL data on skills associated with those growing occupations. We established the reliability of these data by reviewing DOL documentation and interviewing knowledgeable DOL staff. In addition, we used information from selected case study states, described below, to provide examples of data available on a state and local level with regard to in-demand jobs and skills needed.

To help address both objectives, we conducted case studies in four states, including those with a high concentration of jobs susceptible to automation based on a prior GAO report, diverse urban and rural geographies, a variety of in-demand jobs, and that were recommended to us by workforce stakeholders in early interviews as having promising workforce responses to automation. The states were California, Kentucky, Pennsylvania, and Washington. In each state, we conducted semi-structured interviews with state workforce boards, which included representation from government agencies, business, labor, and training providers.[8] We asked questions related to how the states collect data on in-demand jobs and any challenges to obtaining in-demand jobs within their state. We also asked for examples of workforce training programs to serve at-risk workers.

[6]H.R. Rep. No. 116-450, at 22 (2020).

[7]Unless otherwise noted, the word “stakeholders” refers to anyone or any group we interviewed, including state and local workforce boards, academics, and representatives of other organizations. In addition to individual interviews, we interviewed a number of stakeholders in group settings, and not all stakeholders offered thoughts on every question. As used in the report, the term “several” indicates that three to four stakeholders gave a particular response, while the term “many” indicates that five or more stakeholders gave a particular response. We also sometimes refer to the number of states represented by stakeholders to provide another sense of breadth for the comments.

[8]We obtained information from several local workforce boards recommended to us by state workforce board representatives as having particularly noteworthy programs.

Additionally, we interviewed stakeholders, including officials from DOL and the Census Bureau, as well as nine other organizations, such as national organizations of state workforce boards and agencies, business, labor, industry, and academic organizations, to obtain their perspectives on skills needed for in-demand jobs and the challenges workers face in obtaining those jobs. We selected these stakeholders based on our prior work on automation and workforce issues, as well as additional suggestions from initial outreach. The views of the stakeholders we interviewed provide illustrative examples on these topics and are not generalizable.

We also reviewed prior GAO reports and other literature to understand skills required for in-demand jobs; programs that provide workers with in-demand skills; challenges to obtaining in-demand jobs; and any lessons to consider as agencies respond to changes in the labor market due to automation. For additional information about our methodology, see appendix I.

We conducted this performance audit from April 2021 to August 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The Changing Composition of Jobs and Skills as a Result of Automation

Historically, new technologies have enhanced productivity and improved societal standards of living. Many workplace technologies have been designed to save labor through automation. However, as automation has replaced tasks performed by some types of workers, it has also created a greater demand for other types of workers.

Automation continues to affect the workforce landscape, as advanced technologies change the composition of jobs and skills demanded by employers. In March 2019, we found that technology adoption is likely to lead to increased demand for certain types of jobs, while reducing

demand for other jobs—both in the short and long term.[9] That report also noted that multiple tasks comprise a job and multiple jobs comprise an occupation. If automation simplifies a few tasks, for example, it will change the nature of the job and perhaps allow a worker to take on more or different tasks. Likewise, if automation replaces some tasks, the skills needed to perform those tasks might also become unnecessary and could lead to declines in the number of jobs requiring those skills.[10] If automation eliminates enough tasks in a given job, the job might be eliminated. Finally, if enough of those jobs are eliminated, the occupation consisting of those jobs might also be eliminated. For example, one study noted that an occupation that features basic use of numbers, such as a cashier, might be replaced with self-checkout machines, leading to decreased demand for that occupation. In addition, workers with lower levels of education who perform more routine tasks have tended to experience the greatest disruptions from automation, putting workers such as cashiers or clerical workers at risk.

On the other hand, where automation requires new skills, such as monitoring an automated process, it can lead to a skills gap in the labor market, with employers unable to find enough workers with the new skills needed. Several studies have attempted analyses of the skills gap in the labor market. For example, a 2018 study concluded that the skills gap had widened, and estimated that the gap could account for approximately 2.4 million skilled manufacturing job vacancies from 2018 through 2028.[11] In the same study, surveyed manufacturers cited a “shifting skill set due to the introduction of new advanced technology and automation” as the greatest cause of their skills shortage.[12] Another study that analyzed the skills associated with job openings noted similar dynamics, stating that technological advancement has caused the skills required for common job postings to change up to 40 percent in the last decade.[13] Other

[9]GAO, *Workforce Automation: Better Data Needed to Assess and Plan for Effects of Advanced Technologies on Jobs*, GAO-19-257 (Washington, D.C.: Mar. 7, 2019).

[10]The Occupational Information Network (O*NET) defines skills as “the ability to perform a task well,” and notes that skills are “usually developed over time through training or experience.”

[11]Giffi et al., *2018 Deloitte and The Manufacturing Institute Skills Gap*.

[12]Giffi et al., *2018 Deloitte and The Manufacturing Institute Skills Gap*.

[13]Burning Glass Technologies, *After the Storm*.

research noted that the current speed of change can leave large segments of the population with obsolete skills.[14]

Federal and Other Data on Jobs and Skills

To help understand workforce changes, including job trends and skills needed for specific occupations, DOL provides data on the workforce. For example, DOL's Bureau of Labor Statistics (BLS) publishes annual, 10-year employment projections for the U.S. These projections analyze changes in the economy, among other things, to predict how employment levels across about 800 occupations may change during the next 10 years. The projections incorporate factors that can affect occupational employment. These include how automation might limit employment demand in the manufacturing sector (as machines perform more tasks that human workers previously did), or how automation might reduce demand for administrative support occupations (as new software programs automate administrative tasks).

For skills needed for specific occupations, DOL's Employment and Training Administration oversees the Occupational Information Network (O*NET). O*NET collects data on skills needed for occupations, including the degree of importance of a particular skill for a given occupation.[15] O*NET groups 35 skills into seven categories: content; process; complex problem solving; resource management; social; systems; and technical.[16] O*NET organizes the information about occupations in a similar way to the BLS employment projections, which allows job projections information to be matched with occupational skill information. This matching can identify skills needed for in-demand occupations.

In addition to DOL's data efforts, the Census Bureau also collects data on automation. As we noted in March 2019, the Census Bureau has long measured the impact of technology, and obtains information through

[14]Melanie Arntz, Terry Gregory, and Ulrich Zierahn, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis," *OECD Social, Employment and Migration Working Papers*, no. 189 (Paris: OECD Publishing, 2016).

[15]O*NET is sponsored by the Employment and Training Administration through a grant to the North Carolina Department of Commerce, according to DOL. O*NET also collects information on knowledge and abilities, as well as more specific job tasks. O*NET has a 5-point scale of importance for its 35 skills, with ratings ranging from "Not Important" (1) to "Extremely Important" (5). See appendix I for additional information on O*NET.

[16]O*NET groups content and process skills together as "basic" skills, and refers to the other five skill categories as "cross-functional" skills. See appendix I for additional information.

surveys such as its Annual Business Survey.[17] The Census Bureau also collects capital expenditure data on industrial robotics in the Annual Survey of Manufactures and on industrial, as well as service, robotics in the Annual Capital Expenditures Survey.[18]

Beyond federal efforts, states capture data related to labor market conditions and projections, as well as the demand for particular skills and occupations in their respective geographic areas. States and employers can use this information to help plan for their area's future workforce needs, including those for in-demand jobs.

Workforce System and Training Programs

State and local workforce development boards—key components of the workforce system that include representatives from area businesses, labor organizations, government, and training providers, among others—help direct employment and training in their respective geographic areas. The boards coordinate between DOL and local American Job Centers to optimize services for jobseekers and employers.[19]

Training programs, also known as workforce development programs, seek to provide participants with education and training to prepare them for work and help them improve their prospects in the labor market. Programs may focus on some combination of job-search assistance, career counseling, occupational skill training, classroom training, or on-the-job training. While training programs may support individuals who are unemployed with the goal of facilitating reentry into the job market, programs may also provide skills to already employed individuals, also known as incumbent workers. Incumbent worker training can have several benefits: it can help workers gain skills needed to maintain

[17]GAO-19-257.

[18]According to Census Bureau officials, these surveys do not directly make inferences about the impact of automation on work, but do produce experimental statistics on the share of workers at establishments (or firms) with robotics, a measure of exposure to automation technologies, including robotics. Officials also noted that agency efforts at collecting data on advanced technology have not been continuous, but have more recently been restarted.

[19]GAO, *Economic Adjustment Assistance: Experts' Proposed Reform Options to Better Serve Workers Experiencing Economic Disruption*, GAO-21-324 (Washington, D.C.: Apr. 19, 2021).

employment, avert layoffs, and promote development of skills to help workers progress in their careers.[20]

Within the workforce system, training programs can use a variety of methods. Some programs offer training that results in a credential or certificate to signal the skills participants have mastered. The Workforce Innovation and Opportunity Act (WIOA) affirms the importance of effective credentialing by stating that one of the purposes of the act is to provide workforce investment activities, through statewide and local workforce development systems, that increase participants' attainment of recognized postsecondary credentials.[21] Other programs are centered on a "career pathways" approach—a workforce strategy designed to bolster long-term earnings and self-sufficiency for workers by combining high-quality education, training, and other services to support participants' success. As part of this strategy, workers would have multiple opportunities to enter and exit training and jobs in a specific industry.[22] This can mean encouraging workers to find new jobs in "adjacent" careers that require similar skills or tasks to their previous jobs.[23] Programs can also help participants not just by teaching skills, but by providing "wraparound" services—comprehensive supports such as basic education, and supportive services such as childcare support or transportation—that enable participants to concentrate on their learning.[24]

[20]GAO-21-324.

[21]29 U.S.C. § 3101(6).

[22]ABT Associates, *Building Better Pathways: An Analysis of Career Trajectories and Occupational Transitions* (Rockville, MD: Dec. 2021). This study, funded by and prepared for DOL, noted that the career pathways approach has four main tenets: (1) offers multiple places to enter and exit training and jobs in a specific industry; (2) results in recognized credentials intended to lead to better jobs with higher pay; (3) uses support services and flexibility for nontraditional students; and (4) relies on employer partnerships.

[23]Burning Glass Technologies, *After the Storm*.

[24]GAO-21-324.

Available Data Do Not Explicitly Identify Workers at Risk of Losing Their Jobs to Automation, but Indicate Skills Needed for In-Demand Jobs

Federal and other data do not explicitly identify U.S. workers who are at risk of losing their jobs to automation, and recent estimates attempting to identify the number of workers affected have varied widely. DOL and the Census Bureau are seeking additional data on skills that the general worker population will need for in-demand jobs in light of automation. Currently available federal data show that in-demand jobs require workers to have a mix of skills, including soft skills; process skills that help a person acquire knowledge quickly (e.g., active learning and critical thinking); and technical expertise (e.g., equipment maintenance).[25] The data also indicate that the number of skills required for in-demand jobs increases with education and pay level. Further, research indicates that certain jobs and skills are less likely to be automated. In addition, in some states, state, local, and private data are used to inform which skills are most important for in-demand jobs in a given geographic area.[26]

Federal Data and Other Research Do Not Explicitly Identify At-Risk Workers, and Agencies Are Seeking Additional Information on Automation's Workforce Effects

Existing federal data do not explicitly identify, or provide detailed occupational characteristics about, workers that are most at risk for job loss. DOL officials noted that one of the primary challenges of collecting information on at-risk workers is accurately identifying who is at risk. Further, officials said any additional agency efforts would require significant resources and yield uncertain results. Officials also noted the large degree of uncertainty in academic estimates on the effects of automation on employment.[27] Our prior work corroborates this perspective. For example, in 2019 we found that academic research quotes anywhere from 9 to 47 percent or more of the workforce could hold jobs at risk of being automated. Additionally, we noted that workforce data do not identify the causes of employment shifts; so even for workers who have actually lost jobs, the data do not specify whether automation was the cause.[28]

[25]O*NET defines soft skills as interpersonal and thinking skills needed to interact successfully with people and to perform efficiently and effectively in the workplace.

[26]Descriptions and terms for skills vary across data sources such as O*NET or private research, making it difficult to directly compare different research studies' conclusions about specific skills required for in-demand jobs.

[27]DOL officials said that the agency is tracking a range of studies that use different datasets and methodological approaches to assessing automation's effect on the workforce.

[28]As noted in GAO-19-257, federal data do not provide a comprehensive picture of the causes of employment shifts or the skills needed for in-demand jobs.

Moreover, DOL officials noted that some occupations may be considered at risk of automation and yet still be projected to grow. For example, DOL officials noted that the number of truck driving jobs is projected to grow by about 3 percent from 2019 through 2029, but studies have also predicted those jobs are among the most at risk of automation further in the future.[29] DOL does not currently—and has no plans to—produce any public statistics on particular occupations' vulnerability to automation, due to the uncertainty and complications of creating such data.[30]

Like DOL, the Census Bureau collects data on the impact of automation on the workforce, but does not specifically identify at-risk workers. The Census Bureau's efforts include the Annual Business Survey, which Census Bureau officials said collected qualitative data at a high level and did not identify the subset of workers impacted by automation. Officials said other Census Bureau efforts likewise did not identify at-risk workers.[31]

DOL and the Census Bureau are expanding their efforts to collect and analyze data on skills needed by the workforce in light of automation. For example, BLS officials said they plan to conduct case studies of employers to examine how automation is affecting jobs and to inform potential future data collection efforts on automation. The agency plans to focus the studies on three sectors: retail trade, health care, and transportation and warehousing.[32] Additionally, in fiscal year 2020, DOL submitted a study to Congress on ways to supplement DOL data collection to understand the impact of changing technology on the

[29]See, for example, GAO, *Automated Trucking: Federal Agencies Should Take Additional Steps to Prepare for Potential Workforce Effects*, GAO-19-161 (Washington, D.C.: Mar. 7, 2019), which noted that widespread use of self-driving trucks was still years to decades away.

[30]As noted earlier, although BLS does not produce these statistics, BLS nonetheless incorporates technological impacts—such as automation—into its employment projections. Those projections examine automation along with other factors, such as changes in consumer preferences, demographic changes, and outsourcing, according to BLS officials. BLS's Occupational Outlook Handbook discusses automation for occupations when the BLS research concludes that automation has a significant impact on the expected future number of workers in an occupation.

[31]Census Bureau officials noted that they have an ongoing effort with BLS to combine establishment level data with worker skill data from O*NET.

[32]BLS officials said they plan to prioritize advanced technologies with the largest effects on jobs, and will review automation that is part of each sector's production. They anticipate publishing findings from the case studies in 2023.

workforce.[33] That study identified additional data needed on the demand for skills, including soft skills such as collaboration and more technical proficiencies such as coding. BLS has created working groups to evaluate the study's recommendations and plan next steps. DOL officials also said they are evaluating additional ways to collect data through surveys to further identify automation's effects on worker skills.

Likewise, researchers from the Census Bureau and others analyzed the 2019 Annual Business Survey data, which asked companies about their employment outcomes attributable specifically to adopted advanced technologies.[34] Among other findings, preliminary analysis showed the following:

- Most respondents—about 75 percent—reported no employment change attributable to technology, and of the respondents reporting change, more reported employment increases than decreases.[35]
- About half of respondents reported changes in skill levels due to adoption of technology, and, of those, firms generally reported that adopting technology resulted in increasing firms' demand for skills.
- Respondents that reported greater adoption of new technologies (e.g., high degree of use for robotics or specialized equipment) were more likely to report a greater increase in the skills needed to work at the respondent's company.

The Census Bureau is continuing to validate the results of the 2019 Annual Business Survey, and plans to release a final paper in September

[33]This study, among other efforts, helped DOL implement our recommendation to gather additional data on automation's effect on the workforce. See Gallup, *Assessing the Impact of New Technologies on the Labor Market: Key Constructs, Gaps, and Data Collection Strategies for the Bureau of Labor Statistics* (Omaha, NE: Feb. 7, 2020). DOL has also studied the feasibility of using its O*NET system to track changes in occupations over time and concluded that it was not feasible. DOL is also monitoring additional studies to assess the effects of automation.

[34]The Census Bureau specifically asked firms about the adoption of five technologies: artificial intelligence, cloud computing, dedicated equipment, robotics, and specialized software.

[35]Census Bureau officials noted that firms that reported greater use of robotics were just as likely or more to report a decrease in employment as to report an increase (conditional on a change in employment in either direction).

2022. Currently, the Census Bureau plans to repeat the workforce related questions in the 2023 Annual Business Survey.[36]

Data Indicate That In-Demand Occupations with More Skills May Require More Education and Offer Higher Pay, and Research Suggests These Jobs Are Less Likely to Be Automated

We analyzed BLS employment projections for the period 2019 to 2029 and 2020 O*NET skills data and found that in-demand occupations with more "important" skills (as indicated by O*NET) tend to require higher levels of education and offer greater pay.[37] Specifically, from the set of occupations with above-average changes in employment levels, we analyzed O*NET data on skills for the 20 fastest-growing occupations overall—regardless of education level—and also for the top 20 fastest-growing occupations according to three education levels needed for them:

- a high school degree or less;[38]
- some college;[39] or
- a bachelor's degree or higher.[40]

We found that in-demand occupations at every education level share many "important" skills. Further, as the education requirement increases,

[36]In addition, the Census Bureau plans to collect data on technology adoption through its Economic Census in 2022, but no questions on worker effects will be included, according to agency officials. The Economic Census collects data on businesses and economic impact every 5 years.

[37]O*NET uses a 5-point "importance scale" to quantify the importance of a particular skill to a particular occupation (such as the importance of the skill of speaking to the occupation of nursing). In this report, we used O*NET's average score of 3 or above to identify a skill as "important." Projections about future job growth and skills needed have limited certainty, as with any projections, and are subject to error because of the many unknown factors that may affect the economy over the projection period. Moreover, our analysis is at the national level, and the set of jobs projected to grow and the skills needed for them might differ across localities. For example, even if an occupation is projected to grow at the national level it does not mean that it will be growing in all localities. Additionally, given that these are national-level data, the characteristics of the selected occupations, such as median wages, might differ across localities. For additional information about O*NET and our analyses, see appendix I.

[38]We defined occupations needing "a high school degree or less" as those occupations with a typical entry-level education, based on BLS's projections data, of "high school diploma or equivalent" or "no formal educational credential."

[39]We defined occupations needing "some college" as those occupations with a typical entry-level education, based on BLS's projections data, of "associate's degree" or "postsecondary nondegree award" or "some college, no degree."

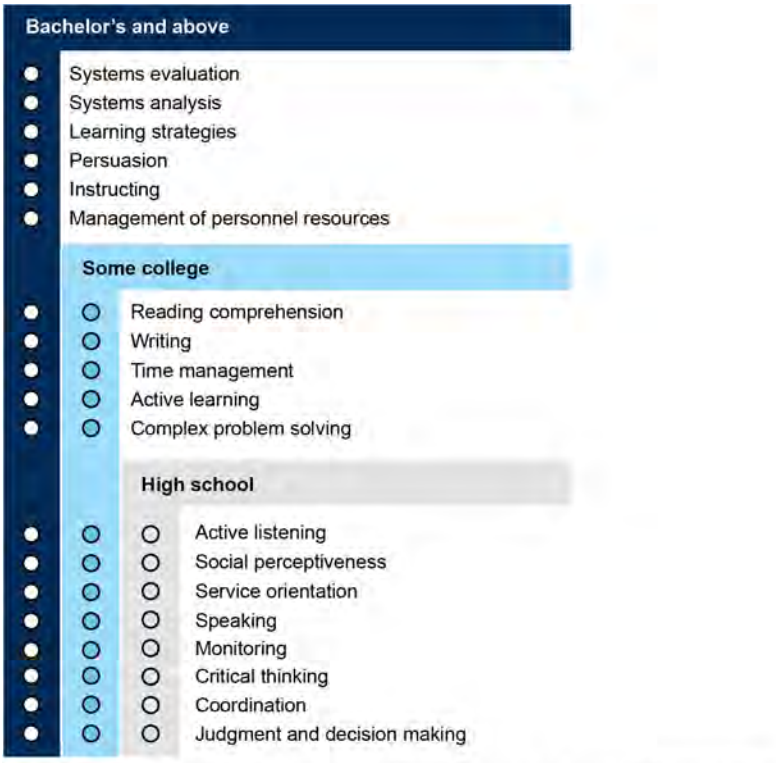
[40]We defined occupations needing "a bachelor's degree or higher" as those occupations with a typical entry-level education, based on BLS's projections data, of "bachelor's degree" or "doctoral or professional degree" or "master's degree."

so does the number of “important” skills.[41] Specifically, in-demand occupations across all education levels share eight “important” skills—including critical thinking and service orientation. Occupations requiring at least some college or a bachelor’s degree or higher have an additional five skills in common.[42] Similarly, we found that skills for occupations requiring a bachelor’s degree or higher have six additional “important” skills that were not associated with skills listed for the other two levels of education, as shown in figure 1.

[41]In addition, we regressed the total number of skills deemed important for each occupation on the education level and found a positive and statistically significant relationship in the sample of our top 20 jobs as well as in the overall dataset. This relationship represents a correlation, and we did not control for other factors. Thus, it could be driven by factors related to both the total number of skills deemed important and to the education level. For a full list of occupations and skills, see appendix I.

[42]In order to identify the skills deemed important for each education group, for each skill in that group we calculated the weighted average importance score (weighted by 2019 employment) and selected the skills with a weighted average importance score of 3 or above. While our analysis of O*NET data identifies skills required for the top 20 in-demand occupations collectively, those data also include skills unique to each in-demand occupation. For example, among our top 20 in-demand occupations where the typical education needed for entry is high school or less, “equipment selection” is a skill deemed important only for the occupation of industrial machinery mechanic. Likewise, “installation” is a skill deemed important only for solar photovoltaic installers. For the list of weighted average importance scores for each education group, see appendix I.

Figure 1: Skills Deemed Important in the Top 20 In-Demand Occupations, by Education Level



Source: GAO analysis of U.S. Bureau of Labor Statistics (BLS) Employment Projections program data and U.S. Department of Labor Occupational Information Network (O*NET) data. | GAO-22-105159

Notes: We restricted our study of the fastest-growing, "in-demand" jobs to those occupations that were projected to gain an above-average number of jobs in the 2019-2029 period for each of the three education groups. Then, using O*NET's skills and "importance scores," we identified the most important skills for the 20 fastest-growing occupations by calculating the weighted average importance score (weighted by 2019 employment) and selecting the skills with a weighted average importance score of 3 or above for each education level. For additional information on how O*NET describes skills, see: basic skills and cross-functional skills.

The number of skills deemed important in each education category were similar for in-demand occupations and all other occupations. (See table 1.)

Table 1: Number of Skills Deemed Important by Occupational Information Network (O*NET) Data, According to Education Level Required for Occupations

Education level	Number of "important" skills for in-demand occupations	Number of "important" skills for other occupations
High school or less	8	9
Some college	13	13
Bachelor's degree or more	19	20

Source: GAO analysis of U.S. Bureau of Labor Statistics (BLS) Employment Projections (EP) program data and U.S. Department of Labor Occupational Information Network (O*NET) data. | GAO-22-105159

Notes: We identified in-demand occupations as those occupations that were projected to gain an above-average number of jobs during the 2019–2029 period for each of the three education groups, and then chose the 20 fastest growing occupations for each education group. We also identified occupations outside of the top 20 in-demand occupations in the relevant education group. For each category, in order to determine if one of O*NET's 35 skills was deemed important for a particular education level, we first calculated the weighted average importance score (weighted by 2019 employment) for the top 20 in-demand occupations and for the occupations outside of the 20 in-demand occupations in that education group and selected the skills with a weighted average importance score of 3 or above. O*NET uses a 5-point "importance scale" to quantify the importance of a particular skill to a particular occupation (such as the importance of the skill of speaking to the occupation of nursing). We used O*NET's average score of 3 or above to identify a skill as "important."

In addition, in-demand jobs that require a greater number of "important" skills also have higher average pay, according to our analysis of BLS and O*NET data. For example, those top-20 overall in-demand jobs in the highest quartile—with median pay of nearly $110,000—have about 18 skills deemed important, while jobs in the lowest quartile—with median pay of about $30,000—have about eight skills deemed important.[43]

Research suggests that many of the skills needed for in-demand occupations at the higher levels of education—including more abstract skills and those involving judgment and adaptability—might protect individuals from the effects of automation. For example, one study noted that the skills most vulnerable to automation are routine cognitive and physical skills, such as operating machinery or collecting and processing data, while the least vulnerable are skills such as creativity, social skills,

[43]We divided our top 20 in-demand occupations into quartiles based on median wage data (in 2020 dollars) from BLS's Occupational Employment and Wage Statistics program. We also regressed the total number of "important" skills on median annual wages and found a positive and statistically significant relationship in the sample of our top 20 jobs, as well as in the overall dataset. This relationship represents a correlation, and we did not control for other factors. Thus, it could be driven by factors related to the total number of skills deemed important and to wages.

management, and planning.[44] That study noted that nursing and home health support are good examples of occupations with tasks that are difficult to automate because they involve high levels of social and emotional interaction. Those occupations are growing and were included in our analysis of in-demand occupations.[45]

O*NET Has additional Resources for Individual Job Seekers

O*NET has additional information on jobs and the skills required for them. For example, O*NET lists "Bright Outlook" occupations, which, like in-demand jobs, are projected to grow faster than average or to have more than 100,000 openings over a 10-year period, nationally. For each occupation, O*NET provides detailed information, including particular tasks common to the occupation; skills ranked by importance; and specific technology skills such as cloud-based software or spreadsheet skills. For example, for home health aides, O*NET details 11 common tasks such as maintaining records of patient care and checking patients' pulse and temperature. O*NET also lists active listening, service orientation, and social perceptiveness as the top three most important skills for those aides. DOL officials noted that American Job Center staff work with job seekers to identify their skills and abilities, and advise them on in-demand jobs and potential training opportunities available in their local areas based on local labor market information.

Source: GAO analysis of Occupational Information Network (O*NET) data and Department of Labor interviews. | GAO-22-105159

Other studies have suggested that paths for obtaining new skills might help with performing new jobs in the future. For example, one study stated that workers have found some success in meeting changing job demands by acquiring new skills through formal educational attainment, such as obtaining a bachelor's or associate's degree.[46] That study noted that new and emerging jobs may have a high demand for analytical skills. Another study stated that formal educational attainment will not be the only path, noting that automation will also create other jobs that do not require a college degree, such as robotics technicians.[47]

Workers who acquire additional skills may be able to leverage those skills to obtain jobs that offer higher pay. For example, one report observed that a retail worker could acquire some basic computer skills to become a "help desk" specialist.[48] Another study stated that workers at risk of automation could, with reskilling, expand their career options and increase their income.[49] Moreover, without reskilling, a quarter of at-risk workers could see their income drop, according to the same study.

[44]See Conor McKay, Ethan Pollack, and Alastair Fitzpayne, *Automation and a Changing Economy, Part I: The Case for Action* (Washington, D.C.: Aspen Institute, April 2019).

[45]For example, nurse practitioners, occupational therapy assistants, home health and personal care aides, and physical therapy assistants all made the list of top 20 in-demand occupations. See appendix I for the complete list.

[46]Anthony P. Carnevale, Megan L. Fasules, and Kathryn Peltier Campbell, *Workplace Basics: The Competencies Employers Want 2020* (Georgetown University Center on Education and the Workforce, 2020).

[47]Burning Glass Technologies, *After the Storm*.

[48]Burning Glass Technologies, *After the Storm*.

[49]The Boston Consulting Group, *Towards a Reskilling Revolution: A Future of Jobs for All* (Geneva: World Economic Forum, January 2018)

Likewise, one group of researchers noted that occupations requiring intellectual knowledge, skills, and abilities yield the highest pay.[50]

State Data and Other Research Provide Additional Information on Skills Needed for In-Demand Jobs in Specific Geographic Areas

States Have Flexibility to Identify In-Demand Jobs

States can identify in-demand jobs in different ways, including taking into account factors such as predicted job growth, wages, stability, and future outlook. For example, all of our case study states incorporated projected job growth rates and job openings to determine their in-demand jobs. In addition, California, Pennsylvania, and Washington analyzed supply and demand to determine their in-demand jobs, while California, Kentucky, and Pennsylvania included wages and education levels as part of their determinations.

Source: Department of Labor data and interviews. | GAO-22-105159

Stakeholders we interviewed in our case study states said that many state and other entities—such as governments, business organizations, training providers, unions, and private companies—collect data on the in-demand jobs and skills needed in their specific geographic areas.

State governments. State governments collect data on in-demand jobs and skills needed in their states and, according to DOL, are able to do so because of the nationwide workforce and labor market information system that is authorized and funded under the Wagner-Peyser Act as amended by the Workforce Innovation and Opportunity Act (WIOA).[51] In addition, states must include an analysis of economic conditions in their state as part of their WIOA state plan.[52] Each of our case study states maintains data online that provide information on occupational projections within their states, as well as skills and training or education needed for specific occupations. For example, California publishes data by occupation at a regional level, along with an interactive tool that shows occupational profiles of job skills needed and training requirements for high-growth occupations, which officials said workers could use to identify “adjacent” jobs that can build on skills a worker already has. Likewise, Washington maintains data on in-demand occupations by county, as well as employment projections, pay, and skills information. Washington officials noted that the local workforce development boards finalize the lists of in-demand jobs in their regions. For skills information in particular, Washington uses private data to identify skills from online announcements. Kentucky has created a workforce dashboard showing 5-year projected job growth by region, wage estimates, and skills self-assessments for all occupations collectively or specific occupations. The dashboard can present information on occupations by education, experience level, growth, and typical on-the-job training, among other

[50]Anthony P. Carnevale, Megan L. Fasules, and Kathryn Peltier Campbell, *Workplace Basics: The Competencies Employers Want 2020*.

[51]See 29 U.S.C. § 49l-(2).

[52]See 29 U.S.C. § 3112(b)(1)(A). In order for states to be eligible for WIOA funding for adult and dislocated worker employment and training activities, states must submit a unified state plan outlining a 4-year strategy for the core programs defined under the act. 29 U.S.C. § 3112(a). See also 34 C.F.R. § 361.105. The determination of whether an industry sector or occupation is in-demand for purposes of WIOA is made by the state board or local board, as appropriate, using state and regional business and labor market projections, including the use of labor market information. 29 U.S.C. § 3102(23)(B).

characteristics. Pennsylvania officials said their state labor department uses data from research organizations within the state to obtain information pertaining specifically to workers at risk of losing their jobs to automation.

Business organizations. Business organization representatives on state boards said they took various approaches regarding collecting information on skills needed for in-demand jobs, as well as information on the effects of automation. For example, officials from a business organization in one state said it tracks jobs that could be lost to automation, and reports these data to the governor's office during monthly meetings. The organization collects information from thousands of businesses in its region through questionnaires and calls, and asks questions such as whether jobs at the business will exist in 5 years or if the company is considering automating jobs. The officials said they research potential trainings that could support workers whose jobs may soon be automated. In contrast to collecting their own data, an official representing businesses on another state workforce board said that their association relies on outside sources for data and worked closely with a local economist to study automation in their state. The study found, among other things, that automation is creating new tasks for workers to perform, which may require specific training. Similarly, business representatives in another state said that their state used a public-private partnership to collect data from businesses and employers to report on jobs in high demand.

Training providers. Training providers in our selected states presented a range of data collection efforts, from collecting data themselves on skills needed for in-demand jobs to relying on outside information. One training provider, for instance, said it gathers data on projected automation, digital skills, and job openings and shortages. Specifically, the provider said it examined the degree to which tasks within certain health care jobs are likely to be automated, and found that from 30 to 60 percent of those tasks are likely to be automated. The study also found that the percentage of tasks subject to automation decreases as a worker moves further up the career ladder. Another training provider said it collects data on in-demand jobs and skills by surveying industry partners, as well as reviewing projected retirement data and state community college data. One training provider noted that it relies significantly on state and regional workforce development board data, as well as private data, which the provider uses to identify demand for training.

Unions. Union representatives in two case study states said that they collect workforce information. Of those, one representative said that their

union's apprenticeship program collects information from its contractors to determine the demand for its programs, while the other said that their union provides labor demand data to state officials. Separately, a union representative in another case study state said that their organization does not collect data, and instead relies on the state's employment data.

Private data. Some companies collect workforce data such as skills for in-demand jobs, credentials, and training needs. These companies can obtain the data from job postings and other data, which can provide more insight than federal data alone.[53] For example, these data

- provide skills data that are more up to date than O*NET because the job postings are current. This allows private data collection companies to readily observe workforce effects of current events, such as the COVID-19 pandemic. One such company published the trends it saw in jobs and skills coming out of the pandemic, including a greater push toward automation.[54] A company representative also said that O*NET job data can be slow to identify emerging trends; the representative noted that, for example, "data scientist" was added to the O*NET jobs list in 2018, despite being an identifiable occupation for a decade prior to then.[55]
- identify more specific skills than O*NET's set of 35 skills because job postings have more specific requirements. For example, skills could include mastery of specific software or familiarity with social media platforms. However, O*NET also uses private data to compile and update a list of "Technology Skills," which identify the general skill (e.g., "spreadsheet software"), as well as the specific software technology. O*NET lists these skills on its website by occupation.

[53]A representative from one company, for instance, testified to Congress that it monitors nearly 50,000 job sites daily and at any given time tracks over 3 million current job openings. The representative said that the company's database holds more than a billion current and historical job postings, which allows the company to identify trends and see changes in the market quickly.

[54]See Burning Glass Technologies, *After the Storm*.

[55]DOL officials noted that O*NET purchases job postings data from a private company and uses the data, in part, to identify alternate job titles. These alternate job titles are associated with O*NET occupations and used to make the online keyword searches more effective for users who search on job titles, rather than by federal occupational codes. However, DOL officials also said that O*NET skills and other data are generally updated every 5 years, and it is unfeasible to track changes in occupational skill requirements over time.

- could help job seekers identify possible ways to build on existing skills to obtain a job that might be less subject to automation.
- can identify in-demand skills for specific geographic areas.

However, two stakeholders cited concerns about relying too heavily on private data to identify skills important for in-demand jobs. One stakeholder noted, for example, that the universe of online job postings is more heavily weighted toward professional occupations in large companies and consequently may not feature occupations that are projected to have many job openings over the next decade, such as food service. Both stakeholders said that the postings may not contain the skills typically required for the occupation. For example, job postings are often quite short, the stakeholders said, so they do not describe the majority of skills needed for the job. One stakeholder also said that the process of translating the job posting text to data can yield unreliable results.

Selected Stakeholders Suggested Workforce Programs Could Better Serve Displaced Workers by Refining Content and Increasing Accessibility and Investment

Stakeholders we interviewed offered insights on how existing workforce programs could better serve displaced workers who face challenges to getting in-demand jobs, and those at risk of losing their jobs to automation. Specifically, stakeholders proposed focusing training content on in-demand skills, designing programs to maximize their accessibility, incentivizing additional training opportunities, and collaborating with other workforce stakeholders to enrich the training landscape, among other potential steps, to better serve workers displaced by automation.

State Workforce Officials Cited a Few Examples of Training Programs Serving At-Risk Workers

While selected state workforce board representatives cited very few programs that targeted workers at risk of losing their jobs to automation, some efforts do exist. In Kentucky, for example, the National Dislocated Worker Grants program was used to fund employment and training services for approximately 200 displaced workers when their plant relocated due to automation. One plant worker, facing a potential layoff after 34 years, said he found new employment as a controls engineer after completing a 12-week training program. Another worker used career services and training to eventually earn a commercial driver's license, according to Kentucky workforce officials.

In addition, California workforce board officials said that an agricultural company in California automated its manual fruit-packing processes. The company sponsored in-house training to retain about 90 percent of their affected employees, who learned how to operate, clean, and maintain the new machinery.

Source: GAO analysis of interviews with state and local workforce boards. | GAO-22-105159

Training Program Content That Includes Aligning Existing and In-Demand Skills May Help Workers Obtain In-Demand Jobs

Characteristics of Workers at Risk of Automation May Differ from General Population

Previous GAO work has found that the characteristics of workers in jobs at risk of automation may differ from those of the workforce generally. For example, at-risk workers earn less, on average, and have on average fewer years of education. Other research has observed similar dynamics, noting for example that rural workers are more likely to be negatively impacted by automation. This research has suggested that training programs centered on at-risk workers should consider how the program can respond to the particular skills, needs, and characteristics of this population.

Source: GAO, Workforce Automation: Better Data Needed to Assess and Plan for Effects of Advanced Technologies on Jobs, GAO-19-257 (Washington, D.C.: Mar. 7, 2019) and GAO analysis of National Governors Association Center for Best Practices, Future Workforce Now: Reimagining Workforce Policy in the Age of Disruption (Washington, D.C.: July 2020). | GAO-22-105159

According to many stakeholders, providing in-demand skills training could help workers overcome some of the challenges they face in obtaining in-demand jobs. For example, stakeholders in three states said one challenge is that training program content does not always focus on in-demand skills. One state official said that some programs focus on interviewing and resume writing skills, rather than helping workers acquire the actual skills needed to do the tasks for their next jobs. Two other stakeholders noted that workforce programs tend to focus on getting workers new jobs quickly, rather than finding jobs that could provide a longer career or work that is less susceptible to automation. Several stakeholders reported that, as a result, such programs can lead to short-term or low-wage jobs while doing little to promote entry into jobs that provide satisfactory levels of stability and wages.[56] For example, one stakeholder mentioned a program that taught participants to operate a cash register, which, upon program completion, would likely lead to a low-wage job that the stakeholder did not believe provided enough financial stability.

A second challenge, mentioned by state board stakeholders across all four states, is that workers may struggle psychologically to accept reskilling programs or new jobs. For example, one stakeholder said that job loss can be traumatic for many workers, while another said training programs that do not adequately consider workers' psychological barriers can limit opportunities to obtain in-demand jobs. According to state board stakeholders in two states, workers may not be able to envision how their skills can translate to another occupation because they have been doing the same job the same way for many years.

Lastly, two stakeholders suggested that some training programs that do not result in an industry-recognized credential hinder access to in-demand jobs. When workers do not have a recognizable credential, or when skills associated with a credential are unclear, employers may be unsure whether workers have obtained skills relevant to their job openings. Likewise, one stakeholder noted that even when credentials are provided, workers may not understand which ones are valuable to employers. Consequently, workers may not understand which training programs are most useful for obtaining in-demand jobs.

[56]According to DOL officials, states can consider stability and pay as part of the requirements for the definitions of in-demand jobs in their states.

Stakeholders offered various approaches to mitigate some of these challenges. Stakeholders and research noted that workforce organizations can adjust program curriculum in several ways to help workers obtain in-demand jobs. For example, workforce officials in one state noted the importance of teaching skills that lead to jobs that are less likely to be automated, while officials from another state said that training should help workers obtain "higher-level" skills in order to compete in the labor market; as we noted earlier, these skills may be less likely to be automated. Another state's workforce officials suggested that workforce programs should train workers for high-growth, good quality jobs by emphasizing skills needed to perform jobs that will be automation resistant. Additionally, one labor representative stated that while training often focuses on resume writing and interviewing, training would be more useful if it identified which occupations each worker should pursue and relevant skills for that occupation.

Another strategy, suggested by two studies, emphasizes building upon existing skills to move employees to "adjacent" jobs quickly.[57] State board stakeholders in two states echoed this; one state board stakeholder who represented employers said that long-haul truckers whose jobs are at risk of automation could apply skills from that job to other trucking-related positions such as monitoring vehicles for an emergency call center tracking those vehicles. The stakeholder noted the importance of workers believing their skills will be transferrable, suggesting that transitioning to new jobs that rely on already mastered skills may alleviate psychological barriers.

A 2021 report funded by DOL includes similar insights. It suggests focusing training on occupations that are likely to lead to wage growth for workers. Accordingly, the report intends to help training providers design programs that focus on "career pathways" by providing information on career trajectories and occupational transitions (such as which occupations are associated with higher-than-average wage growth for job entrants over time). The report also suggested that programs should not focus solely on a narrow range of highly specialized skills.[58] Instead, it recommended teaching skills such as problem solving and

[57]Burning Glass Technologies, *After the Storm;* and McKinsey Global Institute, *The Future of Work in America* (Washington, D.C.: July 2019).

[58]DOL officials noted that programs focusing on a narrow range of highly specialized skills may still be highly desirable for certain occupations or industries, such as health care.

communication, which are associated with occupations with strong wage growth and are also transferrable to a variety of industries and occupations.[59]

Washington's "Upskill Backfill" Initiative Provides Advanced-Skill Training

Washington stakeholders cited the Upskill Backfill initiative as a potentially useful model to train workers impacted by automation, though the initiative has not served these specific workers to date. One such training sought to upskill welders and machinists for supervisory roles by advancing both technical and "soft" skills, such as communication and teamwork. At the end of the program, 255 people completed training and 28 people were promoted. While technical skills were considered important, the workforce board attributed the promotions to the soft-skills training.

Source: Washington Workforce Training and Education Coordinating Board documentation and interviews with state workforce board officials. | GAO-22-105159

Additionally, one study advised that training programs be designed to lead to widely recognized credentials that signal mastery of in-demand skills. For instance, the study highlighted one state that provides programs that result in recognized certificates, like a welding certificate from a community college. This state is also developing a way to track relevant data to signal the credentials job applicants carry.[60] Another state's governor signed an executive order requiring the state to recommend ways to create more transparency for credentials conferred by public higher education institutions by translating them wherever possible into skills and competencies. Similarly, workforce experts we interviewed for our April 2021 report suggested providing workers with information on the quality of credentials and how credentials can be combined to help career progression.[61] Moreover, another study of four sector-based training programs noted that training programs that focused on occupational skills leading to an industry-recognized credential, as well

[59]ABT Associates, *Building Better Pathways: An Analysis of Career Trajectories and Occupational Transitions* (Rockville, MD: Dec. 2021).

[60]National Governors Association Center for Best Practices, *Future Workforce Now: Reimagining Workforce Policy in the Age of Disruption* (Washington, D.C.: July 2019).

[61]GAO-21-324.

as targeting high-wage sectors, among other characteristics, produced the largest and most persistent wage gains.[62]

Finally, some workforce stakeholders have taken steps to define or broaden understandings of which credentials provide meaningful skills for in-demand jobs. For example, a state board stakeholder representing training providers stated that the community college system can be leveraged to provide many workers with credentials a variety of employers understand and value. Another stakeholder noted that an organization comprised of academic, manufacturing, technology, and government stakeholders created credentials, and members agreed that the credentials represented skills critical for working in their sector.

Improving Access to Training Can Lead to Greater Worker Participation and Opportunities to Obtain In-Demand Jobs

According to stakeholders, access to training presents a key challenge to obtaining skills needed for in-demand jobs, and workers would benefit from better solutions related to childcare concerns, scheduling, financial hardships, or geography.

- **Childcare concerns.** State board stakeholders from all four states, as well as other interviewed stakeholders, cited childcare obligations as a significant barrier to accessing job training, with stakeholders from one state noting barriers are exacerbated by a shortage of affordable childcare options for many parents. Furthermore, government representatives on one state board said childcare services had been reduced recently (and therefore childcare options diminished), and a business representative from another state board said childcare had been significantly disrupted by the pandemic. The level of concern over lack of childcare aligns with our prior work, which identified childcare as one of the two most-needed support services and was particularly challenging for rural and tribal communities.[63]
- **Difficulties with scheduling.** Two stakeholders also said that inconvenient training program schedules can hinder access, such as when training conflicts with work hours for workers with ongoing jobs.

[62]Lawrence F. Katz et al., "Why Do Sectoral Employment Programs Work? Lessons from WorkAdvance," paper from *JOLE* Virtual Conference in Honor of Alan Krueger (version from December 10, 2020). This study noted that it was not clear exactly which mechanisms of the training programs studied produced these gains. The study stated that a combination of upfront screening of applicants on basic skills and motivation, training on soft skills, and wraparound support services were all characteristics of the training programs that resulted in the largest and most persistent wage gains.

[63]GAO, *Economic Adjustment Assistance: Actions Needed to Better Address Workers' Needs and Assess Program Effectiveness*, GAO-20-521 (Washington, D.C.: July 29, 2020).

For example, one local workforce board director stated that training programs scheduled to operate over a long period of time may be unattractive to workers, who cannot put their life on hold for the duration of the program.

- **Financial hardships.** Several stakeholders also said that workers who would benefit from training may face financial hardships, especially if they struggle to cover living expenses while enrolled in unpaid training. For example, state board stakeholders from two states and other stakeholders said that income insecurity was a major challenge for at-risk or unemployed workers. Faced with a decision about whether to engage in training that may boost job prospects and earnings long term on the one hand, or work in a job that offers low but immediate pay on the other hand, potential participants may choose the latter. Unpaid training can worsen financial hardships since time spent in training may erode savings a participant might have.
- **Transportation and geographic barriers.** Several stakeholders also noted barriers relating to transportation or geography, including lack of consistent transportation to training or job sites. For example, representatives from three state boards and other stakeholders interviewed said that available jobs might be far away from some local areas. Likewise, three stakeholders noted that some areas with more employment opportunities were difficult to reach for some job seekers, creating transportation and geographic barriers to employment. We have also found that job automation varies significantly by geographic location, with certain areas of the country more reliant on occupations susceptible to automation.[64] This could exacerbate automation's effects on the labor market in particular geographic locations.

Programs that respond to these challenges can help Americans access training aimed at entry into in-demand jobs, according to stakeholders. For example, several stakeholders stated they saw wraparound services as useful for mitigating access challenges. A state agency representative said that a community college had helped job seekers experiencing homelessness through comprehensive wraparound services that included connecting them with housing support and helping them apply for COVID-19-related grants. Stakeholders also said that training participation rates may improve as a result of wraparound services (such as substance

[64]GAO-19-257. Census Bureau officials said the agency has recently produced new maps that show the concentration of robotics adopters in manufacturing across states and the susceptibility of workers to automation.

abuse counseling) that address participants' personal struggles. Likewise, one study noted that wraparound services may be particularly important for training participants who may find it difficult to thrive in more traditional postsecondary educational institutions.[65]

Two state board stakeholders stated that training programs should consider optimal schedules for their target population. Specifically, scheduling training outside of normal work hours and for relatively short periods may enable attendance for workers with schedule conflicts stemming from their ongoing jobs or other obligations. For example, a state workforce board labor representative credited the short length (15 weeks) of a general industrial training program with its success in placing participants in employment.

Another strategy to promote greater access to job training is for programs to offer financial support. Several stakeholders, as well as experts interviewed for a prior report, said training programs that pay stipends or combine work with training could help increase enrollment of at-risk workers.[66] This financial support may alleviate pressure to find immediate work that may come at the expense of obtaining in-demand skills. Stakeholders from several state boards spoke favorably of the federal Registered Apprenticeship program because it provides participants with income while it offers training. However, two stakeholders cautioned that these apprenticeship programs face barriers themselves, such as cost and administrative burden (as discussed further in the next section).

To lessen geographic barriers, state workforce board stakeholders mentioned several potential approaches. For example, stakeholders in one state suggested using technology to mitigate geographical challenges, and noted that a training provider received private funding to focus its efforts on underserved rural areas. Stakeholders in another state emphasized the need to promote more economic growth in rural areas. Other state stakeholders said that they should consider how to bring in-demand jobs to workers. Another factor to consider is the likelihood of a worker and their family choosing to relocate to a new area away from their established community. One stakeholder said relocation could be

[65]Lawrence F. Katz et al., "Why Do Sectoral Employment Programs Work? Lessons from WorkAdvance."

[66]GAO-21-324.

complex and disruptive, and suggested that it may not be the appropriate solution to geography-related challenges.

Washington Program Helps Mitigate Challenges by Tailoring Training to Meet Employer and Trainee Needs

Workforce officials in Washington highlighted its Job Skills Program, which pairs colleges with employers on a project basis to provide employers with the necessary support to meet their specific training needs. For example, a meat processing company partnered with a local community college to enhance its in-house training for an industrial maintenance certification. Trainees were paid for a 40-hour work week that included attending training for 16 hours a week at one pay rate, while working at the company for the remaining 24 hours at a different pay rate. The company also covered 66 percent of the tuition costs of the training. A company official reported that the training provided workers with opportunities to both improve their skills and move into higher-skilled positions within the company. In all, 15 workers were upskilled through the program, and most were promoted following training.

Source: State documentation and interviews with state workforce board. | GAO-22-105159

Stakeholders Cited Importance of Greater Investment in Training and Collaboration to Facilitate In-Demand Skills and Jobs

According to stakeholders, increasing investment in training and strengthening collaboration in the workforce system can mitigate challenges with funding and developing new training programs, thereby facilitating in-demand skills and jobs. Stakeholders from all four state workforce boards said their states have struggled with funding for training in various ways. For example, stakeholders from one state said that they pursue multiple funding sources but still find it difficult to fund trainings that the industry needs. Likewise, one local workforce board director stated that developing training programs is often costly, particularly when program administrators seek to improve accessibility through features like wraparound services.[67] We previously reported expert opinion that firms vulnerable to technological advancements may not have the resources to retrain workers, and one report we reviewed similarly noted that limited funding for training may especially limit lower-wage, front-line workers who are seeking advancement opportunities and are at significant risk of displacement due to automation and other technologies.[68]

Several stakeholders also noted that employers may face additional challenges in offering training, limiting the availability of programs. For example, several stakeholders from one state's workforce board said that employers hesitated to offer Registered Apprenticeships because they have burdensome administrative requirements. Another stakeholder also

[67]Board stakeholders from two states said that that their funding was not sufficient for wraparound services to accompany training programs, though one stakeholder emphasized that such services are meaningful components of training to get an in-demand job, rather than "just" another job.

[68]GAO-21-324 and *Talent Finance: A New Consensus and Return-To-Investment*. U.S. Chamber of Commerce Foundation (Washington D.C.).

noted the significant startup and administrative costs of Registered Apprenticeships, and said limited funding can make those programs unstable. Stakeholders from one state board suggested increasing federal funding for a state training program they said has shown good results and has a waitlist. Likewise, one study suggested that government could help employers by providing financial incentives for paid work-based learning in cooperation with external education and training partners who also receive government incentives for that training.

In addition, several stakeholders noted examples of collaboration that promoted entry into in-demand jobs. For example, stakeholders on one state board said their upskilling program encouraged collaboration among workforce development organizations, community colleges, and employers to provide participants a pathway from training to an in-demand job. A business representative on another state board highlighted a similar program, where a training provider solicited the input of local employers on course work and gathered their ideas for key course content. Lastly, another board representative from that state discussed a program, in which a company collaborated with another state's community college to train workers in advanced skills, including skills necessary for technician positions that the company and other employers had been struggling to fill. The state board stakeholder said that types of collaboration like this—employers partnering with academia—could reduce problems from programs operating in separate silos.

Similarly, many stakeholders noted the benefits of collaboration through industry partnerships. For example, one stakeholder noted that collaboration across industry, trainers, and government officials helps generate new job training programs to address the region's skill gaps. Likewise, a local workforce board launched a project involving hospital systems, clinics, and health care providers to identify high-demand occupations, learn how the region was producing skilled workers for those occupations, and identify the industry sector's challenges. As a result of that collaboration, the local area obtained an H-1B grant that provided federal funding to train health care providers and close the skills gap.[69] Additionally, one study we reviewed emphasized the importance of cross-stakeholder collaboration among stakeholders, such as workforce development boards, employers, training providers, and private entities.

[69]H-1B Skills Training grants fund projects that provide training and related activities to workers to assist them in gaining the skills and competencies needed to obtain or upgrade employment in high-growth industries or economic sectors. See 29 U.S.C. § 3224a.

Another study suggested that public-private partnerships may be needed to generate more comprehensive labor market information. According to the study, the information can then be used to better evaluate workers' outcomes, inform state decision-making, help employers invest in training, and help workers identify in-demand job opportunities.[70]

Agency Comments

We provided a draft of this report to the Departments of Labor and Commerce for review and comment. Both agencies provided technical comments, which we incorporated, as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Labor, the Secretary of Commerce, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-7215 or locked@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix II.

Dawn G. Locke, Acting Director
Education, Workforce, and Income Security Issues

[70]National Governors Association Center for Best Practices, *Future Workforce Now*.

Appendix I: Objectives, Scope, and Methodology

The objectives of this review were to examine (1) what available data indicate about which workers are at risk of automation and the skills needed for in-demand jobs; and (2) what insights stakeholders offer for workforce programs to better serve displaced workers, and those affected by automation.

Section 1: Analyses Using Data from the Bureau of Labor Statistics and Occupational Information Network

For our first objective, we analyzed Department of Labor (DOL) data to identify occupations projected to grow over the next decade, as well as the skills associated with those growing occupations. Interviews with officials from selected case study states (described in Section 2 in this appendix) helped us understand what data existed on in-demand jobs and skills on a state and local level, and likewise, what data were unavailable to state and local stakeholders.

This section describes our methodology for identifying "in-demand" jobs, the methodology for matching occupational data from the U.S. Bureau of Labor Statistics (BLS) Employment Projections data to the DOL Occupational Information Network (O*NET) skills data, and how we identified the skills deemed important for our "in-demand" jobs.[1] It also presents the results of the analysis, as well as the associated caveats and limitations. We established the reliability of these data through a

[1]BLS's Employment Projections (EP) program publishes 10-year projections of national employment by industry and occupation based on analysis of historical and current economic data for the labor market, the macroeconomy, and industrial activity. The projections are developed annually and present employment for approximately 300 industries and about 800 occupations covering all occupations in the U.S. economy.

O*NET is a comprehensive database of worker attributes and job characteristics. The O*NET Data Collection Program provides information on skills, knowledge, abilities, and other information on nearly 1,000 occupations covering the entire U.S. economy. According to DOL officials, O*NET data are collected through a statistically valid two-stage sampling method of selected business establishments and incumbent workers within those sampled businesses. This is supplemented with responses from occupational experts (who are not themselves incumbent workers in the occupation) and occupation analysts—both of whom have knowledge of the requirements of work in relevant occupations. The O*NET survey methodology has been approved and re-approved by the Office of Management and Budget every 3 years since 2000.

The number of occupations is higher in O*NET than in the Employment Projections because O*NET provides information on some occupations at a more detailed level than the Employment Projections. Moreover, according to BLS officials, while O*NET provides some information for all occupations in the economy, it does not provide O*NET-specific information (such as knowledge, skills, and abilities) for residual ("All Other") occupations. Even though O*NET does not have O*NET-specific data at the residual level, it may incorporate more detailed occupations within the broader "All Other" category which have O*NET-specific data.

review of relevant agency documentation and interviews with knowledgeable agency officials.

Selection of In-Demand Jobs

Although BLS had released 2020-2030 projections at the time of our analysis and also provided a list of occupations that excluded those most affected by the pandemic, we decided to use projections for 2019-2029. We did so because the COVID-19 pandemic triggered an economic recession from February to April 2020, which led to substantial and immediate declines in output and employment during that period. Because 2020 serves as the base year for BLS's 2020–30 projections, these recession impacts translate to lower base-year employment values than seen in recent projections and, therefore, disproportionately higher projected employment growth between 2020 and 2030 among the occupations most affected by the 2020 recession. Consequently, industries most affected by the pandemic, such as accommodations and food services, would see a large change in employment, partly due to the low base and the accompanying short-term recovery. Thus the 2020-2030 employment growth projections include both short-term recovery from the pandemic and longer-term structural changes, and it is unclear what portion of the projected growth is due to the short-term pandemic recovery versus structural changes. Moreover, besides the pandemic affecting short-term changes in employment, it might have longer-term impacts (independent of or in addition to structural changes already underway before the pandemic). However it will take at least a few years or perhaps longer for those longer-term pandemic-related effects to be known and accounted for in the employment projections.[2]

For these reasons, we concluded that using 2020-2030 projections with all occupations would lead us to select occupations with high growth due primarily to having been more affected by the pandemic, thus the growth rate could represent short-term adjustments to the recession rather than long-term structural changes. We also concluded that using the 2020-2030 projections excluding occupations most affected by the pandemic omits almost half of all occupations—some or many of which may have had high growth due to long-term structural factors, as well as short-term adjustments—but we would be excluding them altogether because we could not distinguish what share of the growth rate was due to structural factors versus short-term adjustments. Additionally, we concluded that using 2019-2029 projections, while based on data that are 1 year older,

[2]For a fuller discussion, see Kevin S. Dubina, Lindsey Ice, Janie-Lynn Kim, and Michael J. Rieley, "Projections overview and highlights, 2020–30," *Monthly Labor Review* (U.S. Bureau of Labor Statistics, October 2021), https://doi.org/10.21916/mlr.2021.20.

represented the best option for capturing the longer-term structural changes to the economy, including those associated with trends in technological change, economic policy and other macro-economic indicators that affect employment levels.[3] Thus, we used 2019-2029 employment projections to identify "in-demand" jobs.[4]

The following describes how we selected our "in-demand" occupations:

1. We excluded occupations with a lower than average 2019-2029 change in employment levels, both overall (i.e., no education filter) and by education level (high school or less, some college, and bachelor's and above). This ensured that we did not include occupations that were adding a relatively small number of jobs over the period but with a high growth mainly due to the low base. Specifically, given this selection criteria:
    a. For the overall list (no education filter), we restricted our "in-demand" jobs to those occupations that were projected to add more than about 7,600 jobs from 2019 through 2029 (i.e., the average job gain across all occupations for this period.)
    b. For the "high school or less" list, we restricted our jobs to those occupations with a typical entry level education, based on BLS's projections data, of "high school diploma or equivalent" or "no formal educational credential." We further restricted our jobs to those occupations that were projected to add more than about 5,200 jobs from 2019 through 2029 (i.e., the average job gain during the 2019-2020 period for occupations where the typical entry level education was high school or less).
    c. For the "some college" list, we restricted our jobs to those occupations with a typical entry level education, based on BLS's projections data, of "associate's degree" or "postsecondary

[3]Using 2019-2029 projections does not incorporate the effects of the pandemic. Given the uncertainty around the long-term effects of the pandemic, this is an important caveat of our analysis. For example, the pandemic introduced large numbers of employers and employees to remote work. If these arrangements become more frequent in the long term they could have direct effects on employment. For a more detailed discussion see Lindsey Ice and Michael J. Reiley, "Expected pandemic-driven employment changes: a comparison of 2019–29 and 2020–30 projection sets," *Monthly Labor Review* (U.S. Bureau of Labor Statistics, February 2022), https://doi.org/10.21916/mlr.2022.5.

[4]We consulted DOL on our approach, and DOL officials agreed that the reasoning behind our approach was sound.

nondegree award" or "some college, no degree." We further restricted our jobs to those occupations that were projected to add more than about 8,100 jobs from 2019 through 2029 (i.e., the average job gain during the 2019-2020 period for occupations where the typical entry level education was some college).

d. For the "bachelor's and above" list we restricted our jobs to those occupations with a typical entry-level education, based on BLS's projections data, of "bachelor's degree" or "doctoral or professional degree" or "master's degree." We further restricted our jobs to those occupations that were projected to add more than about 11,300 jobs from 2019 through 2029 (i.e., the average job gain during the 2019-2020 period for occupations where the typical entry level education was bachelor's degree and above).

2. From each of the four lists (overall; high school or less; some college; and a bachelor's and above), we selected the 20 occupations with the fastest 2019-2029 growth rate.

Thus we use the phrase "in-demand jobs" to refer to occupations that, among the set of occupations with above-average change in employment levels, DOL projects will grow the fastest. In summary, in order to identify "in-demand" jobs, we restricted such jobs to those occupations that were projected to add more than the average job gain during the 2019-2029 period for that education group (i.e., overall, high school or less, some college and bachelor's and above). Of these, we then chose the 20 fastest growing occupations for each group. Using this approach, our analyses excluded occupations that were projected to add relatively few jobs, even if they were projected to grow quickly. For example, the occupation of wind turbine technicians had the highest growth rate (61 percent), but was projected to add a total of about 4,300 new jobs over the 2019-2029 period. Thus, even though the occupation is growing quickly, it is nevertheless adding relatively few jobs over the 2019-2029 period and was therefore excluded, based on our selection criteria for "in-demand" jobs.

Matching BLS Employment Projections to O*NET Data

BLS Employment Projections data are at the six-digit Standard Occupational Classification level, and the O*NET data are at the eight-digit occupational code level. Because of differences in the purpose and methods of data collection across programs—differences that result in a different set of occupations included in each program—matching the BLS Employment Projections and O*NET data requires resolving various types of non-matches. We matched the Employment Projections data to

the O*NET skills data using the matching data provided by DOL, where the agency provided us with the BLS Employment Projections code, the associated O*NET code, and the weight assigned to each O*NET occupation code based on employment, among other variables. The matching was based on a BLS publication in which BLS outlined how to match projections data to O*NET data, such as by doing direct matches (i.e., those occupations that in the O*NET data are at the six-digit level, ending in xx-xxxx.00), and doing employment weighted scores for matches that were not directly matched, among other steps.[5]

We used O*NET skills data based on O*NET 25.0, which was published in August 2020, along the O*NET 25.0 mapping provided by DOL.[6]

Determining Skills Deemed Important for "In-Demand" Jobs

The O*NET skills database has 35 elements, broadly categorized into "basic" skills and "cross functional" skills. The basic skills are shown below:

- Content: reading comprehension; active listening; writing; speaking; mathematics; science
- Process: critical thinking; active learning; learning strategies; monitoring

The cross functional skills are further broken down into five categories:

- Complex problem solving skills
- Resource management skills: management of financial resources; management of material resources; management of personnel resources; time management
- Social skills: coordination; instructing; negotiation; persuasion; service orientation; social perceptiveness
- Systems skills: judgment and decision-making; systems analysis; systems evaluation

[5]For more information on BLS's method for mapping occupational data from the BLS's Employment Projections program to the U.S. Department of Labor O*NET data, see Amy Hopson, "Mapping Employment Projections and O*NET data: a methodological overview," *Monthly Labor Review* (U.S. Bureau of Labor Statistics, August 2021), https://doi.org/10.21916/mlr.2021.18

[6]We did not use O*NET 26.0, published in August 2021, because skills data for some occupations, including those in the list of our "in-demand" jobs, in the 26.0 O*NET dataset were not yet available at the time of our analysis.

- Technical skills: equipment maintenance; equipment selection; installation; operation and control; operations analysis; operations monitoring; programming; quality control analysis; repairing; technology design; troubleshooting.

O*NET contains two scores for each of the 35 elements: one for *importance* and one for *level.*[7] For *importance*, the rating indicates the degree of importance a particular descriptor is to the occupation. The possible ratings range from 1 (not important) through 5 (extremely important). For *level,* the rating indicates the degree to which a particular descriptor is required or needed to perform the occupation. The possible ratings range from 1 through 7. For our analysis, we decided to use only the *importance* score due to the high correlation between the importance and the *level* scores. According to our analysis of O*NET skills data, the correlation between the *importance* and level score was 0.97.[8] We created two main analyses:

- For each of our 20 "in-demand" jobs, we counted the total number of skills deemed important. Specifically, we counted the skills for each top 20 in-demand occupation that had an *importance* score of 3 and above.[9] We also present other selected characteristics for these occupations, such as median wages.
- For each of the 35 skills in the dataset, we calculated a weighted average (weighted by 2019 employment) *importance* score for each list (overall and by education level) of top 20 in-demand occupations, as well as for those occupations not in our top-20 in-demand occupations list. This allowed us to examine what skills are deemed the most important, on average, for our top 20 in-demand occupations for each education group, with the non-top 20 occupations serving as a comparison group. In order to identify the skills that are, on average, deemed important for each education group (i.e., overall, high school

[7]According to O*NET, a skill is the ability to perform a task well. It is usually developed over time through training or experience. A skill can be used to do work in many jobs or it can be used in learning.

[8]According to DOL officials, the article, "Mapping Employment Projections and O*NET data: a methodological overview," *Monthly Labor Review* (U.S. Bureau of Labor Statistics, August 2021), https://doi.org/10.21916/mlr.2021.18 included just "importance" of skills (and not "level") because they noticed a high correlation between ratings of importance and level.

[9]We defined a skill as deemed "important" if the *importance* score is 3 or above given that, according to the O*NET skills questionnaire, when asked the question "How important is the skill to the performance of your current job?" the job incumbent's answer can be: (3) if "important", (4) if "very important" or (5) if "extremely important."

or less, some college, bachelor's and more) of the top 20 in-demand jobs, we highlight the skills that have a weighted average score of 3 and above.

In-Demand Jobs and Selected Characteristics, Including Total Number of Skills Deemed Important

For each education category, table 2 lists the top 20 in-demand occupations we selected based on our criteria described above. The table also presents selected characteristics for each occupation, such as the typical education needed for entry; total number of skills deemed important; and median wages for that occupation and for all occupations with the associated typical entry level education.

As an additional analysis, for both the sample of top 20 in-demand occupations overall and the entire dataset, which included all occupations (i.e., top 20 and non-top 20 in-demand occupations), we examined if occupations with a higher wage or a higher education level needed for entry tended to have more skills deemed important (i.e., an importance score of 3 and above). Specifically, we regressed the total number of skills deemed important on the median annual wage and regressed the total number of skills deemed important on the typical education needed for entry. We found a positive and statistically significant relationship between the total number of skills deemed important and the education level, as well as between the total number of skills deemed important and the median annual wage in both the sample of our top 20 in-demand occupations and in the dataset which included all occupations. These relationships represent correlations, and we did not control for other factors. Thus, they could be driven by factors related to the total number of skills deemed important and to the education level, or to the total number of skills deemed important and to wages.

Table 2: Selected Characteristics of Top 20 In-demand Occupations, by Education Level

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Top 20 in-demand occupations and selected characteristics, overall									
Nurse practitioners	29-1171	211.3	322	110.7	52.4	Master's degree	22	111,680	76,800
Statisticians	15-2041	42.7	57.5	14.8	34.6	Master's degree	15	92,270	76,800
Occupational therapy assistants	31-2011	47.1	63.5	16.3	34.6	Associate's degree	16	62,940	55,870
Home health and personal care aides	31-1120	3439.7	4599.2	1159.5	33.7	High school diploma or equivalent	10	27,080	39,070
Physical therapist assistants	31-2021	98.7	130.9	32.2	32.6	Associate's degree	15	59,770	55,870
Medical and health services managers	11-9111	422.3	555.5	133.2	31.5	Bachelor's degree	23	104,280	78,020
Physician assistants	29-1071	125.5	164.8	39.3	31.3	Master's degree	19	115,390	76,800
Information security analysts	15-1212	131	171.9	40.9	31.2	Bachelor's degree	15	103,590	78,020

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Data scientists and mathematical science occupations, all other	15-2098	33.2	43.4	10.3	30.9	Bachelor's degree	15	98,230	78,020
Roustabouts, oil and gas	47-5071	58.5	73.1	14.7	25.1	No formal educational credential	6	39,420	27,510
Speech-language pathologists	29-1127	162.6	203.1	40.5	24.9	Master's degree	19	80,480	76,800
Operations research analysts	15-2031	105.1	131.3	26.1	24.8	Bachelor's degree	17	86,200	78,020
Substance abuse, behavioral disorder, and mental health counselors	21-1018	319.4	398.4	79	24.7	Bachelor's degree	20	47,660	78,020
Cooks, restaurant	35-2014	1417.3	1744.6	327.3	23.1	No formal educational credential	6	28,800	27,510
Service unit operators, oil and gas	47-5013	51.7	63.6	11.8	22.9	No formal educational credential	17	47,380	27,510

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Animal caretakers	39-2021	300.7	369.5	68.8	22.9	High school diploma or equivalent	6	26,080	39,070
Marriage and family therapists	21-1013	66.2	80.9	14.8	22.3	Master's degree	20	51,340	76,800
Film and video editors	27-4032	38.3	46.5	8.3	21.6	Bachelor's degree	11	67,250	78,020
Software developers and software quality assurance analysts and testers	15-1256	1469.2	1785.2	316	21.5	Bachelor's degree	10	110,140	78,020
Physical therapist aides	31-2022	50.6	61.3	10.8	21.3	High school diploma or equivalent	10	28,450	39,070
Top 20 in-demand occupations and selected characteristics, high school or less									
Solar photovoltaic installers	47-2231	12	18.1	6.1	50.5	High school diploma or equivalent	12	46,470	39,070
Home health and personal care aides	31-1120	3439.7	4599.2	1159.5	33.7	High school diploma or equivalent	10	27,080	39,070

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Rotary drill operators, oil and gas	47-5012	20.9	26.6	5.6	26.9	No formal educational credential	17	53,820	27,510
Roustabouts, oil and gas	47-5071	58.5	73.1	14.7	25.1	No formal educational credential	6	39,420	27,510
Cooks, restaurant	35-2014	1417.3	1744.6	327.3	23.1	No formal educational credential	6	28,800	27,510
Service unit operators, oil and gas	47-5013	51.7	63.6	11.8	22.9	No formal educational credential	17	47,380	27,510
Animal caretakers	39-2021	300.7	369.5	68.8	22.9	High school diploma or equivalent	6	26,080	39,070
Physical therapist aides	31-2022	50.6	61.3	10.8	21.3	High school diploma or equivalent	10	28,450	39,070
Flight attendants	53-2031	121.9	143	21.1	17.3	High school diploma or equivalent	10	59,050	39,070
Social and human service assistants	21-1093	425.6	497.1	71.5	16.8	High school diploma or equivalent	15	35,960	39,070

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
First-line supervisors of gambling services workers	39-1013	58	67.5	9.5	16.4	High school diploma or equivalent	15	50,440	39,070
Veterinary assistants and laboratory animal caretakers	31-9096	99.5	115.2	15.7	15.8	High school diploma or equivalent	10	29,930	39,070
Crematory operators and personal care and service workers, all other	39-9098	111.3	128.8	17.5	15.7	High school diploma or equivalent	13	28,420	39,070
Industrial machinery mechanics	49-9041	399.4	461.7	62.3	15.6	High school diploma or equivalent	15	55,490	39,070
Exercise trainers and group fitness instructors	39-9031	373.7	431.3	57.6	15.4	High school diploma or equivalent	10	40,510	39,070
Community health workers	21-1094	64.9	74.8	9.9	15.2	High school diploma or equivalent	20	42,000	39,070

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Animal trainers	39-2011	50.2	56.9	6.7	13.3	High school diploma or equivalent	13	31,520	39,070
Residential advisors	39-9041	115.2	128.7	13.6	11.8	High school diploma or equivalent	15	31,190	39,070
Fast food and counter workers	35-3023	4047.7	4508.6	460.9	11.4	No formal educational credential	4	23,860	27,510
Agricultural equipment operators	45-2091	70.3	78.3	8	11.4	No formal educational credential	7	32,750	27,510
Top 20 in-demand occupations and selected characteristics, some college									
Occupational therapy assistants	31-2011	47.1	63.5	16.3	34.6	Associate's degree	16	62,940	55,870
Physical therapist assistants	31-2021	98.7	130.9	32.2	32.6	Associate's degree	15	59,770	55,870
Massage therapists	31-9011	166.7	201.1	34.4	20.6	Postsecondary nondegree award	9	43,620	41,520
Respiratory therapists	29-1126	135.8	162	26.3	19.4	Associate's degree	18	62,810	55,870

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Manicurists and pedicurists	39-5092	155.3	185.2	29.9	19.2	Postsecondary nondegree award	4	27,870	41,520
Medical assistants	31-9092	725.2	864.4	139.2	19.2	Postsecondary nondegree award	14	35,850	41,520
Phlebotomists	31-9097	132.6	155.5	22.8	17.2	Postsecondary nondegree award	12	36,320	41,520
Diagnostic medical sonographers	29-2032	74.3	86.8	12.5	16.8	Associate's degree	19	75,920	55,870
Skincare specialists	39-5094	78.6	91.6	13.1	16.6	Postsecondary nondegree award	9	36,510	41,520
Veterinary technologists and technicians	29-2056	112.9	131.2	18.3	16.2	Associate's degree	14	36,260	55,870
Ophthalmic medical technicians	29-2057	59.5	67.9	8.5	14.2	Postsecondary nondegree award	10	37,940	41,520

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Psychiatric technicians	29-2053	82.8	93.8	11	13.3	Postsecondary nondegree award	19	35,030	41,520
Audio and video technicians	27-4011	91.8	103.1	11.3	12.3	Postsecondary nondegree award	16	47,920	41,520
Paralegals and legal assistants	23-2011	337.8	373.1	35.3	10.5	Associate's degree	12	52,920	55,870
Licensed practical and licensed vocational nurses	29-2061	721.7	787.4	65.7	9.1	Postsecondary nondegree award	18	48,820	41,520
Medical dosimetrists, medical records specialists, and health technologists and technicians, all other	29-2098	341.6	370.6	29	8.5	Postsecondary nondegree award	9	44,090	41,520

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Web developers and digital interface designers	15-1257	174.3	188.3	14	8	Associate's degree	15	77,200	55,870
Computer user support specialists	15-1232	687.2	741.9	54.8	8	Some college, no degree	13	52,690	37,770
Nursing assistants	31-1131	1528.5	1645.5	116.9	7.6	Postsecondary nondegree award	8	30,850	41,520
Radiologic technologists and technicians	29-2034	212	226.1	14.1	6.7	Associate's degree	15	61,900	55,870
Top 20 in-demand occupations and selected characteristics, bachelor's and above									
Nurse practitioners	29-1171	211.3	322	110.7	52.4	Master's degree	22	111,680	76,800
Statisticians	15-2041	42.7	57.5	14.8	34.6	Master's degree	15	92,270	76,800
Medical and health services managers	11-9111	422.3	555.5	133.2	31.5	Bachelor's degree	23	104,280	78,020
Physician assistants	29-1071	125.5	164.8	39.3	31.3	Master's degree	19	115,390	76,800

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Information security analysts	15-1212	131	171.9	40.9	31.2	Bachelor's degree	15	103,590	78,020
Speech-language pathologists	29-1127	162.6	203.1	40.5	24.9	Master's degree	19	80,480	76,800
Operations research analysts	15-2031	105.1	131.3	26.1	24.8	Bachelor's degree	17	86,200	78,020
Substance abuse, behavioral disorder, and mental health counselors	21-1018	319.4	398.4	79	24.7	Bachelor's degree	20	47,660	78,020
Marriage and family therapists	21-1013	66.2	80.9	14.8	22.3	Master's degree	20	51,340	76,800
Software developers and software quality assurance analysts and testers	15-1256	1469.2	1785.2	316	21.5	Bachelor's degree	10	110,140	78,020

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Health specialties teachers, postsecondary	25-1071	254	306.1	52.1	20.5	Doctoral or professional degree	19	99,090	110,160
Interpreters and translators	27-3091	77.4	92.9	15.5	20	Bachelor's degree	15	52,330	78,020
Physical therapists	29-1123	258.2	305.2	47	18.2	Doctoral or professional degree	19	91,010	110,160
Market research analysts and marketing specialists	13-1161	738.1	868.4	130.3	17.7	Bachelor's degree	17	65,810	78,020
Nursing instructors and teachers, postsecondary	25-1072	72.9	85.7	12.8	17.6	Doctoral or professional degree	20	75,470	110,160
Social and community service managers	11-9151	175.5	205.4	29.8	17	Bachelor's degree	20	69,600	78,020
Mental health and substance abuse social workers	21-1023	123.2	143.8	20.7	16.8	Master's degree	20	48,720	76,800

Occupation title	Occupation code	Employment, 2019 (thousands)	Projected employment, 2029 (thousands)	Projected employment change 2019-2029 (thousands)	Projected employment change 2019-2029 (percent)	Typical education needed for entry	Total number of skills deemed important	Median annual wage in dollars (2020)	Median annual wage in dollars (2020) for occupations with corresponding typical entry-level education
Occupational therapists	29-1122	143.3	166	22.7	15.9	Master's degree	21	86,280	76,800
Veterinarians	29-1131	89.2	103.4	14.2	15.9	Doctoral or professional degree	19	99,250	110,160
Financial managers	11-3031	697.9	806	108.1	15.5	Bachelor's degree	22	134,180	78,020

Source: GAO analysis of U.S. Bureau of Labor Statistics (BLS) Employment Projections (EP) program data and U.S. Department of Labor (DOL) Occupational Information Network (O*NET) data. | GAO-22-105159

Notes: In order to identify the top 20 in-demand jobs, we restricted such jobs to those occupations that BLS projected to add more than the average job gain during the 2019-2029 period for that education group (i.e., overall, high school or less, some college and bachelor's and above). Of these, we then chose the 20 fastest growing occupations for each group. In order to calculate the total number of skills deemed important, we counted the number of skills with an importance score greater or equal to 3 based on O*NET 25.0 skills data. We chose this threshold because, according to the O*NET skills questionnaire, when asked the question "How important is the skill to the performance of your current job?" the job incumbent's answer can be: (3) if "important", (4) if "very important" or (5) if "extremely important."

Average Importance Score by Education Level

Table 3 shows the weighted average importance score and weighted standard deviation (weighted by 2019 employment) for each list of top 20 in-demand jobs as well as non-top 20 jobs for each level of typical education needed for entry. Weighted average scores with a value of greater or equal to 3 are highlighted in order to highlight the skills that are, on average, deemed important for that list based on the value of the weighted average score. Given that this is for the average occupation in that group (i.e., for the typical worker in that education group), even if a skill is not deemed important on average it might be important for particular occupations in that group. For example, even though repairing has the lowest weighted average score in the top 20 in-demand occupations (overall), it is a skill deemed important for the occupation "service unit operators, oil and gas."

Table 3: Skills Average Importance Scores for Top 20 and Non-Top 20 In-Demand Occupations, by Education Level

Standard deviation (SD) in parentheses

Skill name	Average and SD, non-top 20 overall	Average and SD, top 20 overall	Average and SD, non-top 20 high school or less	Average and SD, top 20 high school or less	Average and SD, non-top 20 some college	Average and SD, top 20 some college	Average and SD, non-top 20 bachelor's and above	Average and SD, top 20 bachelor's and above
Active Listening	3.6 (0.5)	3.5 (0.4)	3.4 (0.4)	3.4 (0.3)	3.4 (0.4)	3.7 (0.3)	4.0 (0.2)	3.9 (0.4)
Social Perceptiveness	3.2 (0.5)	3.4 (0.5)	3.1 (0.4)	3.2 (0.4)	3.0 (0.3)	3.5 (0.4)	3.6 (0.4)	3.5 (0.5)
Critical Thinking	3.3 (0.5)	3.3 (0.4)	3.1 (0.3)	3.0 (0.3)	3.3 (0.3)	3.4 (0.3)	3.9 (0.2)	3.9 (0.2)
Speaking	3.5 (0.5)	3.3 (0.4)	3.4 (0.5)	3.2 (0.2)	3.4 (0.4)	3.6 (0.4)	4.0 (0.3)	3.8 (0.4)
Service Orientation	3.1 (0.5)	3.3 (0.6)	3.0 (0.5)	3.3 (0.6)	3.0 (0.4)	3.5 (0.5)	3.3 (0.4)	3.3 (0.5)
Judgment and Decision Making	3.1 (0.4)	3.2 (0.4)	2.9 (0.3)	3.0 (0.1)	3.0 (0.2)	3.1 (0.3)	3.6 (0.3)	3.7 (0.2)
Reading Comprehension	3.3 (0.5)	3.2 (0.4)	3.1 (0.4)	2.9 (0.3)	3.3 (0.3)	3.6 (0.4)	3.9 (0.2)	3.8 (0.3)
Monitoring	3.2 (0.4)	3.2 (0.3)	3.1 (0.3)	3.1 (0.2)	3.1 (0.3)	3.4 (0.4)	3.6 (0.3)	3.5 (0.4)
Coordination	3.2 (0.4)	3.1 (0.3)	3.0 (0.3)	3.0 (0.2)	3.0 (0.3)	3.2 (0.4)	3.5 (0.4)	3.3 (0.4)
Time Management	3.1 (0.4)	3.0 (0.3)	3.0 (0.3)	2.8 (0.3)	3.0 (0.2)	3.1 (0.4)	3.4 (0.3)	3.3 (0.4)
Complex Problem Solving	3.0 (0.5)	3.0 (0.5)	2.8 (0.4)	2.6 (0.4)	3.0 (0.3)	3.0 (0.4)	3.5 (0.3)	3.7 (0.2)
Active Learning	3.0 (0.5)	3.0 (0.4)	2.7 (0.4)	2.7 (0.2)	3.0 (0.2)	3.1 (0.2)	3.5 (0.2)	3.5 (0.4)
Writing	3.0 (0.6)	3.0 (0.5)	2.7 (0.5)	2.5 (0.5)	3.0 (0.2)	3.2 (0.4)	3.7 (0.3)	3.6 (0.4)
Instructing	2.8 (0.6)	2.8 (0.4)	2.5 (0.5)	2.8 (0.4)	2.7 (0.5)	2.8 (0.4)	3.3 (0.5)	3.1 (0.4)
Learning Strategies	2.7 (0.6)	2.7 (0.4)	2.4 (0.4)	2.6 (0.3)	2.7 (0.5)	2.7 (0.3)	3.2 (0.5)	3.2 (0.3)
Persuasion	2.8 (0.5)	2.7 (0.4)	2.7 (0.6)	2.6 (0.3)	2.6 (0.3)	2.5 (0.4)	3.2 (0.4)	3.1 (0.3)
Systems Analysis	2.5 (0.5)	2.6 (0.7)	2.2 (0.4)	2.1 (0.3)	2.4 (0.4)	2.5 (0.4)	3.1 (0.3)	3.3 (0.3)
Systems Evaluation	2.4 (0.5)	2.6 (0.7)	2.2 (0.4)	2.1 (0.3)	2.4 (0.4)	2.4 (0.3)	3.1 (0.4)	3.3 (0.3)

Skill name	Average and SD, non-top 20 overall	Average and SD, top 20 overall	Average and SD, non-top 20 high school or less	Average and SD, top 20 high school or less	Average and SD, non-top 20 some college	Average and SD, top 20 some college	Average and SD, non-top 20 bachelor's and above	Average and SD, top 20 bachelor's and above
Negotiation	2.7 (0.6)	2.5 (0.4)	2.6 (0.5)	2.2 (0.3)	2.5 (0.3)	2.4 (0.4)	3.1 (0.4)	2.9 (0.3)
Management of Personnel Resources	2.5 (0.5)	2.4 (0.5)	2.4 (0.5)	2.2 (0.3)	2.3 (0.3)	2.4 (0.4)	3.0 (0.4)	3.0 (0.4)
Mathematics	2.4 (0.5)	2.4 (0.5)	2.3 (0.5)	2.2 (0.3)	2.4 (0.5)	2.3 (0.3)	2.8 (0.5)	2.9 (0.6)
Operation Monitoring	2.3 (0.6)	2.3 (0.3)	2.4 (0.6)	2.3 (0.5)	2.7 (0.9)	2.5 (0.5)	2.2 (0.5)	2.1 (0.3)
Quality Control Analysis	2.2 (0.6)	2.3 (0.4)	2.2 (0.6)	2.2 (0.4)	2.3 (0.8)	2.3 (0.4)	2.2 (0.6)	2.1 (0.4)
Science	1.5 (0.7)	2.0 (0.6)	1.2 (0.4)	1.4 (0.4)	1.7 (0.6)	2.1 (0.6)	2.1 (0.8)	2.5 (0.6)
Management of Material Resources	1.9 (0.5)	1.9 (0.4)	1.8 (0.4)	1.9 (0.2)	1.9 (0.3)	1.7 (0.3)	2.2 (0.5)	2.0 (0.4)
Operations Analysis	1.8 (0.6)	1.9 (1.0)	1.6 (0.4)	1.3 (0.4)	1.9 (0.4)	1.8 (0.6)	2.4 (0.6)	2.9 (0.4)
Troubleshooting	1.9 (0.7)	1.9 (0.4)	1.9 (0.6)	1.9 (0.5)	2.3 (1.0)	1.9 (0.5)	1.6 (0.6)	1.6 (0.6)
Management of Financial Resources	1.8 (0.5)	1.8 (0.4)	1.7 (0.5)	1.8 (0.3)	1.7 (0.3)	1.6 (0.3)	2.2 (0.6)	2.1 (0.7)
Operation and Control	2.0 (0.8)	1.7 (0.4)	2.1 (0.8)	1.9 (0.5)	2.4 (1.1)	2.0 (0.6)	1.6 (0.5)	1.4 (0.4)
Technology Design	1.6 (0.3)	1.7 (0.5)	1.5 (0.3)	1.4 (0.2)	1.7 (0.3)	1.7 (0.3)	1.8 (0.3)	1.9 (0.4)
Programming	1.4 (0.4)	1.6 (0.9)	1.3 (0.3)	1.1 (0.2)	1.5 (0.3)	1.5 (0.6)	1.8 (0.5)	2.2 (0.9)
Equipment Selection	1.5 (0.6)	1.3 (0.4)	1.5 (0.7)	1.3 (0.5)	1.9 (0.8)	1.4 (0.4)	1.3 (0.4)	1.3 (0.3)
Installation	1.2 (0.4)	1.1 (0.2)	1.2 (0.5)	1.1 (0.3)	1.5 (0.7)	1.2 (0.4)	1.1 (0.2)	1.2 (0.3)
Equipment Maintenance	1.5 (0.8)	1.1 (0.3)	1.6 (0.8)	1.2 (0.7)	2.1 (1.0)	1.3 (0.5)	1.1 (0.4)	1.1 (0.2)
Repairing	1.5 (0.8)	1.1 (0.2)	1.6 (0.8)	1.2 (0.6)	2.1 (1.1)	1.3 (0.5)	1.1 (0.4)	1.1 (0.2)
Total observations	**769**	**20**	**405**	**20**	**77**	**20**	**247**	**20**

Source: GAO analysis of U.S. Bureau of Labor Statistics (BLS) Employment Projections (EP) program data and U.S. Department of Labor (DOL) Occupational Information Network (O*NET) data. | GAO-22-105159

Notes: In order to identify the top 20 in-demand jobs, we restricted such jobs to those occupations that were projected to add more than the average job gain during the 2019-2029 period for each education group (i.e., overall, high school or less, some college and bachelor's and above). Of these, we then chose the 20 fastest growing occupation for each group. We then calculated the average importance value, weighted by 2019 employment, for each of the 35 skills in O*NET 25.0 for each group of top 20 and non-top 20 in-demand jobs for each education group. Shaded scores are for the skills deemed important for that group (i.e., skills with a weighted average score value greater or equal to 3). We chose this threshold because, according to the O*NET skills questionnaire, when asked the question "How important is the skill to the performance of your current job?" the job incumbent's answer is (3) if "important", (4) if "very important" or (5) if "extremely important". Standard deviations (SD) weighted by 2019 employment are in parentheses.

Caveats and Limitations

Uncertainty exists in the projections and the skills that will be deemed important in the future. Projections are estimates of future job growth

based on a series of modeling assumptions.[1] As with any projections, the projections for individual occupations are subject to error because of the many unknown factors that may affect the economy over the projection period. Thus, due to a variety of factors, actual changes in employment might differ from projected changes. Moreover, our analysis of skills is based on the skills that are currently deemed important, while the skills deemed important in the future might differ from the skills deemed important currently.

According to BLS's documentation, its 2019-2029 Employment Projections do not include impacts of the COVID-19 pandemic and response efforts. The BLS Employment Projections are developed using models based on historical data, as well as other qualitative and quantitative information available at the time the projections are made. This set of projections covers the time period through 2019; all input data therefore precede the pandemic.

We examined national-level projections, though projections might differ across localities. Given that we used national data, the data did not allow a discussion of where the "in-demand" jobs would be located. For example, even if an occupation is projected to grow at the national level it does not mean that it will be growing in all localities. Moreover, given that these are national level data, the characteristics of the selected occupations, such as median wages, might differ across localities.

The skills needed for a particular occupation might differ across localities and firms. The data did not allow us to discuss how the skills need for a particular occupation differ across locations or firms. According to DOL officials, customers should not use O*NET data and applications as a stand-alone, off-the-shelf tool to make selection or hiring decisions. Instead, for these type of human resource activities, O*NET data can serve an important starting point for job analyses. However, the data

[1]The BLS's projections of industrial and occupational employment are developed in a series of six interrelated steps, each of which is based on a different procedure or model and related assumptions: labor force, aggregate economy, final demand (GDP) by consuming sector and product, industry output, employment by industry, and employment by occupation. For example, according to DOL officials, one of the key assumptions of the projections is full employment. That is, the 10-year projections assume the economy will be operating at its full potential and the unemployment rate is equal to the nonaccelerating inflation rate of unemployment. The purpose of this assumption is to focus on the long-term trends in the economy by excluding the effects of the business cycle.

would need to be reviewed, augmented, and validated for the particular purpose and local organization context.[2]

Further, the O*NET skills presented are broad and may not allow for nuanced analysis in some instances, according Employment and Training Administration officials.

Any relationships we present are correlations and, as such, could be driven by other factors. For example, the statistically significant relationship between the total number of skills deemed important and the median annual wage could be driven by factors related to both the total number of skills deemed important and to median annual wages.

Section 2: Other Analyses

To address both objectives, we conducted interviews with stakeholders from four states: California, Kentucky, Pennsylvania and Washington. For our state selection process, we sought recommendations through initial stakeholder interviews and non-GAO reports that mentioned state programs as particularly effective in supporting at-risk workers. We also sought to select states that had a high concentration of jobs susceptible to automation by referring to a prior GAO report.[3] Additionally, we sought states that had diversity across urban and rural geographies using Census data on urban and rural area classifications, including one state that did not have an urban area in the top 25 most populous in the United States (Kentucky).[4] We also sought to select states with diversity in the type of their in-demand jobs, using data submitted to DOL by states.

In each state, we conducted semi-structured interviews with state workforce boards, which generally included representation from government agencies, business, labor, and training providers. In each state, we obtained information from local workforce boards recommended to us by state workforce board representatives as having particularly

[2]According to DOL officials, occupation is a concept—that groups many specific jobs across specific industries, representing many specific firms, in different parts of the country—all of which likely have distinct features that cannot be captured in aggregate national occupational data.

[3]GAO, *Workforce Automation: Better Data Needed to Assess and Plan for Effects of Advanced Technologies on Jobs*, GAO-19-257 (Washington, D.C.: Mar. 7, 2019).

[4]To qualify as an urban area under the Census Bureau classification, a territory must encompass at least 2,500 people, at least 1,500 of which reside outside institutional group quarters. Rural areas encompass all population, housing, and territory not included within an urban area. For additional information, see the 2010 Census Urban and Rural Classification and Urban Area Criteria.

noteworthy programs or experience. We asked questions related to how the states collect data on, and challenges to, obtaining in-demand jobs, and examples of workforce training programs to serve at-risk workers. The views of the stakeholders we interviewed provided illustrative examples on these topics and are not generalizable.

In addition, we asked interviewees for their views on how well federal workforce programs served at-risk workers. Specifically, we asked about four such programs: (1) WIOA Dislocated Worker Formula Program, (2) WIOA National Dislocated Worker Grants, (3) H1-B Job Training Grants, and (4) Registered Apprenticeship program. To identify these four programs, we reviewed our prior work that cataloged federal employment and training programs.[5] To narrow this list of programs to those that could serve workers at risk of losing their jobs to automation, we narrowed it to only programs that served the general population; provided occupational training; targeted workers who were on the job, underemployed or displaced; did not base eligibility on income; and had a goal of providing skills for in-demand jobs. We also reviewed a second GAO report that reviewed economic adjustment assistance programs that could serve workers, including programs that pertained to workers laid off due to any reason (as opposed to those laid off from a specific economically disruptive event, such as trade).[6]

Additionally, we interviewed stakeholders, including officials from DOL and the Census Bureau, as well as nine other organizations, such as national organizations of state workforce boards and agencies, business, labor, industry, and academic organizations, to obtain their perspectives on skills needed for in-demand jobs and challenges to obtaining those jobs.[7] We selected these stakeholders based on our prior work on automation and workforce issues, as well as additional suggestions from initial outreach. In the report, we use the term “other stakeholders interviewed” to specify we are referring to stakeholders not from a state or

[5]GAO, *Employment and Training Programs: Department of Labor Should Assess Efforts to Coordinate Services Across Programs*, GAO-19-200 (Washington, D.C.: Mar. 28, 2019).

[6]GAO, *Economic Adjustment Assistance: Actions Needed to Better Address Workers’ Needs and Assess Program Effectiveness*, GAO-20-521 (Washington, D.C.: July 29, 2020).

[7]These organizations include Upskill America, Burning Glass Technologies, the Georgetown Center on Education and the Workforce, the National Association of Workforce Boards, the National Association of State Workforce Agencies, and the National Governors Association.

local workforce board. The views of the stakeholders we interviewed provided illustrative examples on these topics and are not generalizable.

In describing responses of interviewees, the report sometimes specifies the number of states or stakeholders who voiced a particular response (such as “four states,” or “two business representatives”). In other instances, the report uses other terms to describe the number of responses. As used in the report, the term “several” indicates that three to four stakeholders gave a particular response, while the term “many” indicates that five or more stakeholders gave a particular response.

In addition to the GAO reports discussed above, we reviewed other GAO reports related to automation’s effects on the labor market. These GAO reports were published in the last 5 years and focused on automation, labor market policies, or in-demand jobs or skills.[8]

Additionally, we reviewed other relevant literature for information related to our objectives. We performed a literature search based on search terms related to the engagement’s objectives, such as automation, skill, and workforce. We narrowed search results by excluding articles or studies that did not include the United States, were more than 5 years old, and did not provide information related to the engagement’s objectives. We also reviewed several reports referred to us by interviewed stakeholders. We determined the credibility of relevant literature by reviewing the methodology and conclusions of those studies. We incorporated the results of our literature analyses into the report as appropriate. We did not conduct a comprehensive review of the factors that affect a firm’s decision to automate any of its tasks, but rather focused on the labor market once the automation decision has been made.

In addition, we reviewed relevant federal laws, regulations, and guidance.

[8]GAO reports we reviewed include: GAO, *Workforce Automation: Better Data Needed to Assess and Plan for Effects of Advanced Technologies on Jobs*, GAO-19-257 (Washington, D.C.: Mar. 7, 2019); *Automated Trucking: Federal Agencies Should Take Additional Steps to Prepare for Potential Workforce Effects*, GAO-19-161 (Washington, D.C.: Mar. 7, 2019); *Economic Adjustment Assistance: Actions Needed to Better Address Workers’ Needs and Assess Program Effectiveness*, GAO-20-521 (Washington, D.C.: July 29, 2020); and *Economic Adjustment Assistance: Experts’ Proposed Reform Options to Better Serve Workers Experiencing Economic Disruption*, GAO-21-324 (Washington, D.C.: Apr. 19, 2021).

We conducted this performance audit from April 2021 to August 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: GAO Contacts and Staff Acknowledgments

GAO Contact

Dawn G. Locke, (202) 512-7215 or locked@gao.gov

Staff Acknowledgments

In addition to the contact named above, Meeta Engle (Assistant Director), Andrew Nelson (Analyst-In-Charge), Laura Abendroth, and Dylan Desjardins made significant contributions to this report. Also contributing to this report were Charlotte Cable, Lilia Chaidez, Sherwin Chapman, Gabrielle Crossnoe, Hayden Huang, Kirsten Lauber, Lara Laufer, Ty Mitchell, Nhi Nguyen, Stacy Ouellette, Dae Park, Moon Parks, James Rebbe, Almeta Spencer, Curtia Taylor, Adam Wendel, and Candice Wright.

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Artificial Intelligence, Automation, and the Economy

Executive Office of the President

December 2016

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EXECUTIVE OFFICE OF THE PRESIDENT

WASHINGTON, D.C. 20502

December 20, 2016

Advances in Artificial Intelligence (AI) technology and related fields have opened up new markets and new opportunities for progress in critical areas such as health, education, energy, economic inclusion, social welfare, and the environment. In recent years, machines have surpassed humans in the performance of certain tasks related to intelligence, such as aspects of image recognition. Experts forecast that rapid progress in the field of specialized artificial intelligence will continue. Although it is unlikely that machines will exhibit broadly-applicable intelligence comparable to or exceeding that of humans in the next 20 years, it is to be expected that machines will continue to reach and exceed human performance on more and more tasks.

AI-driven automation will continue to create wealth and expand the American economy in the coming years, but, while many will benefit, that growth will not be costless and will be accompanied by changes in the skills that workers need to succeed in the economy, and structural changes in the economy. Aggressive policy action will be needed to help Americans who are disadvantaged by these changes and to ensure that the enormous benefits of AI and automation are developed by and available to all.

Following up on the Administration's previous report, *Preparing for the Future of Artificial Intelligence*, which was published in October 2016, this report further investigates the effects of AI-driven automation on the U.S. job market and economy, and outlines recommended policy responses.

This report was produced by a team from the Executive Office of the President including staff from the Council of Economic Advisers, Domestic Policy Council, National Economic Council, Office of Management and Budget, and Office of Science and Technology Policy. The analysis and recommendations included herein draw on insights learned over the course of the Future of AI Initiative, which was announced in May of 2016, and included Federal Government coordination efforts and cross-sector and public outreach on AI and related policy matters.

Beyond this report, more work remains, to further explore the policy implications of AI. Most notably, AI creates important opportunities in cyberdefense, and can improve systems to detect fraudulent transactions and messages.

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Executive Summary

Accelerating artificial intelligence (AI) capabilities will enable automation of some tasks that have long required human labor.[1] These transformations will open up new opportunities for individuals, the economy, and society, but they have the potential to disrupt the current livelihoods of millions of Americans. Whether AI leads to unemployment and increases in inequality over the long-run depends not only on the technology itself but also on the institutions and policies that are in place. This report examines the expected impact of AI-driven automation on the economy, and describes broad strategies that could increase the benefits of AI and mitigate its costs.

Economics of AI-Driven Automation

Technological progress is the main driver of growth of GDP per capita, allowing output to increase faster than labor and capital. One of the main ways that technology increases productivity is by decreasing the number of labor hours needed to create a unit of output. Labor productivity increases generally translate into increases in average wages, giving workers the opportunity to cut back on work hours and to afford more goods and services. Living standards and leisure hours could both increase, although to the degree that inequality increases—as it has in recent decades—it offsets some of those gains.

AI should be welcomed for its potential economic benefits. Those economic benefits, however, will not necessarily be evenly distributed across society. For example, the 19th century was characterized by technological change that raised the productivity of lower-skilled workers relative to that of higher-skilled workers. Highly-skilled artisans who controlled and executed full production processes saw their livelihoods threatened by the rise of mass production technologies. Ultimately, many skilled crafts were replaced by the combination of machines and lower-skilled labor. Output per hour rose while inequality declined, driving up average living standards, but the labor of some high-skill workers was no longer as valuable in the market.

In contrast, technological change tended to work in a different direction throughout the late 20th century. The advent of computers and the Internet raised the relative productivity of higher-skilled workers. Routine-intensive occupations that focused on predictable, easily-programmable tasks—such as switchboard operators, filing clerks, travel agents, and assembly line workers—were particularly vulnerable to replacement by new technologies. Some occupations were virtually eliminated and demand for others reduced. Research suggests that technological innovation over this period increased the productivity of those engaged in abstract thinking, creative tasks, and problem-solving and was therefore at least partially responsible for the substantial growth in jobs employing such traits. Shifting demand towards more skilled labor raised the relative pay of this group, contributing to rising inequality. At the same time, a

[1] A more extensive introductory discussion of artificial intelligence, machine learning, and related policy topics can be found in the Administration's first report on this subject. *See* The White House, "Preparing for the Future of Artificial Intelligence," October 2016 (https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf).

slowdown in the rate of improvement in education, and institutional changes such as the reduction in unionization and decline in the minimum wage, also contributed to inequality—underscoring that technological changes do not uniquely determine outcomes.

Today, it may be challenging to predict exactly which jobs will be most immediately affected by AI-driven automation. Because AI is not a single technology, but rather a collection of technologies that are applied to specific tasks, the effects of AI will be felt unevenly through the economy. Some tasks will be more easily automated than others, and some jobs will be affected more than others—both negatively and positively. Some jobs may be automated away, while for others, AI-driven automation will make many workers more productive and increase demand for certain skills. Finally, new jobs are likely to be directly created in areas such as the development and supervision of AI as well as indirectly created in a range of areas throughout the economy as higher incomes lead to expanded demand.

Recent research suggests that the effects of AI on the labor market in the near term will continue the trend that computerization and communication innovations have driven in recent decades. Researchers' estimates on the scale of threatened jobs over the next decade or two range from 9 to 47 percent. For context, every 3 months about 6 percent of jobs in the economy are destroyed by shrinking or closing businesses, while a slightly larger percentage of jobs are added—resulting in rising employment and a roughly constant unemployment rate. The economy has repeatedly proven itself capable of handling this scale of change, although it would depend on how rapidly the changes happen and how concentrated the losses are in specific occupations that are hard to shift from.

Research consistently finds that the jobs that are threatened by automation are highly concentrated among lower-paid, lower-skilled, and less-educated workers. This means that automation will continue to put downward pressure on demand for this group, putting downward pressure on wages and upward pressure on inequality. In the longer-run, there may be different or larger effects. One possibility is superstar-biased technological change, where the benefits of technology accrue to an even smaller portion of society than just highly-skilled workers. The winner-take-most nature of information technology markets means that only a few may come to dominate markets. If labor productivity increases do not translate into wage increases, then the large economic gains brought about by AI could accrue to a select few. Instead of broadly shared prosperity for workers and consumers, this might push towards reduced competition and increased wealth inequality.

Historically and across countries, however, there has been a strong relationship between productivity and wages—and with more AI the most plausible outcome will be a combination of higher wages and more opportunities for leisure for a wide range of workers. But the degree that this materializes depends not just on the nature of technological change but importantly on the policy and institutional choices that are made about how to prepare workers for AI and to handle its impacts on the labor market.

Policy Responses

Technology is not destiny; economic incentives and public policy can play a significant role in shaping the direction and effects of technological change. Given appropriate attention and the right policy and institutional responses, advanced automation can be compatible with productivity, high levels of employment, and more broadly shared prosperity. In the past, the U.S. economy has adapted to new production patterns and maintained high levels of employment alongside rising productivity as more productive workers have had more incentive to work and more highly paid workers have spent more, supporting this work. But, some shocks have left a growing share of workers out of the labor force. This report advocates strategies to educate and prepare new workers to enter the workforce, cushion workers who lose jobs, keep them attached to the labor force, and combat inequality. Most of these strategies would be important regardless of AI-driven automation, but all take on even greater importance to the degree that AI is making major changes to the economy.

Strategy #1: Invest in and develop AI for its many benefits. If care is taken to responsibly maximize its development, AI will make important, positive contributions to aggregate productivity growth, and advances in AI technology hold incredible potential to help the United States stay on the cutting edge of innovation. Government has an important role to play in advancing the AI field by investing in research and development. Among the areas for advancement in AI are cyberdefense and the detection of fraudulent transactions and messages. In addition, the rapid growth of AI has also dramatically increased the need for people with relevant skills from all backgrounds to support and advance the field. Prioritizing diversity and inclusion in STEM fields and in the AI community specifically, in addition to other possible policy responses, is a key part in addressing potential barriers stemming from algorithmic bias. Competition from new and existing firms, and the development of sound pro-competition policies, will increasingly play an important role in the creation and adoption of new technologies and innovations related to AI.

Strategy #2: Educate and train Americans for jobs of the future. As AI changes the nature of work and the skills demanded by the labor market, American workers will need to be prepared with the education and training that can help them continue to succeed. Delivering this education and training will require significant investments. This starts with providing all children with access to high-quality early education so that all families can prepare their students for continued education, as well as investing in graduating all students from high school college- and career-ready, and ensuring that all Americans have access to affordable post-secondary education. Assisting U.S. workers in successfully navigating job transitions will also become increasingly important; this includes expanding the availability of job-driven training and opportunities for lifelong learning, as well as providing workers with improved guidance to navigate job transitions.

Strategy #3: Aid workers in the transition and empower workers to ensure broadly shared growth. Policymakers should ensure that workers and job seekers are both able to pursue the job opportunities for which they are best qualified and best positioned to ensure they receive an appropriate return for their work in the form of rising wages. This includes steps to modernize the social safety net, including exploring strengthening critical supports such as unemployment

insurance, Medicaid, Supplemental Nutrition Assistance Program (SNAP), and Temporary Assistance for Needy Families (TANF), and putting in place new programs such as wage insurance and emergency aid for families in crisis. Worker empowerment also includes bolstering critical safeguards for workers and families in need, building a 21st century retirement system, and expanding healthcare access. Increasing wages, competition, and worker bargaining power, as well as modernizing tax policy and pursuing strategies to address differential geographic impact, will be important aspects of supporting workers and addressing concerns related to displacement amid shifts in the labor market.

Finally, if a significant proportion of Americans are affected in the short- and medium-term by AI-driven job displacements, policymakers will need to consider more robust interventions, such as further strengthening the unemployment insurance system and countervailing job creation strategies, to smooth the transition.

Conclusion

Responding to the economic effects of AI-driven automation will be a significant policy challenge for the next Administration and its successors. AI has already begun to transform the American workplace, change the types of jobs available, and reshape the skills that workers need in order to thrive. All Americans should have the opportunity to participate in addressing these challenges, whether as students, workers, managers, technical leaders, or simply as citizens with a voice in the policy debate.

AI raises many new policy questions, which should be continued topics for discussion and consideration by future Administrations, Congress, the private sector, academia, and the public. Continued engagement among government, industry, technical and policy experts, and the public should play an important role in moving the Nation toward policies that create broadly shared prosperity, unlock the creative potential of American companies and workers, and ensure America's continued leadership in the creation and use of AI.

Outreach and Development of this Report

This report was developed by a team in the Executive Office of the President including staff from the White House Council of Economic Advisers (CEA), Domestic Policy Council (DPC), National Economic Council (NEC), Office of Management and Budget (OMB), and Office of Science and Technology Policy (OSTP). This report follows a previous report published in October 2016 titled *Preparing for the Future of Artificial Intelligence* and the accompanying *National Artificial Intelligence Research and Development Strategic Plan*, developed by the National Science and Technology Council's (NSTC) Subcommittee on Machine Learning and Artificial Intelligence. This subcommittee was chartered in May 2016 by OSTP to foster interagency coordination and provide technical and policy advice on topics related to AI, and to monitor the development of AI technologies across industry, the research community, and the Federal Government. This report also follows a series of public-outreach activities as a part of the White House Future of Artificial Intelligence Initiative, designed to allow government officials to learn from experts and from the public, which included five co-hosted public workshops, and a public Request for Information (RFI).[2]

This report more deeply examines the impact of AI-driven automation on the economy and policy responses to it. It considers the economic evidence to better understand the lessons from past waves of automation, the impact already caused by the current wave of AI-driven automation and its prospects for the near future, and how AI-driven automation may affect workers in the future. The report also considers policy steps that are needed to address the economic dislocation caused by the arrival of these technologies and to prepare for longer-term trends in the economy caused by AI, automation, and other factors that are systemically disadvantaging certain workers. The report lays out three broad strategies for policymakers to consider.

[2] Ed Felten and Terah Lyons, "Public Input and Next Steps on the Future of Artificial Intelligence," *Medium*, September 6 2016 (https://medium.com/@USCTO/public-input-and-next-steps-on-the-future-of-artificialintelligence-458b82059fc3). Further details on the public workshops and the RFI can be found in the October 2016 report, *Preparing for the Future of Artificial Intelligence*.

Introduction

Recent progress in Artificial Intelligence (AI) has brought renewed attention to questions about automation driven by these advances and their impact on the economy. The current wave of progress and enthusiasm for AI began around 2010, driven by three mutually reinforcing factors: the availability of *big data* from sources including e-commerce, businesses, social media, science, and government;[3] which provided raw material for dramatically *improved machine learning approaches and algorithms;* which in turn relied on the capabilities of *more powerful computers.*[4] During this period, the pace of improvement surprised AI experts. For example, on a popular image recognition challenge that has a 5 percent human error rate according to one error measure, [5] the best AI result improved from a 26 percent error rate in 2011 to 3.5 percent in 2015. This progress may enable a range of workplace tasks that require image understanding to be automated, and will also enable new types of work and jobs. Progress on other AI challenges will drive similar economic changes.

Technical innovation has been expanding the American economy since the country's founding. American ingenuity has always been one of the Nation's greatest resources, a key driver of economic growth, and a source of strategic advantage for the United States. Remarkable homegrown innovations have improved quality of life, created jobs, broadened understanding of the world, and helped Americans approach their full potential. At the same time, they have forced Americans to adapt to changes in the workplace and the job market. These transformations have not always been comfortable, but in the long run—and supported by good public policy—they have provided great benefits.

The current wave of AI-driven automation may not be so different. For example, robots have made the economy more efficient. A 2015 study of robots in 17 countries found that they added an estimated 0.4 percentage point on average to those countries' annual GDP growth between 1993 and 2007, accounting for just over one-tenth of those countries' overall GDP growth during that time.[6] Some of that growth has been achieved by U.S. manufacturers adopting robots, allowing more goods to be produced while employing fewer workers at some facilities. AI in its many manifestations also holds promise to transform the basis of economic growth for countries across the world; a recent analysis of 12 developed economies (including the United States)

[3] "Big Data: Seizing Opportunities, Preserving Values," Executive Office of the President, May 2014, https://www.whitehouse.gov/sites/default/files/docs/big_data_privacy_report_may_1_2014.pdf.
[4] For more information about AI and its policy implications, see: The White House, "Preparing for the Future of Artificial Intelligence," October 2016.(https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf).
[5] The ImageNet Large Scale Visual Recognition Challenge provides a set of photographic images and asks for an accurate description of what is depicted in each image. Statistics in the text refer to the "classification error" metric in the "classification+localization with provided training data" task. *See* http://image-net.org/challenges/LSVRC/.
[6] Georg Graetz and Guy Michaels, "Robots at Work," *CEPR Discussion Paper No. DP10477*, March 2015 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2575781).

found that AI has the potential to double annual economic growth rates in the countries analyzed by 2035.[7]

Some experts have characterized the rise of AI-driven automation as one of the most important economic and social developments in history. The World Economic Forum has characterized it as the lynchpin of a Fourth Industrial Revolution.[8] Furthermore, the economist Andrew McAfee wrote, "Digital technologies are doing for human brainpower what the steam engine and related technologies did for human muscle power during the Industrial Revolution. They're allowing us to overcome many limitations rapidly and to open up new frontiers with unprecedented speed. It's a very big deal. But how exactly it will play out is uncertain."[9]

At the same time, AI-driven automation has yet to have a quantitatively major impact on productivity growth. In fact, measured productivity growth over the last decade has slowed in almost every advanced economy. It is plausible, however, that the pace of measured productivity growth will pick up in the coming years. To the degree that AI-driven automation realizes its potential to drive tremendous positive advancement in diverse fields, it will make Americans better off on average. But, there is no guarantee that everyone will benefit. AI-driven changes in the job market in the United States will cause some workers to lose their jobs, even while creating new jobs elsewhere. The economic pain this causes will fall more heavily upon some than on others. Policymakers must consider what can be done to help those families and communities get back on their feet and assemble the tools they need to thrive in the transformed economy and share in its benefits.

[7] Paul Daugherty and Mark Purdy, "Why AI is the Future of Growth," 2016 (https://www.accenture.com/t20161031T154852__w__/us-en/_acnmedia/PDF-33/Accenture-Why-AI-is-the-Future-of-Growth.PDF#zoom=50).

[8] Klaus Schwab, "The Fourth Industrial Revolution: what it means, how to respond," World Economic Forum, January 2016 (https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/). (The first three industrial revolutions are listed as those driven by steam power, electricity, and electronics.)

[9] Amy Bernstein and Anand Raman, "The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee," *Harvard Business Review*, June 2015 (https://hbr.org/2015/06/the-great-decoupling).

Economics of AI-Driven Automation

Accelerating AI capabilities will enable automation of some tasks that have long required human labor. Rather than relying on closely-tailored rules explicitly crafted by programmers, modern AI programs can learn from patterns in whatever data they encounter and develop their own rules for how to interpret new information. This means that AI can solve problems and learn with very little human input. In addition, advances in robotics are expanding machines' abilities to interact with and shape the physical world. Combined, AI and robotics will give rise to smarter machines that can perform more sophisticated functions than ever before and erode some of the advantages that humans have exercised. This will permit automation of many tasks now performed by human workers and could change the shape of the labor market and human activity.

These transformations may open up new opportunities for individuals, the economy, and society, but they may also foreclose opportunities that are currently essential to the livelihoods of many Americans. This chapter explores the important role that AI-driven automation is likely to have in growing the economy and potential effects on labor markets and communities. It draws on economic theory and empirical studies of past technological transformations and applies these lessons to the current context. While there are many reasons to think that changes in the labor market prompted by AI-driven automation will be similar to what has been observed in the past, this chapter will also discuss arguments for how the current period could be different from previous technological revolutions.

Critically, technology alone will not determine the economic outcomes in terms of growth, inequality or employment. The advanced economies all have had access to similar levels of technology but have had very different outcomes along all of these dimensions because they have had different institutions and policies. But understanding the technological forces is critical to shaping the continued evolution of these policies.

AI and the Macroeconomy: Technology and Productivity Growth

To the extent that AI-driven automation resembles past forms of technological advancement, it will make important contributions to aggregate productivity growth.

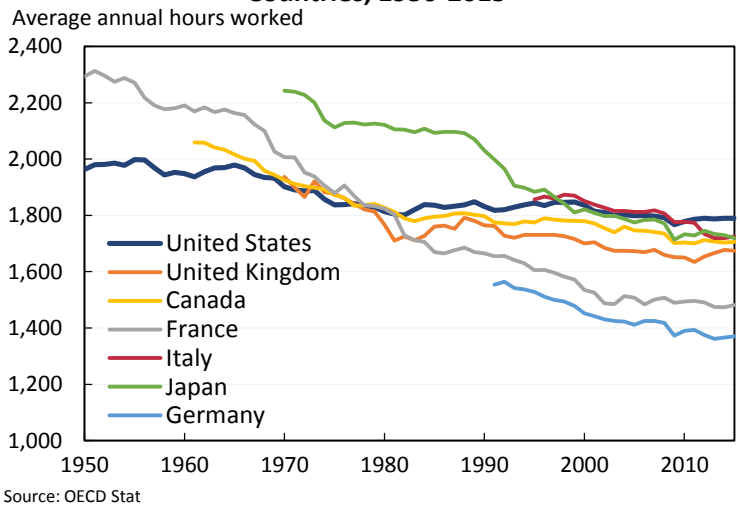
For centuries, the American economy has adjusted to and evolved with technology. Many jobs that existed 150 years ago do not exist today, and jobs no one could have imagined then have taken their place. For example, in 1870, almost 50 percent of American employees worked in agriculture, supplying the Nation's food.[10] Today, thanks in large part to technological change, agriculture employs less than 2 percent of American workers and American food production exceeds domestic demand.[11] In this case, technological innovations, from McCormick harvesters

[10] Patricia A. Daly, "Agricultural Employment: Has the Decline Ended?" *Monthly Labor Review,* November 1981 (http://www.bls.gov/opub/mlr/1981/11/art2full.pdf).
[11] Bureau of Labor Statistics, "Employment Projections: Employment by major industry sector," December 2015 (http://www.bls.gov/emp/ep_table_201.htm).

to today's self-driving tractors, increased the productivity of the agricultural sector and contributed to increases in standard of living.[12]

One of the main ways that technology increases productivity is by decreasing the number of labor hours needed to create a unit of output. Labor productivity increases generally translate into increases in average wages, giving workers the opportunity to cut back on work hours and to afford more goods and services. Living standards and leisure hours could both increase, although to the degree that inequality increases—as it has in recent decades—it offsets some of those gains. The expectation that productivity increases would be accompanied by wage growth is what led John Maynard Keynes to predict in his 1930 essay on "Economic Possibilities for our Grandchildren" that, given the rates of technical progress, we might have achieved a 15-hour workweek by now.[13] While that prediction remains far off, over the last 65 years, most developed economies saw annual hours worked decline substantially (Figure 1). In the United States uniquely, however, this decline stopped in the late 1970s, and hours per worker has remained flat since then.

Figure 1: Average Annual Hours Worked per Worker, G-7 Countries, 1950-2015



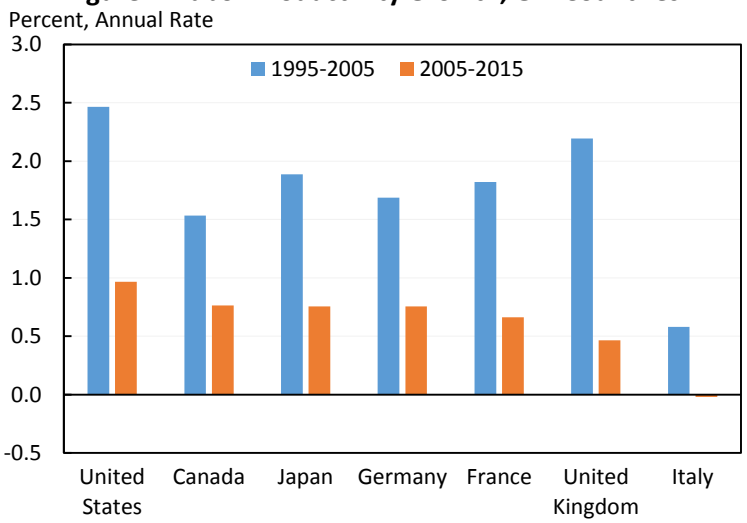
Technology has been one of the main drivers of this productivity growth. Indeed, changes in technology help explain permanent productivity increases throughout the 1990s.[14] There is also

[12] USDA Economic Research Service, "Table 1. Indices of farm output, input, and total factor productivity for the United States, 1948-2013" (https://www.ers.usda.gov/data-products/agricultural-productivity-in-the-us/).
[13] John M. Keynes, "Economic Possibilities for our Grandchildren." In *Essays in Persuasion*, New York: W.W.Norton & Co., pp. 358-373, 1930. (http://www.econ.yale.edu/smith/econ116a/keynes1.pdf).
[14] Susanto Basu, John G. Fernald, and Matthew D. Shapiro, "Productivity growth in the 1990s: technology, utilization, or adjustment?" *Carnegie-Rochester Conference Series on Public Policy* 55(1): 117-65, 2001 (https://ideas.repec.org/a/eee/crcspp/v55y2001i1p117-165.html).

evidence that industrial robotic automation alone increased labor productivity growth by 0.36 percentage points across 17 countries between 1993 and 2007.[15]

The potential positive impact of AI-driven automation on productivity is particularly important given recent trends in productivity. In the last decade, despite technology's positive push, measured productivity growth has slowed in 30 of the 31 advanced economies, slowing in the United States from an average annual growth rate of 2.5 percent in the decade after 1995 to only 1.0 percent growth in the decade after 2005 (Figure 2). While a considerable amount of this slowdown in many countries—including the United States—is due to a slowdown in investment in capital stock, the slowdown in total factor productivity growth (the component influenced by technological change) has also been important.[16] This has contributed to slower growth in real wages and if continued will slow improvements in living standards.

Figure 2: Labor Productivity Growth, G-7 Countries



Source: Conference Board, Total Economy Database; CEA calculations.

AI-driven automation could help boost total factor productivity growth and create new potential to improve the lives of Americans broadly. The benefits of technological change and economic growth, however, are not necessarily shared equally. This can depend on both the nature and speed of the technological change as well as the ability of workers to negotiate for the benefits of their increased productivity, as discussed below.

AI and the Labor Market: Diverse Potential Effects

Few would dispute that the industrial revolution largely made society better off, but the transition led to severe disruptions to the lives and communities of many agricultural workers, with

[15] Georg Graetz and Guy Michaels, "Robots at Work," *Centre for Economic Policy Research (CEPR) Discussion Paper No. DP10477*, 2015 (http://cep.lse.ac.uk/pubs/download/dp1335.pdf).
[16] Jason Furman, "Productivity Growth in the Advanced Economies: The Past, the Present, and Lessons for the Future," Speech at the Peterson Institute for International Economics, Washington, July 9 2015 (https://www.whitehouse.gov/sites/default/files/docs/20150709_productivity_advanced_economies_piie.pdf).

industrialization inducing many Americans to move to new communities where they could acquire new skills and put their time to new uses. Even during these periods of great technological change, America has maintained high employment. Over long periods, between 90 and 95 percent of the people in the United States who want a job at a given point in time can find one, and the unemployment rate is currently less than 5 percent.[17]

Historical Effects of Technical Change

Technological advances have historically had varied impacts on the labor market. New technologies may substitute for some skills while complementing others, and these trends change over time.[18] At times, new technologies have raised the productivity and increased employment opportunities for workers with little education, and other times for workers with more. To illustrate the diversity of potential impacts and provide a framework for understanding today, this section discusses historical examples of how innovations affected workers in different ways.

The 19th century was characterized by technological change that raised the productivity of lower-skilled workers and reduced the relative productivity of certain higher-skilled workers.[19] This kind of innovation has been called *unskill-biased technical change*. Highly-skilled artisans who controlled and executed full production processes saw their livelihoods threatened by the rise of mass production technologies that used assembly lines with interchangeable parts and lower-skilled workers. In reaction, some English textile weavers participated in the Luddite Riots of the early 1800s by destroying looms and machinery that threatened to undercut their highly-skilled, highly-paid jobs with lower-wage roles. Ultimately, the protesters' fears came true, and many skilled crafts were replaced by the combination of machines and lower-skill labor. There were also new opportunities for less-skilled workers and output per hour rose. As a result, average living standards could rise, but certain high-skill workers were no longer as valuable in the market.

Technological change tended to work in a different direction throughout the late 20th century. The advent of computers and the internet raised the relative productivity of higher-skilled workers, an example of *skill-biased technical change*. Routine-intensive occupations that focused on predictable, easily-programmable tasks—such as switchboard operators, filing clerks, travel agents, and assembly line workers—have been particularly vulnerable to replacement by new technologies.[20] Some entire occupations were virtually eliminated and demand for others reduced. Indeed, Nir Jaimovich and Henry Siu argue that the decline in manufacturing and other

[17] Bureau of Labor Statistics, Civilian Unemployment Rate, 1948-2016.
[18] Daron Acemoglu and David Autor, "Skills, tasks and technologies: Implications for employment and earnings," 2011, *Handbook of labor economics* 4(2011): 1043-171, (http://economics.mit.edu/files/5571).
[19] Daron Acemoglu, NBER reporter article, 2002; David Hounshell, *From the American system to mass production, 1800-1932: The development of manufacturing technology in the United States*, Baltimore: JHU Press, 1985; John A. James and Jonathan S. Skinner, "The Resolution of the Labor-Scarcity Paradox," *The Journal of Economic History,* 45(3): 513-40, 1985 (http://www.jstor.org/stable/2121750?seq=1#page_scan_tab_contents); Joel Mokyr, "Technological inertia in Economic History." *The Journal of Economic History,* 52(2): 325-38, 1992 (http://www.jstor.org/stable/2123111?seq=1#page_scan_tab_contents).
[20] David H. Autor, Frank Levy, and Richard J. Murnane, "The Skill Content of Recent Technological Change: An Empirical Exploration," *Quarterly Journal of Economics* 118(4): 1279-1333, 2003.

routine jobs is largely responsible for recent low labor demand for less educated workers.[21] Research suggests that technological innovation over this period increased the productivity of those engaged in abstract thinking, creative ability, and problem-solving skills and, therefore, is partially responsible for the substantial growth in jobs employing such traits.[22] Autor, Levy, and Murnane find that about 60 percent of the estimated relative demand shift favoring college-educated labor from 1970 to 1998 can be explained by the reduced labor input needed for routine manual tasks and the increased labor input for non-routine cognitive tasks, which tended to be more concentrated in higher-skilled occupations.[23] Given that college-educated labor was already more highly compensated, shifting demand towards college-educated labor and raising their relative pay contributed to rising income inequality.[24]

Like these past waves of technological advancements, AI-driven automation is setting off labor-market disruption and adjustment. Economic theory suggests that there must be gains from innovations, or they would not be adopted. Market forces alone, however, will not ensure that the financial benefits from innovations are broadly shared.

Market disruptions can be difficult to navigate for many. Recent empirical research highlights the costs of the adjustment process. In recent decades, U.S. workers who were displaced from their jobs—due to, for example, a plant closing or a company moving—experienced substantial earnings declines.[25] Autor, Dorn, and Hanson find that negative shocks to local economies can have substantial negative and long-lasting effects on unemployment, labor force participation, and wages.[26] Perhaps more significantly, over time, displaced workers' earnings recover only slowly and incompletely. Even ten or more years later, the earnings of these workers remain depressed by 10 percent or more relative to their previous wages.[27] These results suggest that for many displaced workers there appears to be a deterioration in their ability either to match their current skills to, or retrain for, new, in-demand jobs. AI-driven automation can act—and in some cases has already acted—as a shock to local labor markets that can initiate long-standing disruptions. Without some form of transfers and safety net, the economic benefits of AI-driven

[21] Nir Jaimovich and Henry E. Siu, "The Trend is the Cycle: Job Polarization and Jobless Recoveries." NBER Working Paper No. 18334, 2012 (http://www.nber.org/papers/w18334.pdf); Kerwin Kofi Charles, Erik Hurst, and Matthew J. Notowidigdo, "Housing Booms, Manufacturing Decline, and Labor Market Outcomes," Working Paper, 2016 (http://faculty.wcas.northwestern.edu/noto/research/CHN_manuf_decline_housing_booms_mar2016.pdf).
[22] Lawrence F. Katz and Kevin M. Murphy, "Changes in Relative Wages, 1963-1987: Supply and Demand Factors," *Quarterly Journal of Economics*, 107(Feb): 35-78, 1992; Daron Acemoglu, "Technical change, inequality, and the labor market," *Journal of economic literature* 40(1): 7-72, 2002; Autor, Levy, and Murnane 2003; Jaimovich and Siu 2012; David H. Autor and David Dorn, "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market," *American Economic Review* 103(5): 1553-97, 2013 (http://www.ddorn.net/papers/Autor-Dorn-LowSkillServices-Polarization.pdf).
[23] Autor, Levy, and Murnane, 2003.
[24] Katz and Murphy, 1992.
[25] Steven J. Davis and Till Von Wachter, "Recessions and the Costs of Job Loss," Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, 43(2): 1-72, 2011 (http://www.econ.ucla.edu/workshops/papers/Monetary/Recessions%20and%20the%20Costs%20of%20Job%20Loss%20with%20Appendix.pdf).
[26] David H Autor, David Dorn, and Gordon H. Hanson, "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review* 103(6): 2121-68, 2013 (http://gps.ucsd.edu/_files/faculty/hanson/hanson_publication_it_china.pdf).
[27] Davis and Von Wachter, 2011.

automation may not be shared by all, and some workers, families, and communities may be persistently negatively affected.

AI and the Labor Market: The Near Term

Today, it may be challenging to predict exactly which jobs will be most immediately affected by AI-driven automation. Because AI is not a single technology, but rather a collection of technologies that are applied to specific tasks, the effects of AI will be felt unevenly through the economy. Some work tasks will be more easily automated than others, and some jobs will be affected more than others.

Some specific predictions are possible based on the current trajectory of AI technology. For example, driving jobs and housecleaning jobs are both jobs that require relatively less education to perform. Advancements in computer vision and related technologies have made the feasibility of fully automated vehicles (AVs), which do not require a human driver, appear more likely, potentially displacing some workers in driving-dominant professions. AVs rely upon, among other things, capabilities of navigating complex environments, analyzing dynamic surroundings, and optimization. Seemingly similar capabilities are required of a household-cleaning robot, for which the operational mandate is less specific (i.e. "clean the house," as opposed to the objective of navigating to a specific destination while following a set of given rules and preserving safety). And yet the technology that would enable a robot to navigate and clean a space as effectively as a human counterpart appears farther off. In the near to medium term, at least, drivers will probably be impacted more by automation than will housecleaners. The following sections lay out a framework for more general predictions of the effect of AI-driven automation on jobs.

Continued skill-biased technical change?

Recent research suggests that the effects of AI on the labor market in the decade ahead will continue the trend toward skill-biased change that computerization and communication innovations have driven in recent decades. Researchers differ on the possible magnitude of this effect. Carl Frey and Michael Osbourne asked a panel of experts on AI to classify occupations by how likely it is that foreseeable AI technologies could feasibly replace them over roughly the next decade or two.[28] Based on this assessment of the technical properties of AI, the relationship between those properties to existing occupations, and employment levels across occupations, they posit that 47 percent of U.S. jobs are at risk of being replaced by AI technologies and computerization in this period. Researchers at the Organisation for Economic Cooperation and Development (OECD), however, highlighted the point that automation targets tasks rather than occupations, which are themselves particular combinations of tasks.[29] Many occupations are likely to change as some of their associated tasks become automatable, so the OECD analysis

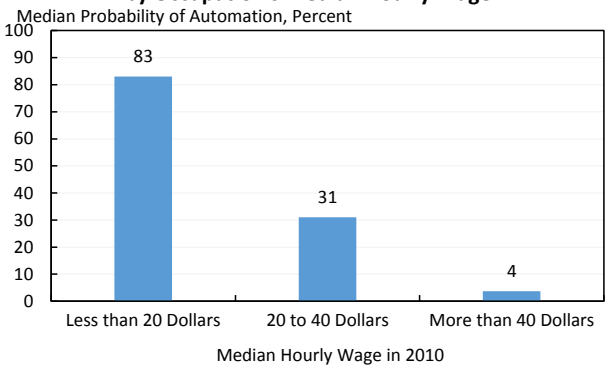
[28] Carl Frey and Michael Osborne, "The Future of Employment: How Susceptible are Jobs to Computerization," Oxford University, 2013 (http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf).
[29] Melanie Arntz, Terry Gregory, and Ulrich Zierahn, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis," OECD Social, Employment and Migration Working Papers No. 189, 2016 (http://www.oecd-ilibrary.org/docserver/download/5jlz9h56dvq7-en.pdf?expires=1480994298&id=id&accname=guest&checksum=6DC4B241A91EE860DC391585FF43C51C).

concludes that relatively few will be entirely automated away, estimating that only 9 percent of jobs are at risk of being completely displaced. If these estimates of threatened jobs translate into job displacement, millions of Americans will have their livelihoods significantly altered and potentially face considerable economic challenges in the short- and medium-term.

In addition to understanding the magnitude of the overall employment effects, it is also important to understand the distributional implications. CEA ranked occupations by wages and found that, according to the Frey and Osbourne analysis, 83 percent of jobs making less than $20 per hour would come under pressure from automation, as compared to 31 percent of jobs making between $20 and $40 per hour and 4 percent of jobs making above $40 per hour (Figure 3a). Furthermore, the OECD study estimates that less-educated workers are more likely to be replaced by automation than highly-educated ones (Figure 3b). Indeed, the OECD study's authors estimate that 44 percent of American workers with less than a high school degree hold jobs made up of highly-automatable tasks while 1 percent of people with a bachelor's degree or higher hold such a job. To the degree that education and wages are correlated with skills, this implies a large decline in demand for lower-skilled workers and little decline in demand for higher-skilled workers. These estimates suggest a continuation of skill-biased technical change in the near term.

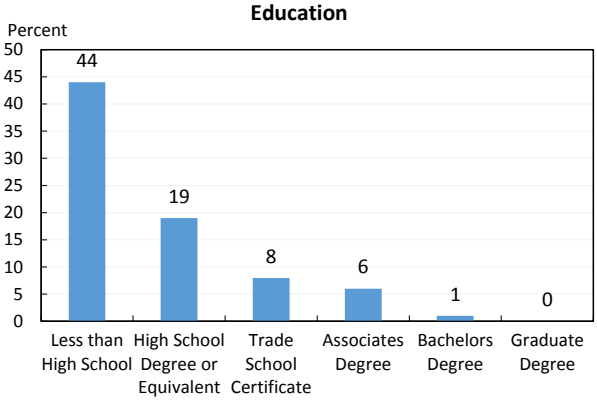
Nevertheless, humans still maintain a comparative advantage over AI and robotics in many areas. While AI detects patterns and creates predictions, it still cannot replicate social or general intelligence, creativity, or human judgment. Of course, many of the occupations that use these types of skills are high-skilled occupations, and likely require higher levels of education. Further, given the current dexterity limits of the robotics that would be needed to implement mass AI-driven automation, occupations that require manual dexterity will also likely remain in demand in the near term.

Figure 3a: Share of Jobs with High Probability of Automation, by Occupation's Median Hourly Wage



Source: Bureau of Labor Statistics; Frey and Osborne (2013); CEA calculations.

Figure 3b: Share of Jobs with Highly Automatable Skills, by Education



Source: Arntz, Gregory, and Zierahn (2016) calculations based on the PIAAC 2012.

Box 1: Automated Vehicle Case Study

A helpful case in understanding the types of effects AI may have on productivity and labor demand is the development of automated vehicles (AVs). Like other forms of technological disruption, AV technology will likely cause disruptions in the labor market as the economy adapts to new paradigms.

CEA estimates that 2.2 to 3.1 million existing part- and full-time U.S. jobs may be threatened or substantially altered by AV technology. Importantly, this is not a net calculation—it does not include the types of new jobs that may be developed—but rather a tally of currently held jobs that are likely to be affected by AI-enabled AV technology. A second caveat is that these changes may take years or decades to occur because there will be a further lag between technological possibility and widespread adoption.

This estimate of the number of current jobs likely displaced or substantially altered by AVs starts by identifying occupations that involve substantial driving and relatively few other responsibilities to lead and coordinate others, drawing occupation descriptions from the Bureau of Labor Statistics (BLS) and the Occupational Information Network (O*NET). For each of these occupations, an analysis of what non-driving tasks the occupation also requires yields an estimate of the share of jobs that will be displaced: driving jobs that also involve less-automatable tasks have a lower chance of disappearing. For example, the job of school-bus driver mixes both the tasks of driving and of attending to children. This job will not disappear, though it may evolve to focus heavily on the task of attending to children. As a result, AV technology may replace only a modest share of school-bus driver jobs, but child care workers will still be required. On the other hand, non-driving tasks are less important in inter-city bus driver jobs, and AV technology will likely replace a large share of these jobs.

Many jobs involve limited amounts of driving. These jobs are not included in the analysis below as individuals in these occupations would likely see a productivity boost, not a threat of displacement, as their time allocated to driving is freed up to focus on other critical tasks.

In addition to occupations identified from BLS and O*NET, CEA's estimate of jobs threatened or likely to be substantially altered by AVs also includes approximately 364,000 self-employed individuals driving either part- or full-time with ride-sharing services as of May 2015 that may find AV technology substituting for their services.

Table 1, below, presents the identified occupation categories.

Table 1

Occupation	BLS Code	# Total Jobs (BLS, May 2015)	Mean Hourly Wage	O*NET Occupation Description
Bus Drivers, Transit and Intercity	53-3021	168,620	$19.31	Drive bus or motor coach, including regular route operations, charters, and private carriage. May assist passengers with baggage. May collect fares or tickets.
Light Truck or Delivery Services Drivers	53-3033	826,510	$16.38	Drive a light vehicle, such as a truck or van, with a capacity of less than 26,000 pounds Gross Vehicle Weight (GVW), primarily to deliver or pick up merchandise or to deliver packages. May load and unload vehicle.
Heavy and Tractor-Trailer Truck Drivers	53-3032	1,678,280	$20.43	Drive a tractor-trailer combination or a truck with a capacity of at least 26,000 pounds Gross Vehicle Weight (GVW). May be required to unload truck. Requires commercial drivers' license.
Bus Drivers, School or Special Client	53-3022	505,560	$14.70	Transport students or special clients, such as the elderly or persons with disabilities. Ensure adherence to safety rules. May assist passengers in boarding or exiting.
Taxi Drivers and Chauffeurs	53-3041	180,960	$12.53	Drive automobiles, vans, or limousines to transport passengers. May occasionally carry cargo. Includes hearse drivers.
Self-employed Drivers	N/A	364,000[30]	$19.35[31]	N/A

As the above occupations involve other, critical non-driving tasks to varying degrees, Table 2, below, presents a weighted estimate of jobs threatened or substantially altered by AV technology in each occupation. For example, a weight of 0.60 indicates that approximately 60 percent of jobs in an occupation are threatened. These weights are generated by CEA using

[30] Calculations based on Hall and Krueger, 2016, (http://www.nber.org/papers/w22843.pdf), who note the number of active driver-partners for Uber more than doubled every six months in the period 2012-2014, and expect this growth rate to continue into 2015. CEA uses data from Harris and Krueger (2015) (http://www.hamiltonproject.org/assets/files/modernizing_labor_laws_for_twenty_first_century_work_krueger_harris.pdf) for only Uber and Lyft. Extrapolating to May 2015 with Hall and Krueger's method, CEA calculates approximately 324,000 individuals were active driver-partners with Uber in May 2015.

[31] Mean hourly earnings reported in Hall and Krueger (2016).

detailed job descriptions, case studies, and surveys of existing and planned technologies for each occupation.

Table 2

Occupation	# Total Jobs (BLS, May 2015)	Range of Replacement Weights	Range of # Jobs Threatened
Bus Drivers, Transit and Intercity	168,620	0.60 – 1.0	101,170 – 168,620
Light Truck or Delivery Services Drivers	826,510	0.20 – 0.60	165,300 – 495,910
Heavy and Tractor-Trailer Truck Drivers	1,678,280	0.80 – 1.0	1,342,620 – 1,678,280
Bus Drivers, School or Special Client	505,560	0.30– 0.40	151,670 – 202,220
Taxi Drivers and Chauffeurs	180,960	0.60 – 1.0	108,580 – 180,960
Self-employed drivers	364,000	0.90 – 1.0	328,000 – 364,000
TOTAL JOBS	3,723,930		2,196,940 – 3,089,990

AV technology could enable some workers to focus time on other job responsibilities, boosting their productivity, and actually fostering wage growth among those still holding the reshaped jobs. For example, salespeople who currently spend a considerable amount of time driving could find themselves able to do other work while a car drives them from place to place, or inspectors and appraisers could fill out paperwork while their car drives itself. This should make these workers more productive, with AV technology serving as a complement, not a substitute. New jobs will also likely be created, both in existing occupations—cheaper transportation costs will lower prices and increase demand for goods and all the related occupations such as service and fulfillment—and in new occupations not currently foreseeable. Conversely, even occupations that have little connection to driving and divorced from the threat of automation could face pressure on wages due to an increased supply of similar, displaced workers.

In cases where downward pressure on wages or consolidation result in displacement of workers, private-sector solutions and public policy should aim to ensure smooth and quick transitions to new opportunities for these workers. CEA analysis finds that a share of workers in a few isolated occupations—truck drivers and delivery service drivers, in particular—currently enjoy a wage premium over others in the labor market with the same level of educational attainment. They may not be able to regain this wage premium if displaced

without intervention to help them re-skill. Job search assistance, education, training and apprenticeships to build and certify new skills, and wage insurance could provide valuable support to them as they transition to finding new jobs.

Policy responses to these challenges are discussed later in this report.

What kind of jobs will AI create?

Predicting future job growth is extremely difficult, as it depends on technologies that do not exist today and the multiple ways they may complement or substitute for existing human skills and jobs. To form an intelligent guess about what these jobs might be like, CEA has synthesized and extended existing research on jobs that would be directly created by AI. It is important to understand, however, that AI will also lead to substantial indirect job creation—to the degree it raises productivity and wages it may also lead to higher consumption that would support additional jobs across the economy in everything from high-end craft production to restaurants and retail.

CEA has identified four categories of jobs that might experience direct AI-driven growth in the future. Employment in areas where humans engage with existing AI technologies, develop new AI technologies, supervise AI technologies in practice, and facilitate societal shifts that accompany new AI technologies will likely grow. Current limits on manual dexterity of robots and constraints on generative intelligence and creativity of AI technologies likely mean that employment requiring manual dexterity, creativity, social interactions and intelligence, and general knowledge will thrive. Below are descriptions and potential examples of future employment for each category.

Engagement. Humans will likely be needed to actively engage with AI technologies throughout the process of completing a task. Many industry professionals refer to a large swath of AI technologies as "Augmented Intelligence," stressing the technology's role as assisting and expanding the productivity of individuals rather than replacing human work. Thus, based on the biased-technical change framework, demand for labor will likely increase the most in the areas where humans complement AI-automation technologies. For example, AI technology such as IBM's Watson may improve early detection of some cancers or other illnesses, but a human healthcare professional is needed to work with patients to understand and translate patients' symptoms, inform patients of treatment options, and guide patients through treatment plans. Shipping companies may also partner workers who pickup and deliver goods over the last 100 feet with AI-enabled autonomous vehicles that move workers efficiently from site to site. In such cases, AI augments what a human is able to do and allows individuals to either be more effective in their specialty task or to operate on a larger scale.

Development. In the initial stages of AI, development jobs are crucial and span multiple industries and skill levels. Most intuitively, there may be a great need for highly-skilled software developers and engineers to put these capacities into practical use in the world. To a certain extent, however, AI is only as good as the data behind it, so there will likely be increased demand for jobs in generating, collecting, and managing relevant data to feed into AI training

processes. Applications of AI can range from high-skill tasks such as recognizing cancer in x-ray images to lower-skill tasks such as recognizing text in images. Finally, to an increasing degree, development may include those specializing in the liberal arts and social sciences, such as philosophers with frameworks for ethical evaluations and sociologists investigating the impact of technology on specific populations, who can give input as the new technologies grapple with more social complexities and moral dilemmas.

Supervision. This category encompasses all roles related to the monitoring, licensing, and repair of AI. For example, after the automated vehicle development phase, the need for human registration and testing of such technology to ensure safety and quality control on the roads will still likely exist. As a widespread new technology, AV will require regular repair and maintenance, which may expand mechanic and technician jobs in this space as well. Real-time supervision will also be required in exceptional, marginal, or high-stakes cases, especially those involving morality, ethics, and social intelligence that AI may lack. This might take the form of quality control of recommendations made by AI or online moderation when sensitive subjects are discussed. The capacity for AI-enabled machines to learn is one of the most exciting aspects of the technology, but it may also require supervision to ensure that AI does not diverge from originally intended uses. As machines get smarter and have improved ability to make practical predictions about the environment, the value of human judgement will increase because it will be the preferred way to resolve competing priorities.[32]

Response to Paradigm Shifts. The technological innovation surrounding AI will likely reshape features of built environment. In the case of AVs, dramatic shifts in the design of infrastructure and traffic laws—which are currently built with the safety and convenience of human drivers in mind—may be needed. The advent of self-driving cars may result in higher demand for urban planners and designers to create a new blueprint for the way the everyday travel landscape is built and used. Paradigm shifts in adjacent fields such as cybersecurity—demanding, for instance, new methods of detecting fraudulent transactions and messages—may also necessitate new occupations and more employment.

[32]Ajay Agrawal, Joshua Gans, and Avi Goldfarb, "The Simple Economics of Machine Intelligence," *Harvard Business Review,* November 17, 2016 (https://hbr.org/2016/11/the-simple-economics-of-machine-intelligence).

Box 2: The End of Work?

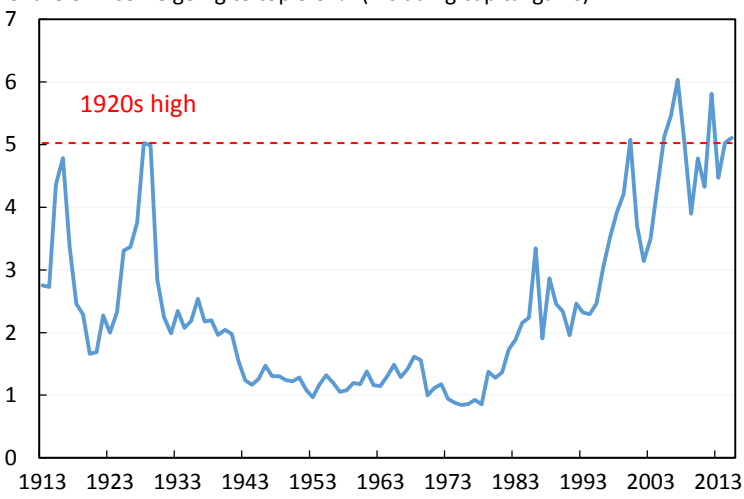
In addition to the arguments that AI and future technologies will broadly follow the same path as past technological revolutions, others make a more radical argument about the possible longer-run effects. They posit that AI could prove different from previous technological change because it has the ability to replicate something previously exclusive to humans: intelligence. There have long been fears that technology—the machines, the assembly lines, or the robots—would replace all human labor, but AI-driven automation has unique features that may allow it to replace substantial amounts of routine cognitive tasks in which humans previously maintained a stark comparative advantage. Initial waves of technology, such as the wheel and lever, allowed humans to do more by replacing or augmenting physical strength. Other processes allowed work to take place faster or more efficiently in a factory. Computers allowed calculations or pattern recognition to take place faster and augment humans' capacity to think or reason.

AI, though, may allow machines to operate without humans to such a degree that they fundamentally change the nature of production and work.[33] It may be that the question is no longer which segment of the population will technology complement, but whether the new technology will complement many humans at all, or if AI will substitute completely for much of human work. The skills in which humans have maintained a comparative advantage are likely to erode over time as AI and new technologies become more sophisticated. Some of this is evident today as AI becomes more capable at tasks such as language processing, translation, basic writing, or even music composition.

AI-driven technological change could lead to even larger disparities in income between capital owners and labor. For example, Brynjolfsson and McAfee argue that current trends in the labor market, such as declining wages in the face of rising productivity, are indicative of a more drastic change in the distribution of economic benefits to come. Rather than everyone receiving at least some of the benefit, the vast majority of that value will go to a very small portion of the population: "superstar-biased technological change." Superstar-biased technological change is somewhat similar to skill-biased technological change, but the benefits of technology accrue to an even smaller portion of society than just the highly-skilled workers. The winner-take-most and winner-take-all nature of the information technology market means that the fortunate few are likely to emerge as victors of the market. This would exacerbate the current trend in the rising fraction of total income going to the top 0.01 percent (Figure 4).

[33] Erik Brynjolfsson and Andrew McAfee, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies,* WW Norton & Company, 2014.

Figure 4: Top 0.01% Income Share, 1913-2015



Source: Piketty and Saez (2003), data update as of June 2016.

In theory, AI-driven automation might involve more than temporary disruptions in labor markets and drastically reduce the need for workers. If there is no need for extensive human labor in the production process, society as a whole may need to find an alternative approach to resource allocation other than compensation for labor, requiring a fundamental shift in the way economies are organized.

Although this scenario is speculative, it is included in this report to foster discussion and shed light on the role and value of work in the economy and society. Ultimately, AI may develop in the same way as the technologies before it, creating new products and new jobs such that the bulk of individuals will be employed as they are today.[34]

Technology is Not Destiny—Institutions and Policies Are Critical

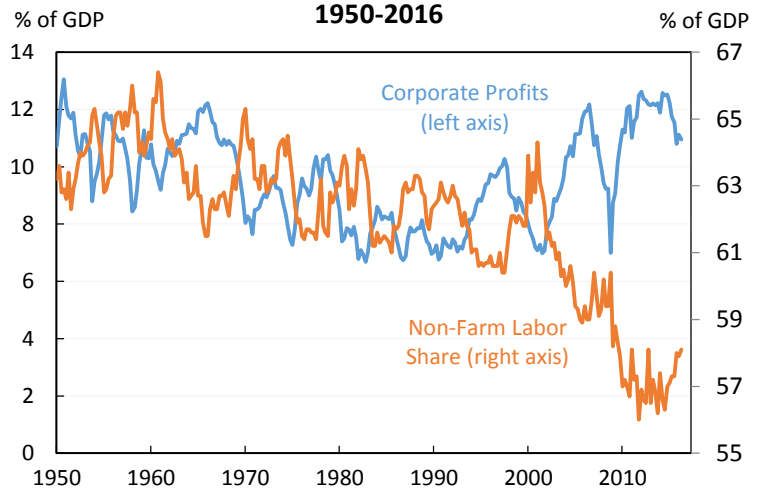
A key determinant of how AI-induced technological change will affect people in the future is the ability of workers to extract the benefits of their increased productivity. For decades after World War II, the share of income going to the bottom 90 percent of workers was roughly unchanged. But since the late 1970s, the bottom 90 percent of households have seen their income fall from two-thirds of the total to about one half of the total share of U.S. income. For much of this period, moreover, productivity growth did not translate to higher real wages for low-income and even middle-income American workers.

This reduced share of income is partly the result of the fact that labor compensation is being increasingly unevenly distributed. But since 2000, it is also because the distribution of benefits going to capital and labor have also been diverging. Starting in about 2000, corporate profits as a share of GDP (a measure of the capital share of GDP) started to increase and labor share of GDP

[34] For more discussion, see John W. Budd, *The Thought of Work*, Cornell University Press, 2011.

began decreasing (Figure 6). The labor share of GDP reached a historical low, though it has trended up somewhat over the last 2 years.

Figure 5: Non-Farm Labor and Corporate Profits Share of GDP, 1950-2016



Source: Bureau of Economic Analysis, Bureau of Labor Statistics; CEA calculations

How AI and AI-driven automation will shape the distribution of gains in coming years depends on non-technical factors including aspects of both the broader economy and policy institutions. First, the direction of innovation is not a random shock to the economy but the product of decisions made by firms, governments, and individuals. Economic factors can drive the direction of technological change. Second, there is a role for policy to help amplify the best effects of automation and temper the worst.

Technological advancement is generated and adopted into the economy as the product of choices of entrepreneurs, workers, and firms looking to better serve a market or streamline a production process, in the context created by public investments in basic and applied research, infrastructure, and other public goods. In a process of directed technical change, incentives draw investment towards more potentially profitable innovations and so the types of technological change that are likely to occur, among those which are technologically feasible, are those which are most profitable.[35] Research examining firms' decisions to innovate argues that the tendency towards unskill-biased technical change in the 1800s came about because it was profitable to create technologies that replaced expensive and scarce resources (skilled artisans) with relatively cheap and abundant resources (machines and low-skilled workers).

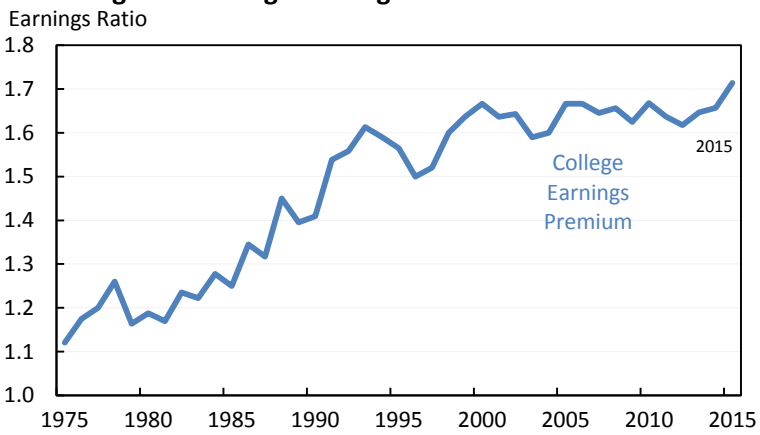
In contrast, research suggests that skill-biased technical change of the 1990s was a function of increases in the supply of educated workers, which made innovations that raised their productivity more profitable because they could be used widely.[36] The Frey and Osborne study

[35] Daron Acemoglu, "Directed Technological Change, *Review of Economic Studies* 69(4): 781-809, 2003 (http://restud.oxfordjournals.org/content/69/4/781.short).
[36] Acemoglu, 2003.

and the OECD study suggest that this trend of skill-biased technical change may continue with AI, as the most automatable occupations tend to be low-wage and low-skill.

On the other hand, the wage premium for higher-skilled labor has increased over time (Figure 6), which creates a countervailing incentive to invest in innovations that might raise the productivity of lower-skill, lower-price workers. For example, automation technology that embodies expertise in medical imaging hardware and software allows middle-skill personnel to make medical diagnosis, reducing demand for more-expensive specialists. Similarly, the introduction of proprietary tax preparation software has allowed less-skilled tax preparers to replace certified accountants in some situations. In both cases, the demand for high-skill computer programmers also increases slightly but their work diffuses widely and scales cheaply. Thus technological change does not happen in a vacuum. The trajectory of AI may shift and change depending on non-technical, competitive incentives.

Figure 6: College Earnings Premium Over Time



Note: The earnings ratio compares the median full-time, full-year worker over age 25 with a bachelor's degree only to the same type of worker with just a high school degree. Prior to 1992, bachelor's degree is defined as four years of college.
Source: CPS ASEC.

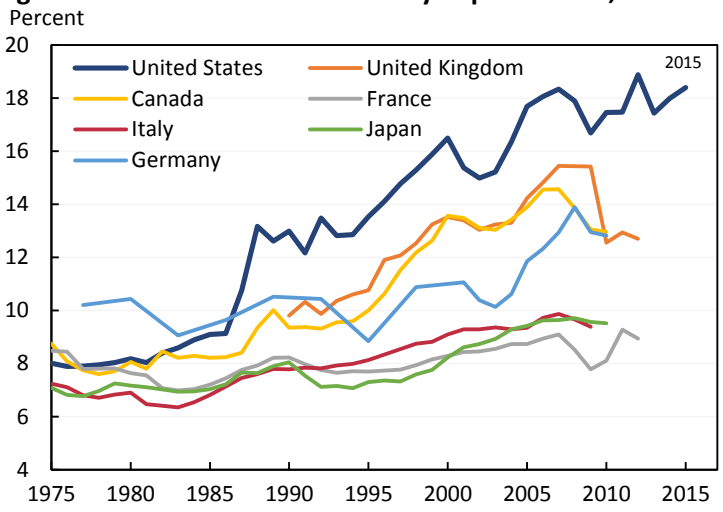
Policy plays a large role in shaping the effects of technological change. Therefore, even if Frey and Osborne's predictions that almost 50 percent of occupations are threatened by new automation technologies are accurate, the labor market impacts also depend on a country's institutions and policies. While relative wages depend on the demand for different levels of skill, which is partially a function of technology, wages also depend on the supply of labor at various skill levels, which is influenced by the distribution of educational opportunity and attainment.[37] Relative wages also depend on collective bargaining,[38] minimum wage laws, and other institutions and policies that affect wage setting.

Over the last 4 decades, other major advanced countries have experienced technological changes similar to the United States, yet the United States has seen both a greater increase in income inequality and higher overall levels of inequality, as shown in Figure 7. While most other

[37] Claudia Goldin and Lawrence F. Katz, *The Race between Education and Technology*, 2008.
[38] Bruce Western and Jake Rosenfeld, "Unions, norms, and the rise in US wage inequality," *American Sociological Review* 76(4): 513-37, 2011.

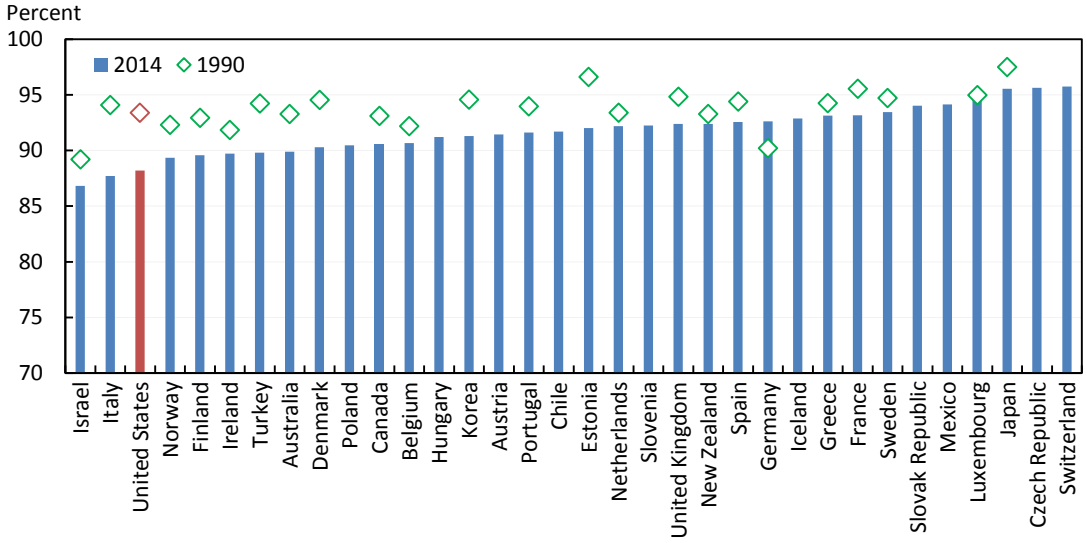
advanced economies have seen declines in prime-age male labor force participation, moreover, the decline in the United States has been steeper than in almost every other advanced economy, as shown in Figure 8.

Figure 7: Share of Income Earned by Top 1 Percent, 1975-2015



Source: World Wealth and Income Database.

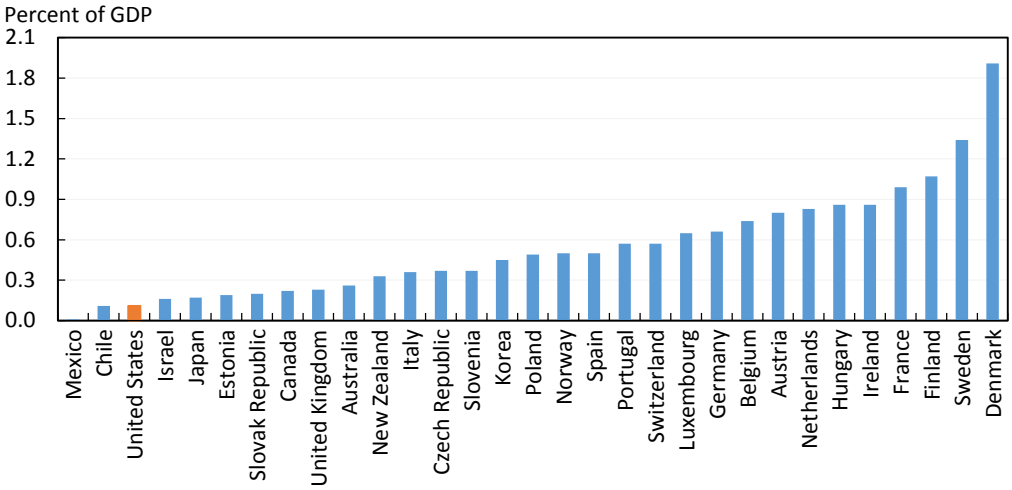
Figure 8: Prime-Age Male Labor Force Participation Rates Across the OECD



If the difference between the United States and the other countries in inequality and labor force participation pictured above cannot be explained by the rate of technological change and which tasks are automatable, then it suggests that differences in a country's policies and institutions may mediate these changes. For example, other countries tend to invest far more resources on active labor market programs that help workers navigate job transitions, such as training programs and job-search assistance. While OECD member countries outside of the United States spent, on average, 0.6 percent of GDP on active labor market policies in 2014, spending by the

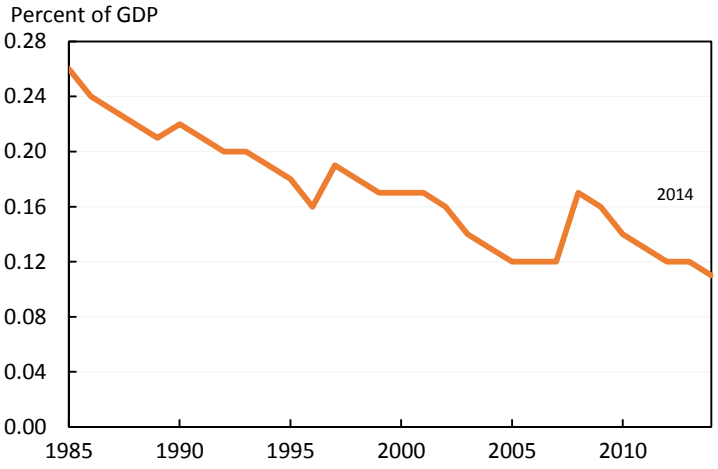
United States was just 0.1 percent of GDP (Figure 9). The United States, moreover, now spends less than half of what it did on such programs 30 years ago as a share of GDP (Figure 10).[39]

Figure 9: Public Expenditure on Active Labor Market Programs (% of GDP)



Note: Data for Ireland, Poland, and Spain from 2013; Data for UK for 2011.
Source: OECD Statistics (2014)

Figure 10: U.S. Public Expenditure on Active Labor Market Programs Over Time as Percent of GDP



Source: OECD Statistics (2014)

It is possible for the economy to generate high levels of employment with more advanced automation and higher levels of productivity than there are today. But Federal policies will need to play a role in helping Americans to navigate transitions in labor market demand caused by changes in technology over time.

[39] OECD, "Labour market programmes: expenditure and participants", *OECD Employment and Labour Market Statistics* (database), 2016 (http://stats.oecd.org/viewhtml.aspx?datasetcode=LMPEXP&lang=en#).

Policy Responses

AI-driven automation stands to transform the economy over the coming years and decades. The challenge for policymakers will be to update, strengthen, and adapt policies to respond to the economic effects of AI.

Although it is difficult to predict these economic effects precisely with a high degree of confidence, the economic analysis in the previous chapter suggests that policymakers should prepare for five primary economic effects:

- Positive contributions to aggregate productivity growth;
- Changes in the skills demanded by the job market, including greater demand for higher-level technical skills;
- Uneven distribution of impact, across sectors, wage levels, education levels, job types, and locations;
- Churning of the job market as some jobs disappear while others are created; and
- The loss of jobs for some workers in the short-run, and possibly longer depending on policy responses.

There is substantial uncertainty about how strongly these effects will be felt, and how rapidly they will arrive. It is possible that AI will not have large, new effects on the economy, such that the coming years are subject to the same basic workforce trends seen in recent decades—some which are positive, and others which are worrisome and may require policy changes. At the other end of the range of possibilities, the economy might potentially experience a larger shock, with accelerating changes in the job market, and significantly more workers in need of assistance and retraining as their skills are no longer valued in the job market. Given presently available evidence, it is not possible to make specific predictions, so policymakers must be prepared for a range of potential outcomes. At a minimum, some occupations such as drivers and cashiers are likely to face displacement from or restructuring of their current jobs, leading millions of Americans to experience economic hardship in the short-run absent new policies.

Because the effects of AI-driven automation will likely be felt across the whole economy, and the areas of greatest impact may be difficult to predict, policy responses must be targeted to the whole economy. In addition, the economic effects of AI-driven automation may be difficult to separate from those of other factors such as other technological changes, globalization, reduction in market competition and worker bargaining power, and the effects of past public policy choices. Even if it is not possible to determine how much of the current transformation of the economy is caused by each of these factors, the policy challenges raised by the disruptions remain, and require a broad policy response.

In the cases where it is possible to direct mitigations to particular affected places and sectors, those approaches should be pursued. But more generally, this report suggests and discusses below three broad strategies for addressing the impacts of AI-driven automation across the whole U.S. economy:

1. Invest in and develop AI for its many benefits;
2. Educate and train Americans for jobs of the future; and
3. Aid workers in the transition and empower workers to ensure broadly shared growth.

Strategy #1: Invest In and Develop AI for its Many Benefits

If care is taken to responsibly maximize its development, AI will make important, positive contributions to aggregate productivity growth, and advances in AI technology hold incredible potential to help America stay on the cutting edge of innovation. Indeed, CEA Chair Jason Furman has written that his biggest worry about AI is "that we do not have enough [of it]."[40] AI technology itself has opened up new markets and new opportunities for progress in critical areas such as health, education, energy, economic inclusion, social welfare, transportation, and the environment. Substantial innovation in AI, robotics, and related technology areas has taken place over the last decade, but the United States will need a much faster pace of innovation in these areas to significantly advance productivity growth going forward.[41] With the right investment in AI and policies to support a larger and more diverse AI workforce, the United States has the potential to accelerate productivity and maintain the strategic advantages that result from American leadership in AI.[42]

Invest in AI research and development

Government has an important role to play in advancing the AI field by investing in research and development. Throughout the public outreach on AI conducted by OSTP, government officials heard calls from business leaders, technologists, and economists for greater government investment in AI research and development. Leading researchers in AI were optimistic about sustaining the recent rapid progress in AI and its use in an ever wider range of applications. A strong case can be made in favor of increased Federal funding for research in AI.

The Administration published its *Artificial Intelligence Research and Development Strategic Plan* in October 2016, laying out a detailed strategy and roadmap for government-funded AI research and development.

Develop AI for cyberdefense and fraud detection

Currently, designing and operating secure systems requires a large investment of time and attention from experts. Automating this expert work, partially or entirely, may enable strong security across a much broader range of systems and applications at dramatically lower cost, and

[40] Jason Furman, "Is This Time Different? The Opportunities and Challenges of Artificial Intelligence." Remarks at AI Now: The Social and Economic Implications of Artificial Intelligence Technologies in the Near Term. New York University, New York, July 7, 2016. (https://www.whitehouse.gov/sites/default/files/page/files/20160707_cea_ai_furman.pdf).
[41] *Ibid.*
[42] More detailed policy recommendations for investments in AI research and development, and development of the AI workforce, see the previous Administration report, *Preparing for the Future of Artificial Intelligence* (https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf), and the accompanying *Artificial Intelligence Research and Development Strategic Plan* (https://www.nitrd.gov/PUBS/national_ai_rd_strategic_plan.pdf).

may increase the agility of cyber defenses. Using AI may help maintain the rapid response required to detect and react to the landscape of ever evolving cyber threats. There are many opportunities for AI and specifically machine-learning systems to help cope with the sheer complexity of cyberspace and support effective human decision making in response to cyberattacks.

Future AI systems could perform predictive analytics to anticipate cyberattacks by generating dynamic threat models from available data sources that are voluminous, ever-changing, and often incomplete. These data include the topology and state of network nodes, links, equipment, architecture, protocols, and networks. AI may be the most effective approach to interpreting these data, proactively identifying vulnerabilities, and taking action to prevent or mitigate future attacks. Results to-date in DARPA's Cyber Grand Challenge competition demonstrate the potential of this approach.[43] The Cyber Grand Challenge was designed to accelerate the development of advanced, autonomous systems that can detect, evaluate, and patch software vulnerabilities before adversaries have a chance to exploit them. The Cyber Grand Challenge Final Event was held on August 4, 2016. To fuel follow-on research and parallel competition, all of the code produced by the automated systems during the Cyber Grand Challenge Final Event has been released as open source to allow others to reverse engineer it and learn from it.

AI also has important applications in detecting fraudulent transactions and messages. AI is widely used in the industry to detect fraudulent financial transactions and unauthorized attempts to log in to systems by impersonating a user. AI is used to filter email messages to flag spam, attempted cyberattacks, or otherwise unwanted messages. Search engines have worked for years to maintain the quality of search results by finding relevant features of documents and actions, and developing advanced algorithms to detect and demote content that appears to be unwanted or dangerous. In all of these areas, companies regularly update their methods to counter new tactics used by attackers and coordination among attackers.

Companies could develop AI-based methods to detect fraudulent transactions and messages in other settings, enabling their users to experience a higher-quality information environment. Further research is needed to understand the most effective means of doing this.

Develop a larger, more diverse AI workforce

The rapid growth of AI has dramatically increased the need for people with relevant skills to support and advance the field. The AI workforce includes AI *researchers* who drive fundamental advances in AI and related fields, a larger number of *specialists* who refine AI methods for specific applications, and a great number of *users* who operate those applications in specific settings. For researchers, AI training is inherently interdisciplinary, often requiring a strong background in computer science, statistics, mathematical logic, and information theory.[44] For

[43] Cyber Grand Challenge (https://www.cybergrandchallenge.com).
[44] There is also a need for the development of a strong research community in fields outside of technical disciplines related to AI, to examine the impacts and implications of AI on economics, social science, health, and other areas of research.

specialists, training typically requires a background in software engineering as well as in the application area. For users, familiarity with AI technologies is needed to apply them reliably.

All sectors face the challenge of how to diversify the AI workforce. The lack of gender and racial diversity in the AI-specific workforce mirrors the significant and problematic lack of diversity in the technology industry and the field of computer science more generally. Unlocking the full potential of the American people, especially in entrepreneurship, as well as science, technology, engineering, and mathematics (STEM) fields, has been a priority of the Administration. The importance of including individuals from diverse backgrounds, experiences, and identities, especially women and members of racial and ethnic groups traditionally underrepresented in STEM, is one of the most critical and high-priority challenges for computer science and AI.

Research has shown that diverse groups are more effective at problem solving than homogeneous groups, and policies that promote diversity and inclusion will enhance our ability to draw from the broadest possible pool of talent, solve our toughest challenges, maximize employee engagement and innovation, and lead by example by setting a high standard for providing access to opportunity to all segments of our society.[45]

Policymakers also will need to address new potential barriers stemming from any algorithmic bias. Firms are beginning to use consumer data, including data sets collected by "third-party" data services companies, to determine individuals' fitness for credit, insurance and even employment. Other firms are pioneering the use of games, simulations, and electronic tests to determine the "fit" of job applicants to a team. To do this, automated algorithms may be trained with data about successful team members in order to look for applicants that resemble them. One important benefit of these innovations is enabling companies to recruit and hire candidates based on demonstrated skills and abilities rather than pedigree, which will become even more critical as people gain skills on the job. But if such training sets are based on a less diverse current workforce, the biases of the existing group may be built into the resulting decisions and may unfairly exclude new potential talent. While employment laws and the Fair Credit Reporting Act currently impose certain restrictions on the use of credit history in making employment decisions, additional statutory or regulatory protections may be need to be explored in this space.

The previous report, *Preparing for the Future of Artificial Intelligence*, discusses workforce needs, including the strong case for increasing diversity, and lays out a detailed plan for AI workforce development.[46]

Support market competition

Competition from new and existing firms has always played an important role in the creation and adoption of new technologies and innovations, and this is no different in the case of AI. Startups

[45] Aparna Joshi and Hyntak Roh, "The Role of Context in Work Team Diversity Research: A Meta-Analytic Review," *Academy of Management Journal* 52: 599-627, 2009; Vivian Hunt, Dennis Layton, and Sara Prince, "Why Diversity Matters," McKinsey & Company, 2015 (http://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters).

[46] The White House, *Preparing for the Future of Artificial Intelligence,* (https://www.whitehouse.gov/sites/default/files/whitehouse_files/microsites/ostp/NSTC/preparing_for_the_future_of_ai.pdf).

are a critical pathway for the commercialization of innovative new ideas and products. Startups, or the possibility of entry by a startup, also incentivize established firms to innovate and reduce costs. Competition pushes firms to invest in new technologies that help to lower costs, and also to invest in innovations that can lead to improvements in the quality of existing products.

The rapid evolution of technology can pose challenges for developing sound pro-competition policies, both in terms of defining the scope of the market as well as assessing the degree of contestability or the possibilities for disruption. For example, while it is probably too early to assess the role of AI in competition policy, one might imagine that when a large incumbent has access to most of the customer data in the market, it is able to use AI to refine its products better than any potential entrant could hope, and can thereby effectively foreclose entry.

Strategy #2: Educate and Train Americans for Jobs of the Future

As AI changes the nature of work and the skills demanded by the labor market, American workers will need to be prepared with the education and training that can help them continue to succeed. If the United States fails to improve at educating children and retraining adults with the skills needed in an increasingly AI-driven economy, the country risks leaving millions of Americans behind and losing its position as the global economic leader.

The United States led the world in economic gains from the industrial revolution in part due to major investments in its workforce. In the 20th century, America shifted from a mostly agrarian economy to an industrial economy. During this period, as today, the type of work and skills required to do work underwent a major transformation. To meet the needs of the new economy, the United States rapidly expanded access to education through high school, and by 1930 America was far ahead of European countries in terms of widely available, free, and publically-provided secondary education.[47] The average American born in 1951 had 6.2 more years of schooling than an American born in 1876. These increases in schooling led to tangible economic gains: economists estimate that educational attainment explains 14 percent of annual increases in labor productivity during that period.[48] Americans used education to adapt to new jobs which could not even have been imagined in prior decades. Today's AI-driven transformation will likely require similar realignments. College- and career-ready skills in math, reading, computer science, and critical thinking are likely to be among the factors in helping workers successfully navigate through unpredictable changes in the future labor market. Providing the opportunity to obtain those skills will be a critical component of preparing children for success in the future.[49]

Educate youth for success in the future job market

A key step towards preparing individuals for the economy of the future is providing quality education opportunities for all.

[47] Ajay Chaudry, "The Case for Early Education in the Emerging Economy," *Roosevelt Institute-The New American Economy's Learning* Series, August 2016, p. 3 (http://rooseveltinstitute.org/wp-content/uploads/2016/08/The-Case-for-Early-Education-in-the-Emerging-Economy.pdf).
[48] Claudia Dale Goldin and Lawrence Katz, *The Race between Education and Technology*, 2008.
[49] The White House, Economic Report of the President 2016, Chapter 4.

While, in the past, many jobs paying decent wages could be done with low levels of skill, continuing changes in technology, including AI, will make such jobs less common in the future. While it is unclear exactly how progress in AI and other technologies will affect the jobs of the future, policymakers must address the low levels of proficiency in basic math and reading for millions of Americans. Despite strong progress over the past 8 years, the United States is still falling behind rather than leading the world in key dimensions for successfully navigating this transition. Children from low-income families start kindergarten over 1 year behind peers in language skills.[50] Student performance in mathematics in China is on average 2 years above U.S. students.[51] American students from lower socioeconomic backgrounds score 15 percent lower on international assessments than higher income peers.[52] And year after year, a stubborn gap persists between how well white students are doing compared to their African American and Latino classmates.[53]

For all students, coursework in STEM, and specifically in areas such as computer science, will likely be especially relevant to work and citizenship in an increasingly AI-driven world. To respond to these shifts, the United States must make real investments in high-quality education, at all levels of education.

All Children Get Off to the Right Start with Access to High-Quality Early Education

In a world of AI-driven skill-biased technological change, people with low levels of even basic skills such as reading and math are at higher risk of displacement. On average, children from poor families score far below their peers from higher-income families in early vocabulary and literacy development, in early math, and in the social skills they need to get along well in their classrooms.[54] Studies indicate that kids who start off with deficits in basic skills fail to catch up to peers by later grades.[55] Therefore, it is all the more important that the United States make key investments in getting kids from all income backgrounds off to the right start. To achieve these goals, the United States must catch up to the rest of the world in pre-school enrollment—the United States is ranked 28th out of 38 OECD countries in the share of 4-year-olds enrolled in early education programs.[56]

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[50] U.S. Department of Education, "A Matter of Equity: Preschool in America," April 2015 (https://www2.ed.gov/documents/early-learning/matter-equity-preschool-america.pdf).
[51] OECD, "Program for International Student Assessment 2012 Results (https://www.oecd.org/unitedstates/PISA-2012-results-US.pdf).
[52] *Ibid.*
[53] The White House, "Remarks of the President to the United States Hispanic Chamber of Commerce," March 2009 (https://www.whitehouse.gov/the-press-office/remarks-president-united-states-hispanic-chamber-commerce).
[54] U.S. Department of Education, "A Matter of Equity: Preschool in America," April 2015 (https://www2.ed.gov/documents/early-learning/matter-equity-preschool-america.pdf).
[55] Connie Juel, "Learning to read and write: A longitudinal study of 54 children from first through fourth grades," *Journal of Educational Psychology* 80.4:437, 1988; David J. Francis, et al., "Developmental lag versus deficit models of reading disability: A longitudinal, individual growth curves analysis," *Journal of Educational Psychology,* 88.1:3, 1996.
[56] OECD, "Education at a Glance: OECD Indicators 2012," Country Note: United States, 2012 (https://www.oecd.org/unitedstates/CN%20-%20United%20States.pdf).

All Students Graduate from High School College- and Career-Ready

Students are much better positioned for jobs that benefit from AI instead of being replaced by it if they graduate from high school with the necessary skills. In the Obama Administration, the U.S. high school graduation rate has reached a record high of 83 percent for the 2014-2015 school year.[57] Too many students, however, are not college- and career-ready when they finish high school. According to the National Assessment of Education Progress, the largest nationally representative and continuing assessment of what America's students know and can do, fewer than 40 percent of graduating students scored at college- and career-ready levels in 2013.[58] A strategy to dramatically speed up school improvement to keep pace with the accelerating rate of change in the global economy should include attracting and retaining the best teachers, making sure all schools have the resources required for success, and holding all students to high standards with rigorous coursework.

Additionally, it will require building on the President's *Computer Science for All* initiative, which seeks to give all students at the K-12 level access to coursework in computing and computational thinking. A bipartisan coalition of governors, mayors, and other public- and private-sector leaders has supported the creation of new standards, courses, and investments in teacher professional development, as well as supplementary extracurricular programs and resources to make this a reality. Further effort is needed to make computer science education available to all children.

The United States has made unprecedented progress ensuring more schools and libraries can access the digital tools to dramatically improve educational outcomes, particularly in delivering technology skills. From 2013 to 2015, 20 million more students gained access to high-speed broadband and wireless in schools, halving the connectivity divide, and the United States is on track to connect 99 percent of students in the near future. But while significant progress has been made, there is still more work to be done to ensure that all schools, libraries, and homes have access to broadband-enabled devices. And educators will need more support and professional development to deliver high-quality learning tailored to their students' needs.

All Americans Have Access to an Affordable Post-Secondary Education that Prepares Them for Good Jobs

Projections show that in the coming years nearly three-quarters of the fastest growing occupations will require at least some postsecondary education beyond high school.[59] Despite these growing needs, state funding for higher education is down by 18 percent on average since the start of the recession, and tuition at four-year public colleges is up by 33 percent since the

[57] National Center for Education Statistics, "The Condition of Education: Public High School Graduation Rates," May 2016.
[58] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2013 Mathematics and Reading Assessments.
[59] Bureau of Labor Statistics, "Employment Projections—2014-24," December 2015 (http://www.bls.gov/news.release/pdf/ecopro.pdf).

2007-2008 school year.[60] To further improve college access, affordability, and completion, the President has proposed making 2 years of community college free for hard-working students through America's College Promise. If all states participated in America's College Promise, an additional 9 million students could benefit.[61] This could be critical for workers seeking to gain new skills as a response to, or in order to avoid, dislocation from AI-driven automation.

Expand access to training and re-training

A commitment to preparing Americans to adapt to continuous and rapid technological change in the future, whether in AI or other fields, requires pursuing policy changes that would significantly expand the availability of high-quality job training to meet the scale of need; help people more successfully navigate job transitions; and target resources to programs that are producing strong results. But despite the clear challenges facing U.S. workers, the current level of investment in active labor market policies, such as training programs, by the United States is low by both international and historical standards. Through the Workforce Innovation and Opportunity Act—the Federal Government's largest job training investment program—only about 175,000 people are trained per year.[62] As shown above in Figures 9 and 10, while the member countries of the OECD spent, on average, 0.6 percent of GDP on active labor market policies in 2014, spending by the United States was just 0.1 percent of GDP. Relative to the overall economy, the United States now spends less than half of what it did on such programs 30 years ago.

The steps described below should be taken to put the United States ahead of, rather than behind, the curve in these critical areas.

Significantly Expand Availability of Job-Driven Training and Lifelong Learning to Meet the Scale of the Need

Increasing funding for job training by six-fold—which would match spending as a percentage of GDP to Germany, but still leave the United States far behind other European countries—would enable retraining of an additional 2.5 million people per year.[63] Over the last 8 years, the Administration has taken important steps to move in this direction. The Administration has made investments in half of community colleges in the country to create job-driven training programs in fields such as healthcare, information technology, energy and other in-demand fields that have trained nearly 300,000 people so far. The Administration also launched the POWER Initiative, a

[60] Center on Budget and Policy Priorities, "Funding Down, Tuition Up: State Cuts to Higher Education Threaten Quality and Affordability at Public Colleges," August 2016 (http://www.cbpp.org/research/state-budget-and-tax/funding-down-tuition-up).
[61] The White House, "Fact Sheet—White House Unveils America's College Promise Proposal: Tuition-Free Community College for Responsible Students," January 2015 (https://www.whitehouse.gov/the-press-office/2015/01/09/fact-sheet-white-house-unveils-america-s-college-promise-proposal-tuitio).
[62] Department of Labor, Employment and Training Administration, 2015.
[63] This assumes $6,000 per person training/reemployment cost, and an increase in Workforce Innovation and Opportunity Act funding from today's $3B to $18B, to match Germany's spending as a fraction of GDP, with all new funding spent on training.

new interagency effort to assist communities negatively impacted by changes in the coal industry and power sector with coordinated Federal economic and workforce-development resources.

Target Resources to Effective Education and Training Programs

Directing funding to training that produces results starts with information about whether programs are placing people into in-demand jobs that pay good salaries. Historically, very little data on the employment outcomes of education and training institutions has existed. Federal and State policymakers should build on Administration initiatives, such as the College Scorecard and the Workforce Innovation and Opportunity Act, by continuing to make investments in collecting and analyzing data on employment and earnings outcomes to hold programs accountable and direct funding to strategies producing results.

Expand Access to Apprenticeships

Job-driven apprenticeships grow the economy and can provide American workers from all backgrounds with the skills and knowledge they need to adapt to a changing economy. Research suggests that apprentices earn a significant premium for their skills—as much as $300,000 more than their peers over a lifetime.[64] The Obama Administration has prioritized expanding apprenticeship programs, and in 2014, called for doubling the number of U.S. registered apprenticeships over the next 5 years. The Administration awarded $175 million to expand apprenticeship in 2015 and announced $50.5 million in grants to support the expansion of new apprenticeship opportunities across the country in all major industry sectors in October 2016.[65]

Strategy #3: Aid Workers in the Transition and Empower Workers to Ensure Broadly Shared Growth

As AI-driven automation changes the economy, empowered workers can be one of the Nation's greatest assets. They can drive and spread innovation, lift consumer demand, and invest in the next generation.[66] This strategy explores how to ensure that workers and job seekers are able to pursue the job opportunities for which they are best qualified, able to bounce back successfully

[64] Debbie Reed, et al. An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States. Mathematica Policy Research, 2012 (https://wdr.doleta.gov/research/FullText_Documents/ETAOP_2012_10.pdf).

[65] The White House, "Fact Sheet: Investing More than $50 Million through ApprenticeshipUSA to Expand Proven Pathways onto the Middle Class." (https://www.dol.gov/sites/default/files/newsroom/newsreleases/WhiteHouseFactSheet-ApprenticeshipUSA-FY2016.pdf)

[66] Ragnhild Balsvik, "Is labor mobility a channel for spillovers from multinationals? Evidence from Norwegian manufacturing," *The Review of Economics and Statistics* 93.1: 285-297, 2011; April M. Franco and Matthew F. Mitchell, "Covenants not to compete, labor mobility, and industry dynamics." *Journal of Economics & Management Strategy* 17.3: 581-606, 2008; Florence Honore, "From Common Ground to Breaking New Ground: Founding Teams' Prior Shared Experience and Start-up Performance." Univ. of Minnesota, 2014; Council of Economic Advisers, "Labor Market Monopsony: Trends Consequences, and Policy Responses," 2016; Council of Economic Advisers, "Worker Voice in a Time of Rising Inequality," 2015; The White House, "Economic Report of the President," Chapter 4. February 2016 (http://go.wh.gov/dM4yPt).

from job loss, and be well-positioned to ensure they receive an appropriate return for their work in the form of rising wages.

Modernize and strengthen the social safety net

Changes to how people work and the dislocation of some workers due to automation heightens the need for a robust safety net to ensure that people can still make ends meet, retrain, and potentially transition careers. That means strengthening critical supports such as unemployment insurance, Medicaid, Supplemental Nutrition Assistance Program (SNAP), and Temporary Assistance for Needy Families (TANF), and putting in place new programs such as wage insurance and emergency aid for families in crisis. It also means exploring whether programs such as Trade Adjustment Assistance should be expanded to help those displaced by automation.

In addition, with the rise of part-time and contingent work, and a more mobile workforce in which individuals do not spend their entire career at a single company, policymakers will need to ensure that workers can access retirement, health care, and other benefits whether or not they get them on the job. For example, the Affordable Care Act expanded eligibility for Medicaid and reformed individual health insurance market to ensure that Americans who do not get coverage on the job can still find affordable, high-quality coverage, while simultaneously introducing reforms to improve coverage for people who are offered coverage at work.

Strengthen Unemployment Insurance

Job displacement is likely to be one of the most serious negative consequences of AI-driven automation, impacting entire industries and communities. Since its inception, unemployment insurance has been a powerful tool to prevent a job loss from hurtling a family into poverty. Last year alone, more than 7 million working Americans relied on the program to get by in tough times. Yet its protections have weakened over time, and today coverage by the program is at its lowest level in at least 50 years.[67] Fewer than one in three unemployed Americans now receive unemployment insurance benefits, and benefits replace a smaller percentage of wages than before for those who do qualify. In 2009, the American Recovery and Reinvestment Act built a foundation for modernizing the program by making $7 billion available to states to expand coverage. Since then, more than 30 states have implemented and sustained important reforms.

The program will need to be further strengthened, as laid out in a proposal to Congress from the President, to ensure that the program can offer a more secure safety net for workers displaced by AI-driven automation and to provide a countervailing force against regional spikes in unemployment. Because workers may be unemployed for longer periods of time as they retrain or shift occupations, benefits should be restored to 26 weeks across the country. The program should also provide up to 52 weeks of additional benefits in states experiencing high levels of unemployment or rapid job loss to dampen the effects of mass layoffs on local economies. This would minimize the chance that these layoffs would lead to broader regional or national recessions. Finally, with fewer than 20 states having sufficient reserves to weather even a single

[67] Internal OMB calculations, with unemployment insurance coverage measured as UI claims divided by the number of unemployed individuals.

year of recession, the system's long-term solvency must be ensured so that states are fully prepared for the potential increased cost of benefits stemming from job losses.

Some new tools could also help. Work-sharing programs can help employers hold on to their workers by reducing hours instead of laying them off, with workers whose hours are cut receiving partial unemployment benefits. States could also adopt temporary work-based training programs and allow workers to continue receiving unemployment benefits while participating in on-the-job training.

Experienced workers who lose their jobs and have to start over find themselves, on average, earning wages at least 10 percent less than what they earned in the jobs they lost, and workers with more than 20 years of experience in their prior job face wages that are nearly a quarter less than they had previously been making.[68] For this reason, the President has proposed providing wage insurance to workers who were displaced from jobs if they take a job earning less, replacing up to half of their lost wages. Such a program would help soften the blow of the lower wages some displaced workers would have to accept, and would encourage workers to put their skills back to work quickly so they do not join the ranks of the long-term unemployed or leave the workforce.

These proposals represent steps that can be taken to prepare for a continuation of the job impacts that are already occurring in the economy. If, however, the economic impact of AI is relatively intense or comes on relatively quickly, and if the number of jobs affected approaches the estimates of Frey and Osbourne, then the unemployment insurance system may need to be significantly upgraded to match the magnitude of economic disruption and ensure that displaced workers do not leave the labor force.

Give Workers Improved Guidance to Navigate Job Transitions

With the AI revolution, guidance about how to effectively navigate this transition will be all the more critical. Simple and relatively inexpensive services such as job-search assistance, advice about education and training, and access to labor-market information have been found to be quite effective at helping individuals looking for work find employment more quickly. Evaluations typically find that employment services speed up employment by one to two weeks.[69] Additionally, more intensive counseling services have been shown to increase recipients' earnings and decrease the time they spend unemployed.[70] AI can also be applied, to help workers find information that is best suited to their particular skills and circumstances.

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[68] The White House, "Fact Sheet: Improving Economic Security by Strengthening and Modernizing the Unemployment Insurance System," Executive Office of the President, January 2016 (https://www.whitehouse.gov/the-press-office/2016/01/16/fact-sheet-improving-economic-security-strengthening-and-modernizing).

[69] Louis Jacobson and Ian Petta, "Measuring the Effect of Public Labor Exchange (PLX) Referrals and Placements in Washington and Oregon," *OWS Occasional Paper 6*, 2000 (https://wdr.doleta.gov/research/FullText_Documents/owsop_2000_06.pdf).

[70] Marios Michaelides, Eileen Poe-Yamagata, Jacob Benus, and Dharmendra Tirumalasetti, "Impact of the Reemployment and Eligibility Assessment (REA) Initiative in Nevada," IMPAQ International, 2012

Strengthen Other Safety Net Programs

Other programs, such as SNAP and TANF, can provide critical safeguards for individuals who have lost their jobs or seen a substantial drop in income, by supplementing low-income households with food and monetary assistance. SNAP has played an important role in lifting millions of Americans out of poverty over the past five decades by providing key nutrition in times of need, with research showing that its benefits go beyond alleviating hunger to improving short-run and long-run health, educational attainment, and economic self-sufficiency.[71]

The TANF program, in conjunction with SNAP, was originally intended to help needy families achieve self-sufficiency. If automation leads to a rise in the number of families needing basic assistance due to growing inequality and poverty, it will be important to have a strong TANF program in place to help especially hard-hit families get back on their feet and work toward self-sufficiency. The President put forward a package of proposals to strengthen TANF, shoring up a system that has eroded over time, which would better support families affected by AI-driven automation.

In addition, the President's budget includes a new $2 billion in funds to test and scale innovative state and local approaches to aid families facing financial crisis. For families on the brink—including those affected by the entry of automation into a sector or occupation—a temporary illness or broken-down car could put them over the edge into a cycle of poverty. The funding would provide families with the emergency help they need to avert or reverse a downward spiral, and then connect those who need it with longer-term assistance so that families are stabilized.

(http://www.impaqint.com/sites/default/files/project-reports/ETAOP_2012_08_REA_Nevada_Follow_up_Report.pdf).

[71] The White House, "Long-Term Benefits of the Supplemental Nutrition Assistance Program," Executive Office of the President, December 2015 (https://www.whitehouse.gov/sites/whitehouse.gov/files/documents/SNAP_report_final_nonembargo.pdf).

Box 3: Replacing the Current Safety Net with a Universal Basic Income Could Be Counterproductive

(Excerpt from a speech by CEA Chair Jason Furman, in New York, July 7, 2016)

Fears of mass job displacement as a result of automation and AI, among other motivations, have led some to propose deep changes to the structure of government assistance. One of the more common proposals has been to replace some or all of the current social safety net with a universal basic income (UBI): providing a regular, unconditional cash grant to every man, woman, and child in the United States, instead of, say, Temporary Assistance to Needy Families (TANF), the Supplemental Nutrition Assistance Program (SNAP), or Medicaid.

While the exact contours of various UBI proposals differ, the idea has been put forward from the right by Charles Murray (2006), the left by Andy Stern and Lee Kravitz (2016), and has been a staple of some technologists' policy vision for the future (Rhodes, Krisiloff, and Altman 2016). The different proposals have different motivations, including real and perceived deficiencies in the current social safety net, the belief in a simpler and more efficient system, and also the premise that we need to change our policies to deal with the changes that will be unleashed by AI and automation more broadly.

The issue is not that automation will render the vast majority of the population unemployable. Instead, it is that workers will either lack the skills or the ability to successfully match with the good, high paying jobs created by automation. While a market economy will do much of the work to match workers with new job opportunities, it does not always do so successfully, as we have seen in the past half-century. We should not advance a policy that is premised on giving up on the possibility of workers' remaining employed. Instead, our goal should be first and foremost to foster the skills, training, job search assistance, and other labor market institutions to make sure people can get into jobs, which would much more directly address the employment issues raised by AI than would UBI.

Increase wages, competition, and worker bargaining power

As the Council of Economic Advisers recently discussed in its report on labor market monopsony,[72] there is growing concern about a general reduction in competition among firms for workers and a commensurate shift in the balance of bargaining power toward employers. Market concentration resulting from the development of AI has the potential to worsen these trends. A displacement of workers from industries being disrupted by AI-driven automation would also create slack in the labor market in the short to medium-run, which is likely to depress wages.

[72] Council of Economic Advisers, "Issue Brief: Labor Market Monopsony: Trends, Consequences, and Policy Responses," October 2016 (https://www.whitehouse.gov/sites/default/files/page/files/20161025_monopsony_labor_mrkt_cea.pdf).

Fortunately, there are several approaches described below that can counterbalance these trends and boost Americans' wages and working conditions.

Raise the Minimum Wage

The minimum wage plays a critical role in reducing inequality, increasing consumption, and strengthening the workforce. Raising it could lift at least 4.6 million people out of poverty.[73] Adjusted for inflation, the value of the minimum wage has fallen by nearly a quarter from its peak value in 1968 and is about one-fifth less than it was when President Reagan took office. While Congress has not acted, 22 states and the District of Columbia enacted legislation raising their minimum wage since that time—including the direct passage of new increases by residents of four states (Arizona, Colorado, Maine, and Washington) in the November 2016 elections.

Modernize Overtime and Spread Work

Offering overtime is one of the single most important steps to help grow middle-class wages and spread jobs to more workers. In May 2016, the Department of Labor finalized revisions to its regulations that would extend overtime protections to 4.2 million more Americans and boost wages for workers by $12 billion over the next decade.[74]

Strengthen Unions, Worker Voice, and Bargaining Power

Growing and sustaining the middle class requires strong labor unions. Labor unions help to build the middle class and have been critical in restoring the link between hard work and opportunity so the benefits of economic growth can be more broadly shared.[75] Unions have been at the forefront of establishing the 40-hour work week and the weekend, eliminating child labor laws, and establishing fair benefits and decent wages. Policymakers should explore ways to empower worker voice in the workplace through strengthening protections for organizing and creating new and innovative ways for workers to make their voices heard.

Protect Wages

Given the unique transformation that may be brought by AI, policymakers may also want to consider whether additional wage protections are needed for low- and middle-skilled workers if automation further "hollows out" middle-skill jobs. One of the most powerful upward pressures on wages is a tight labor market, as demand for labor can drive up wages.

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[73] Arindrajit Dube, "Minimum Wages and the Distribution of Family Incomes," 2014 (http://sites.utexas.edu/chasp/files/2015/04/MinimumWagesandDistributionofFamilyIncomes.pdf)

[74] The White House, "Fact Sheet: Growing Middle Class Paychecks and Helping Working Families Get Ahead by Expanding Overtime Pay," Executive Office of the President, May 2016 (https://www.whitehouse.gov/the-press-office/2016/05/17/fact-sheet-growing-middle-class-paychecks-and-helping-working-families-0). This rule was challenged in court and is currently subject to an injunction.

[75] Council of Economic Advisers, "Issue Brief: Worker Voice in a Time of Rising Inequality," October 2015 (https://www.whitehouse.gov/sites/default/files/page/files/cea_worker_voice_issue_brief.pdf).

Identify strategies to address differential geographic impact

Automation will happen more quickly in some places than in others, because of local policies, access to capital, innovative thinkers, the skill set of the workforce, proximity to urban centers, the culture of a place, and myriad other reasons. This has the potential to further exacerbate geographic disparities in income and wealth. Many of the places that are already grappling with structural changes in the economy, overall economic shifts, and poverty—and that therefore seem left behind from today's economy—may fall even further behind, cementing an already-present divide.

Below are two ways to address the uneven geographic impact: reduce the geographic barriers to work and pursue "place-based" solutions.

Reduce Geographic Barriers to Work

Geographic inequality can be reduced if workers can move to areas with more opportunity. If the new jobs spawned by AI-driven automation continue the trend of urbanization, though, a lack of affordable housing could make it difficult for lower-income families to access them. Over the past 3 decades, a growing number of barriers—including zoning, land-use regulations, and lengthy development approval processes—have made it increasingly difficult for housing markets to respond to growing demand by increasing the supply of housing. Reducing these barriers to affordable housing, expanding broadband access in poor and rural areas, and improving public transit would all serve to reduce geographic barriers to work.

Another barrier is occupational licensing. Nearly one-quarter of all U.S. workers need a government license to do their jobs.[76] While licensing can offer important health and safety protections to consumers, as well as benefits to workers, the current system often requires unnecessary training, lengthy delays, or high fees. Research shows that licensing can not only reduce total employment in licensed professions, but also that unlicensed workers earn roughly 7 percent lower wages than licensed workers with similar levels of education and experience.[77] In addition, the patchwork of state-by-state licensing rules leads to dramatically different requirements for the same occupations depending on the state in which one lives, potentially burdening workers who aim to move across state lines frequently. Best practices in licensing could allow states, working together or individually, to safeguard the well-being of consumers while maintaining a modernized regulatory system that meets the needs of workers and businesses. For example, groups of states could harmonize regulatory requirements as much as possible, and where appropriate enter into inter-state compacts that recognize licenses from other states to increase the mobility of skilled workers.[78]

[76] The White House, "Occupational Licensing: A Framework for Policymakers," July 2015 (https://www.whitehouse.gov/sites/default/files/docs/licensing_report_final_nonembargo.pdf).
[77] Bureau of Labor Statistics. CEA calculations (https://www.whitehouse.gov/blog/2016/06/17/new-data-show-roughly-one-quarter-us-workers-hold-occupational-license).
[78] The White House, "Occupational Licensing: A Framework for Policymakers," July 2015 (https://www.whitehouse.gov/sites/default/files/docs/licensing_report_final_nonembargo.pdf).

Pursue Place-Based Solutions

To the extent that AI will differentially affect certain cities, policies should be appropriately targeted and can build on and learn from existing Administration policies. The Administration has launched a series of "place-based" initiatives, often focused on economically challenged areas, that empower local leaders in participating communities by helping to connect them with the resources they need to enact their own homegrown solutions for the challenges facing their communities.

Initiatives such as Choice Neighborhoods and Promise Zones take a big-picture approach to development. Their work helps improve communities' access to and delivery of a wide range of services and activities, from building housing and creating jobs, to supporting after-school programs and improving the health of local residents. Agencies across the Federal Government have worked together to cut through red tape and expand opportunity for the people they serve.

Another example, TechHire, is a national initiative to create pathways for more Americans to access well-paying technology jobs and expand local technology sectors in communities across the country. Originally announced by President Obama in 2015, TechHire enables employers to fill entry-level, career-path, skilled technology jobs, by hiring trained job seekers with the ability to do the job—but who are overlooked by typical hiring practices or underrepresented in the IT field.

Modernize tax policy

Tax policy plays a critical role in combating inequality, including income inequality that may be exacerbated by changes in employment from AI-based automation. A progressive tax system helps ensure that the benefits of economic growth are broadly shared, pushing back against increased inequality in pre-tax income. Progressive taxation is critical for raising adequate revenue to fund national security and domestic priorities, including supporting and retraining workers who may be harmed by increased automation, and will only grow more important if outsized gains continue to accrue at the top while other workers are left struggling. It is also critical to maintain and strengthen tax credits that encourage and reward work while helping families make ends meet, such as the Earned Income Tax Credit and Child Tax Credit.

Advanced AI systems could reinforce trends of national income shifting from labor to capital, as discussed above. With investment income heavily concentrated among high-income individuals, this shift could significantly exacerbate the rise in income inequality seen over the past few decades, absent an appropriate policy response. Taxing capital can be a highly progressive form of taxation, yet under the current tax system, individuals' capital income currently enjoys lower tax rates than labor income, and often goes untaxed. President Obama has proposed reforming capital taxation and raising revenue by ensuring that inherited assets are subject to capital gains tax (ending so-called "stepped up basis"); increasing the top rate on capital gains and dividends for high-income households to 28 percent, the rate under President Reagan; and increasing the estate tax by restoring its 2009 parameters and closing loopholes. Some experts have proposed other reforms, including taxing capital gains on a mark-to-market basis and further reforming taxes on wealth transfers.

Preparing for all contingencies

If job displacements from AI are considerably beyond the patterns of technological change previously observed in economic history, a more aggressive policy response would likely be needed, with policymakers potentially exploring countervailing job creation strategies, new training supports, a more robust safety net, or additional strategies to combat inequality.

Conclusion

Responding to the economic effects of AI-driven automation will be a significant policy challenge for the next Administration and its successors. AI has already begun to transform the American workplace, changing the types of jobs available and the skills that workers need to thrive. All Americans should have the opportunity to participate in addressing these challenges, whether as students, workers, managers, or technical leaders, or simply as citizens with a voice in the policy debate.

AI raises many new policy questions, which should be continued topics for discussion and consideration by future Administrations, Congress, the private sector, and the public. Continued engagement among government, industry, technical and policy experts, and the public should play an important role in moving the Nation toward policies that create broadly shared prosperity, unlock the creative potential of American companies and workers, and ensure the Nation's continued leadership in the creation and use of AI.

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- In 2023, primary market supply grew 26% year-over-year to 5,174.1 MW.
- An all-time high of 3,077.8 MW was under construction in primary markets, a 46% year-over-year increase. Construction increased most in Atlanta, growing by 211% to 732.6 MW under construction.
- The average monthly asking rate for a 250- to 500-kW requirement across primary markets increased by 18.6% year-over-year, to $163.44 per kW/month. Northern Virginia had a 42% year-over-year price increase, the largest among primary markets.
- Preleasing activity in primary markets is strengthening, with 2,553.1 MW (83%) of the 3,077.8 MW under construction preleased. Cloud providers continue to lease most available power capacity, but artificial intelligence (AI) is also driving significant demand.
- The overall vacancy rate for primary markets remains near a record low, at 3.7%. With few relocation options, most tenants are renewing existing leases rather than seeking new facilities.

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*Vacancy Y-o-Y changes are calculated by comparing the difference between H2 2023 and H2 2022.

**Rental rates are quoted asking rates for 250+ kW at N+1/Tier III requirements.

Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

Figure 2: H2 2023 Wholesale Secondary Market Fundamentals

*Vacancy Y-o-Y changes are calculated by comparing the difference between H2 2023 and H2 2022.

**Rental rates are quoted asking rates for 250+ kW at N+1/Tier III requirements.

Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

> Explore the North America Data Center Trend Markets

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- Limited supply and strong demand drove up asking rates in H2 2023. The average asking rate across primary wholesale colocation markets for a 250- to 500-kW requirement increased by 18.6% year-over-year to a record $163.44 per kW/month.
- Occupiers in California and Virginia faced higher operating costs due to rising fuel costs and taxes as well as electricity rate increases in certain local jurisdictions.
- Data center operators are increasingly investing in renewable energy sources and electricity efficiency practices with cooling technologies. While potentially offering long-term savings, this may require significant upfront investment that can cause pricing to increase.
- Generally, there is a material pricing difference between a new-build facility and a legacy data center.
- Construction costs remain elevated due to ongoing shortages in critical materials like generators, chillers and transformers, despite improved supply chain resilience.

Figure 3: Average Asking Rental Rate with Y-o-Y % Change for Primary Markets

**Rental rates are quoted asking rates for 250–500 kW at N+1/Tier III requirements.

Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

Capital Markets Insights

- New capital sources are attracted by record tenant demand, historic low supply, strong rental growth and data center investment performance. There are ample debt financing options across real estate lenders, infrastructure funds, project finance, TMT lenders, life insurance companies and others.
- Total transaction volume of all data center asset sales increased year-over-year, despite a decline in the number of sales transactions.
- Many would-be sellers remained on the sidelines in 2023 in response to global macroeconomic headwinds, lending volatility and cap rate expansion due to interest rates. Overall activity was largely driven by a handful of transactions from REITs seeking to fund their development pipelines.
- Growing investor interest across the risk spectrum, robust development pipelines and a more stable lending environment should drive more capital markets activity in 2024.
- In this higher-interest rate environment, debt yield and debt-service coverage ratio have become the preferred metrics, as opposed to loan-to-value. As a result, overall leverage levels have decreased to meet cash flow metric stipulations.

Notable H2 2023 Investment Activity

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- $1.3 billion sale of its 80% interest in three Northern Virginia data centers to TPG Real Estate
- $743 million sale of its 65% interest in two stabilized data centers in Chicago to GI Partners
- $275 million sale of its remaining interest in four Cyxtera data centers to Brookfield
- $200 million sale of its 80% interest in a build-to-suit data center in Northern Virginia to Realty Income

- KDDI closed its $1 billion acquisition of Allied Properties' data center portfolio.
- Manulife Investment Management completed its acquisition of Serverfarm.

Figure 4: Inventory Growth of Primary Data Center Markets since 2020

Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

Valuation Insights

Transactional data remained limited in H2 2023. However, activity increased in Q4, which included asset sales from Cyxtera's bankruptcy and new investments from Brookfield. Although capital costs remain high, market-level supply-and-demand dynamics continue to support strong rent growth. Landlords are eager to end leases in power-constrained markets to re-lease at higher prices. Increased market rent dynamics have the potential to push down cap rates and create opportunity for non-stabilized assets with contracts below the current market rate. Some operators are also exploring underserved markets.

Lending activity persists for projects under construction, especially preleased and stabilized assets where developers and operators have committed to completion schedules to meet promised lease commencement dates. Data center providers and customers continue acquiring land in both primary and secondary markets, with lack of suitable sites causing bidding wars for offerings that meet desired power and fiber requirements.

The largest hyperscalers' new developments will complete construction and become operational in established, secondary and tertiary markets over the next few years—with AI requirements driving further demand. This demand increased through H2, leading to significant debt financing by firms such as Blackstone/QTS, Compass and PGIM to fund new development. Additionally, Vantage Data Centers announced a significant equity infusion to support its growth. Digital Bridge's Marc Ganzi recently projected AI could eventually more than double the cloud services market's power requirements.

Power remains undersupplied and is being exacerbated by a scarcity of as-of-right zoned developable land, which offers a faster and more efficient entitlement process. An outcome of Loudoun County, Virginia's December 2023 zoning ordinance is that sites for data center development on office and research and development park-zoned land must undergo a special exemption review. This could increase the value of greenfield sites for projects breaking ground sooner and/or grandfathered under prior development guidelines, further supporting rising lease rates and/or pushing development into less established markets.

Figure 5: Primary Markets Historic Net Absorption, Preleasing & Under Construction

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Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

Network Insights

— Notable Network Activity

- More middle-mile fiber infrastructure is being built across the U.S., including Lake Michigan's first carrier-neutral underwater cable project, announced in H2 2023. A component of the $87.5 million project is two new cables under Lake Michigan connecting Grand Rapids, MI to Lakeside Technology Center at 350 E Cermak Rd. in Chicago. This will strengthen Michigan's data center market, offering a new long-haul path and lower latency.
- Last year, major content providers constructed and/or financed more custom fiber networks to interconnect hyperscale facilities. These private networks provide alternative, low-latency, high-capacity pathways between their facilities. Development is continuing in primary markets such as Atlanta, Dallas-Ft. Worth and Northern Virginia, as well as in tertiary markets such as New Albany, OH, Huntsville, AL, Nashville, TN and Altoona, PA.
- Electric companies such as Dominion, Georgia Power and ComEd have begun deploying and maintaining fiber networks in primary and secondary markets—bolstering network resiliency by establishing unique and secure data pathways. Hundreds of local electric utilities providers have also initiated this in tertiary markets.

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capacity. Large companies such as AT&T, Verizon, Comcast, Astound Broadband, Crown Castle, Zayo and Lumen also have Chicago-based projects at varying development stages.

Figure 6: Total Inventory vs. Under Construction by Primary Market, H2 2023

Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

Figure 7: Total Inventory vs. Under Construction by Secondary Market, H2 2023

Source: CBRE Research, CBRE Data Center Solutions, H2 2023.

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Data Center Outlook

- Data center infrastructure demand keeps increasing with the economy's continued digitization. Revenue from generative AI software advancements is expected to increase at a 58% compound annual growth rate from 2023 to 2028, according to S&P Market Intelligence. This growth is being fueled by AI's further development across technology, healthcare, finance and other sectors.
- Digital transformation will accelerate the need for processing power, storage and cloud services in colocation and hyperscale data centers to provide organizations with more flexibility. However, certain workloads will remain on-premises.
- Cloud service provider and AI company partnerships with other large U.S. companies may emerge to help bring new AI solutions to end users. This will lead to new edge data centers deployed on- or near-premises across various real estate asset classes, including retail, industrial, office, telecommunications towers and more.
- More operators and developers of industrial, retail, shopping center and office real estate will install low-latency fiber, DAS systems and private networks to attract both data-intensive and connectivity-focused occupiers.
- Colocation pricing is expected to increase by double-digits in 2024, as limited power availability and other constraints prevent available supply from expanding quickly.
- Despite power availability delays and rising construction costs, under-construction activity in primary markets is expected to reach a new all-time high of more than 2,500 MW in 2024.
- New markets across North America, like Wisconsin and Indiana, will host large data center campuses in 2024. This will be influenced by tax incentives, renewable power advancements, transmission and distribution electricity infrastructure and affordable power supply.

Trends to Watch

- International Data Corporation (IDC) forecasts that the global AI software market will grow from $64 billion in 2022 to nearly $251 billion in 2027, a 31.4% compound annual growth rate.
- Data centers will require more storage and compute capacity as business, commerce and personal smart device usage continues rising. There will be over 50 billion Internet of Things-connected (IoT) devices by 2025, according to McKinsey.
- More North American utility companies and municipalities will consider transmission and distribution infrastructure development to expand load growth capacity, reducing electricity grid constraints.
- Adoption of newer, lower-carbon energy solutions such as nuclear, geothermal and hydropower will continue, instead of natural gas and coal.
- Natural gas prices remained stable in 2023, after a volatile 2022. In markets highly dependent on natural gas, such as Atlanta and Dallas-Ft Worth, will we continue to see appetite for additional renewable energy projects such as wind and solar?
- Vacancy rates are projected to be near record-lows in 2024, which will prompt users to shift from lengthy request-for-proposal (RFP) processes to simplified letters-of-intent (LOI) for quicker space procurement.

Market Buzz

Individual market pages now feature 10+ MW pricing tier.

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Data center development in the Rocky Mountains has enabled markets like Salt Lake City, UT and Reno, NV to attract major hyperscalers and developers. Tax incentives and ample land availability further this region's appeal. Last year, a Colorado state bill enabling an operator to claim a refund of all state sales and use tax on data center equipment costs failed to pass. But potential new state tax legislation this year could help draw further development.

Columbus/New Albany, OH

Columbus has benefitted tremendously from affordable and reliable regional power availability. Low natural disaster risk, an unregulated electricity market and competitive power costs are major attractions for further regional development. Developers are seeking new frontiers for growth outside of New Albany and into adjacent counties with power capacity. Land prices are more competitive than major markets like Chicago and Northern Virginia, furthering developer interest.

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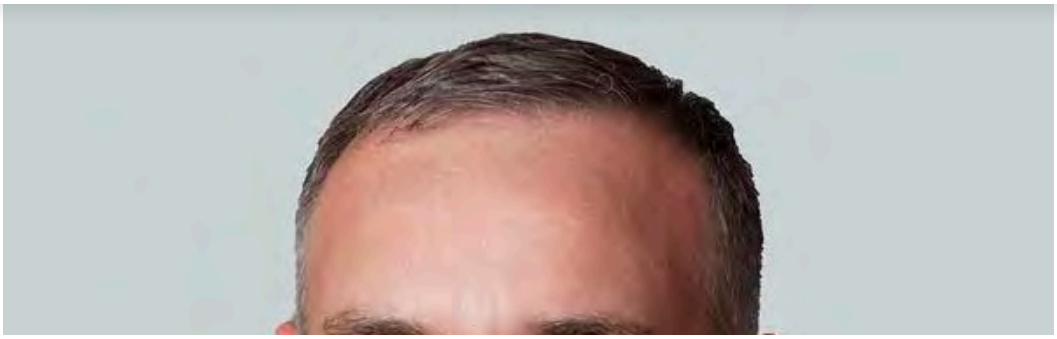

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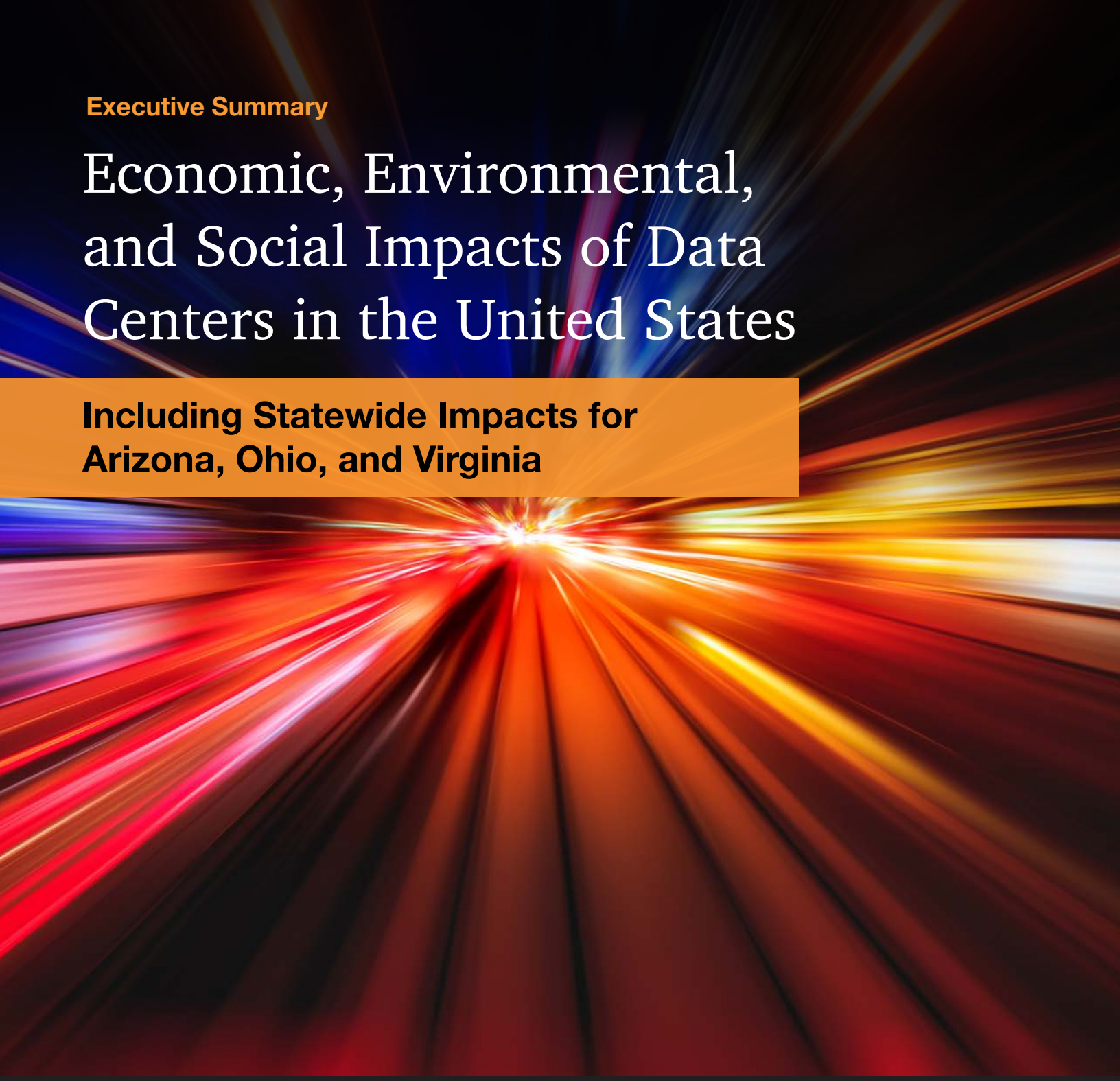
Executive Summary

Economic, Environmental, and Social Impacts of Data Centers in the United States

Including Statewide Impacts for Arizona, Ohio, and Virginia



Prepared for The Data Center Coalition

September 2023

pwc

About

The Data Center Coalition (DCC) engaged PwC to quantify the economic, environmental, and social impacts of the US data center industry. This report presents PwC's impact assessments for the 2017-2021 period at the national level and for three states: Arizona, Ohio, and Virginia. Data for select environmental and social impact metrics were available for 2022 and are included in this report.

DCC is the membership association for the data center industry and represents the industry's interests through a range of activities, including public policy advocacy, thought leadership, stakeholder outreach, and community engagement.

For more information, see www.datacentercoalition.org

At PwC, our purpose is to build trust in society and solve important problems. We're a network of firms in 152 countries with over 327,000 people who are committed to delivering quality in assurance, advisory, and tax services. Find out more and tell us what matters to you by visiting us at: www.pwc.com/US

Executive Summary

Data centers are a crucial component of the modern economy, supporting digitalization, enabling data-driven decision-making, and powering a wide range of industries and services. Their role in storing, processing, and managing data is essential for organizations to thrive in the digital age.

Economic and Tax Impacts

Displayed in **Table E-1** below, the data center industry has had a significant impact on the US economy over the 2017-2021 period. The industry's growth has significantly outpaced that of the overall US economy over this period. From 2017-2021, the US data center industry's direct employment grew by over 17 percent, compared to 2 percent employment growth for the United States overall during the same period.

Between 2017 and 2021, the data center industry's total annual impact (combining its direct, indirect, and induced impacts arising from data center construction and operations) on national employment has grown from 2.9 million jobs in 2017 to 3.5 million jobs in 2021, a 20 percent increase over the period.

Based on preliminary government data for 2022, the industry is estimated to have added more jobs in 2022 than it added over the entire 2017-2021 period, resulting in 560,000 direct jobs and supporting 4.2 million total jobs across the country. This report finds that at the national level, each direct job in the data center industry supports more than six jobs elsewhere in the US economy (including both operational and capital spending impacts).

The US data center industry total* annual economic impacts between 2017-2021 included

2.9 to 3.5 million annual jobs

Each direct job in the data center industry supports more than 6 jobs elsewhere in the US economy.

$209 to $294 billion in annual labor income

Total impact on national labor income grew 40% and labor income earned directly from the data center industry grew by 74% between 2017 and 2021.

$355 to $486 billion in annual GDP contribution

Total contribution to GDP grew 37% from 2017 to 2021. The growth rate in GDP for the US economy as a whole was about half as much over the same time period.

*Total impact includes direct, indirect, and induced impacts. Direct impacts are those occurring directly within the data center industry. Indirect impacts are those occurring within other businesses as part of the supply chain to the data center industry. Induced impacts are those arising from household spending of income earned from the data center industry or its supply chain.

The industry's total annual impact on national labor income grew from $209 billion in 2017 to $294 billion in 2021, a 40 percent increase. The industry's total annual impact on US value added (i.e., contribution to Gross Domestic Product, GDP) grew from $355 billion in 2017 to $486 billion in 2021, a 37 percent increase. Over this same period, the growth rate in GDP for the entire US economy was only about half as much.

Table E-1.– The Economic Impacts of the US Data Center Industry, 2017-2021

Item	2017	2018	2019	2020	2021
Employment (jobs)[1]					
Direct Impact	400,100	420,400	421,600	443,600	468,800
Indirect and Induced Impact	2,525,290	2,628,140	2,683,520	2,883,680	3,039,490
Operational Impact	2,202,100	2,311,400	2,315,700	2,438,200	2,572,900
Capital Spending Impact	323,190	316,740	367,820	445,480	466,590
Total Impact[4]	2,925,390	3,048,540	3,105,120	3,327,280	3,508,290
Labor Income ($billions)[2]					
Direct Impact	$43	$51	$56	$60	$75
Indirect and Induced Impact	$166	$178	$184	$202	$219
Operational Impact	$144	$155	$158	$168	$180
Capital Spending Impact	$22	$23	$26	$34	$39
Total Impact[4]	$209	$229	$240	$262	$294
Value Added ($billions)[3]					
Direct Impact	$89	$103	$112	$114	$136
Indirect and Induced Impact	$267	$287	$297	$322	$350
Operational Impact	$234	$253	$259	$275	$295
Capital Spending Impact	$33	$34	$38	$47	$55
Total Impact[4]	**$355**	**$390**	**$409**	**$436**	**$486**

Source: PwC calculations using the IMPLAN modeling system and public data sources. Details may not add up to totals due to rounding.

1. Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.
2. Labor income is defined as wages, salaries, and benefits as well as proprietors' income.
3. Value added refers to the additional value created at a particular stage of production. It is measured as the difference between the total revenue of the industry and the total cost of its materials, supplies, and services purchased from other businesses, other than capital goods.
4. Total impact includes direct, indirect, and induced impacts. Direct impacts are those occurring directly within the data center industry. Indirect impacts are those occurring within other businesses as part of the supply chain to the data center industry. Induced impacts are those arising from household spending of income earned from the data center industry or its supply chain.

[1]Value added is a term commonly used by economists to describe how much an industry contributes to a nation's or state's GDP. It represents the additional value created at a particular stage of production. Value added is measured as the difference between the total revenue of the industry and the total cost of its materials, supplies, and services purchased from other businesses, other than capital goods. Value added can also be derived as the sum of employee compensation, proprietors' income, pretax income to capital owners from property (including depreciation), and taxes on production and imports (including excise taxes, property taxes, fees, licenses, sales taxes, and custom duties paid by businesses).

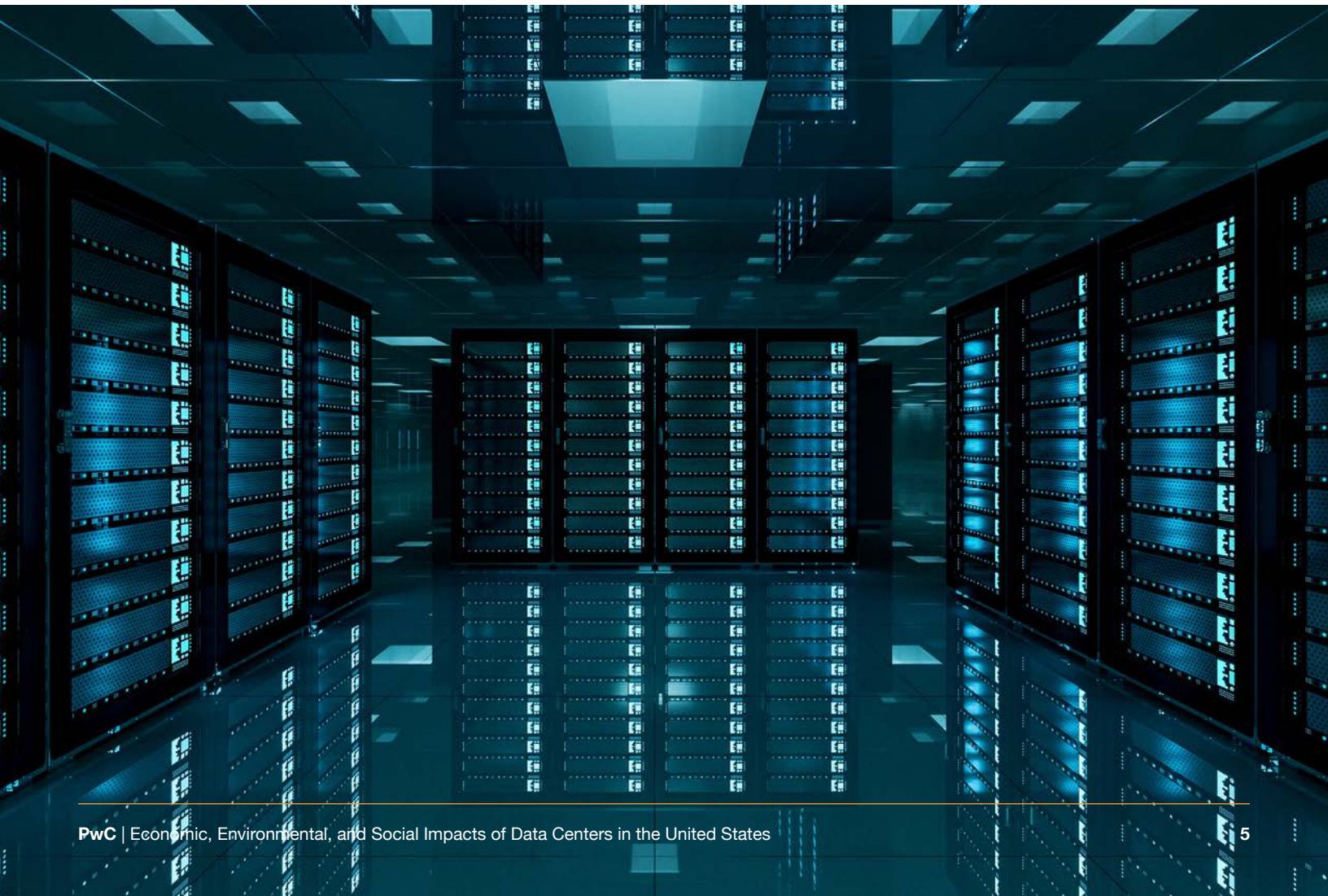
Displayed in **Table E-2** below, the data center industry's total contribution to government revenues at the federal, state, and local level, including direct, indirect, and induced impacts, increased from $66.2 billion in 2017 to $99.6 billion in 2021, a 50 percent increase.

Table E-2.– Federal, State, and Local Tax Impact of the US Data Center Industry, 2017-2021[1]

Item	2017	2018	2019	2020	2021
Total Impact ($billions)	**$66.2**	**$74.0**	**$79.0**	**$84.7**	**$99.6**
Social Insurance Contributions	$20.3	$22.7	$24.2	$26.9	$31.5
Corporate Income Taxes	$5.6	$6.3	$6.8	$7.1	$8.2
Personal Income Taxes	$20.2	$22.6	$24.2	$26.7	$31.2
Property Taxes	$8.1	$9.0	$9.6	$9.6	$11.5
Sales/Use Taxes	$9.1	$10.1	$10.8	$10.8	$12.9
Other payments	$2.9	$3.2	$3.4	$3.6	$4.3

Source: PwC calculations using the IMPLAN modeling system and public data sources. Details may not add up to totals due to rounding.

1. Tax impact includes all federal, state, and local taxes directly or indirectly resulting from the US data center industry's construction and operations (including direct, indirect, and induced economic effects).

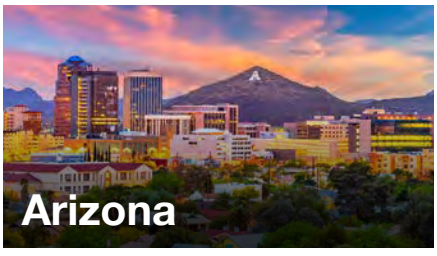


The data center industry operates in all 50 states and the District of Columbia (see Table A-1 in the appendix). In 40 states and the District of Columbia, data centers directly provided at least 1,000 jobs in each jurisdiction in 2021. We examine the total employment impact of the data center industry in three selected states: Arizona, Ohio, and Virginia. Including direct, indirect, and induced impacts, the industry's total annual employment impact in Arizona increased from 60,810 jobs in 2017 to 72,210 jobs in 2021, an 19 percent increase. The industry's total annual employment impact in Ohio increased from 50,330 jobs in 2017 to 61,740 jobs in 2021, a 23 percent increase. The industry's total annual employment impact in Virginia increased from 65,500 jobs in 2017 to 86,290 jobs in 2021, a 32 percent increase (see **Table E-3**).

Table E-3.– Total Economic Impacts of the Data Center Industry on Selected States, 2017-2021

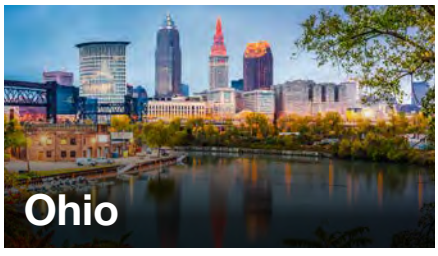
Item	2017	2018	2019	2020	2021
Employment (jobs)[1]					
Arizona	60,810	62,410	64,920	65,660	72,210
Ohio	50,330	53,050	55,140	59,760	61,740
Virginia	65,500	64,460	74,930	81,770	86,290
Labor Income ($millions)					
Arizona	$3,891	$4,147	$4,382	$4,578	$5,330
Ohio	$2,994	$3,358	$3,614	$3,960	$4,388
Virginia	$5,051	$5,041	$6,214	$6,814	$7,921
GDP ($millions)					
Arizona	$6,965	$6,850	$7,211	$7,460	$8,573
Ohio	$5,027	$5,650	$6,099	$6,462	$7,070
Virginia	$8,913	$8,979	$11,079	$11,732	$13,525

Source: PwC calculations using the IMPLAN modeling system and public data sources. Details may not add up to totals due to rounding.



72,210 jobs

The data center industry's total employment impact supported 72,210 jobs in Arizona in 2021, an increase of 19% from 2017.



61,740 jobs

The data center industry's total employment impact supported 61,740 jobs in Ohio in 2021, an increase of 23% from 2017.

86,290 jobs

The data center industry's total employment impact supported 86,290 jobs in Virginia in 2021, an increase of 32% from 2017.

Environmental and Social Impacts

DCC member companies participated in an environmental impact survey and social impact survey in conjunction with this report. Among the small number of survey participants, procurement of clean energy grew substantially over the 2017-2021 period, and participants also reduced their Scope 2[2] greenhouse gas emissions over the period. Data center owners and operators also contributed billions of dollars towards science, technology, engineering, arts, and mathematics (STEAM) education and other workforce development programs, and millions of dollars in charitable contributions.[3] Respondents to the social impact survey also increased workforce representation of women and racial and ethnic minority groups between 2019-2021.

[2] Greenhouse gases are categorized in three scopes. Scope 1 emissions are produced directly from the combustion of fuel. Scope 2 are indirect emissions from the use of purchased electricity. Scope 3 emissions are indirect emissions from a company's value chain, discussed further in Section IV.

[3] PwC Survey of DCC members.

SCIENCE & ENVIRONMENT

Energy demand from data centers growing faster than West can supply, experts say

By Alex Baumhardt (Oregon Capital Chronicle)
Aug. 26, 2024 10 a.m.

In a webinar hosted by regional transmission authorities, data centers were called a “major challenge” for the energy industry, as well as extreme weather

Data centers being rapidly built in the West are becoming an “emerging risk” to electrical grid reliability in the region, according to regional transmission experts.

New data centers, which can be built in as little as 18 months, are far outpacing the growth in new electrical energy supply and transmission, according to members of the Western Electricity Coordinating Council, a nonprofit organization based in Salt Lake City that ensures grid connection and reliability between utilities in 14 western states and parts of Canada and Mexico. Members of the council discussed challenges to grid reliability at a recent webinar first reported by the trade publication RTO Insider.

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Data centers like this Google data center, pictured in The Dalles, Ore., in this Oct. 5, 2021 file photo, are far outpacing the growth in new electrical energy supply and transmission, according to a recent study by a nonprofit organization based in Salt Lake City, Utah.

Andrew Selsky / AP

In it, council members said new energy demand from data centers has emerged as a more prescient challenge than meeting energy demand for transportation, also becoming rapidly electrified. The energy and transmission buildout needed to meet these demands is lagging, they said. By the end of 2023, just about half of the new energy buildout anticipated for the West had been completed. This is due in large part to supply chain issues, prices and skilled labor shortages, according to Branden Sudduth, the commission's vice president of reliability planning.

There are more than 700 data centers within those 14 states, including 109 in Oregon, according to the company Data Center Map, and there are more than 5,000 data centers

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Oregon's data center market is the fifth largest in the nation, according to Chicago-based commercial real estate group Cushman & Wakefield. Amazon, Apple, Facebook, Google and X, formerly named Twitter, have massive data centers in eastern Oregon as well as in The Dalles, Hillsboro and Prineville that require enormous amounts of energy to operate. Amazon is planning to build at least 10 more data centers in eastern Oregon, according to reporting by The Oregonian/OregonLive.

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"We're going to see an industry that wants to come online quickly with very large loads, and how are we going to address that?" Sudduth said.

The council in 2023 projected that demand for electricity in the West would increase about 17% by 2033 – that's about twice what it had predicted just the year before. That leap in projected energy use is due largely to the number of large data centers being built, they said. Data centers run on large amounts of energy needed for processing and for cooling servers.

The Portland-based industry trade group Pacific Northwest Utilities Conference Committee has projected electricity demand to grow 30% in the region in the next decade, also due in large part to data centers.

Another major challenge to grid reliability discussed was extreme weather. Sudduth said more energy sources and transmission would need to be developed both at the local level and across the region to ensure a reliable electricity supply.

The power grid in the West faces another big challenge besides data centers: Extreme weather, which can down power lines like those shown in this July 12, 2021 file photo taken near Klamath Falls, Ore.

Nathan Howard / AP

"Pretty much since the August 2020 heat wave event, the weather patterns that we're experiencing are different from what we've typically planned for in the past. A lot of the weather events are more widespread and they last a lot longer than they have in the past," Sudduth said.

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A growing number of utilities in Oregon and Washington are joining a new western regional market for buying and selling energy from one another at set prices for the day ahead, so that they can better handle demand spikes during extreme weather events, such as heat waves or ice storms. The Bonneville Power Administration – responsible for about 28% of all power consumed in the Northwest – is expected to announce soon whether it will join most other Western utilities in this Western day ahead market, or go to a competing day ahead market run by the Southwest Power Pool, based in Arkansas.

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THE 2023 ANNUAL REPORT OF THE BOARD OF TRUSTEES OF THE FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

COMMUNICATION

FROM

THE BOARD OF TRUSTEES, FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

TRANSMITTING

THE 2023 ANNUAL REPORT OF THE BOARD OF TRUSTEES OF THE FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

LETTER OF TRANSMITTAL

BOARD OF TRUSTEES OF THE
FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND
FEDERAL DISABILITY INSURANCE TRUST FUNDS,
Washington, D.C., March 31, 2023

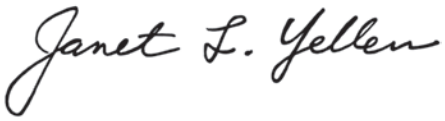
HON. KEVIN MCCARTHY,
Speaker of the House of Representatives.

HON. KAMALA D. HARRIS,
President of the Senate.

DEAR MR. SPEAKER AND MADAM PRESIDENT:

We have the honor of transmitting to you the 2023 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds, the 83rd such report.

Respectfully,



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Chief of Staff, Social Security Administration,
and Acting Secretary, Board of Trustees.

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THE 2023 ANNUAL REPORT OF THE BOARD OF TRUSTEES OF THE FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

I. INTRODUCTION

The Old-Age, Survivors, and Disability Insurance (OASDI) program makes monthly income available to insured workers and their families at retirement, death, or disability. The OASDI program consists of two parts. Retired workers, their families, and survivors of deceased workers receive monthly benefits under the Old-Age and Survivors Insurance (OASI) program. Disabled workers and their families receive monthly benefits under the Disability Insurance (DI) program.

The Social Security Act established the Board of Trustees to oversee the financial operations of the OASI and DI Trust Funds. The Board is composed of six members. Four members serve by virtue of their positions in the Federal Government: the Secretary of the Treasury, who is the Managing Trustee; the Secretary of Labor; the Secretary of Health and Human Services; and the Commissioner of Social Security. The President appoints and the Senate confirms the other two members to serve as public representatives. These two positions are currently vacant. The Deputy Commissioner of the Social Security Administration serves as Secretary of the Board.

The Social Security Act requires that the Board, among other duties, report annually to the Congress on the actuarial status and financial operations of the OASI and DI Trust Funds. The 2023 report is the 83rd such report. The intermediate (best estimate) assumptions for this report were set in December 2022. The Trustees will continue to monitor future developments and modify the projections in later reports as appropriate.

II. OVERVIEW

A. HIGHLIGHTS

This section summarizes the report's major findings.

Now, more than 3 years after the start of the COVID-19 pandemic, the acute stage of the pandemic appears to be over, but the Trustees expect there will be residual effects on the population and the economy for years to come. Since the assumptions for last year's report were set, the Trustees have reassessed their expectations for the economy in light of recent developments, including updated data on inflation and output, and have revised down the levels of gross domestic product (GDP) and labor productivity by about 3 percent over the projection period. Assumptions for growth are largely unchanged after the first 10 years of the projection period. The intermediate (best estimate) assumptions for this report were set in December 2022. The Trustees will continue to monitor developments and modify the projections in later reports.

In 2022

At the end of 2022, the OASDI program was providing benefit payments[1] to about 66 million people: 51 million retired workers and dependents of retired workers, 6 million survivors of deceased workers, and 9 million disabled workers and dependents of disabled workers. During the year, an estimated 181 million people had earnings covered by Social Security and paid payroll taxes on those earnings. The total cost of the program in 2022 was $1,244 billion. Total income was $1,222 billion, which consisted of $1,155 billion in non-interest income and $66 billion in interest earnings. Asset reserves held in special issue U.S. Treasury securities declined from $2,852 billion at the beginning of the year to $2,830 billion at the end of the year.

Short-Range Results (2023-32)

Under the Trustees' intermediate assumptions, Social Security's total cost is projected to be higher than its total income in 2023 and all later years. Total cost began to be higher than total income in 2021. Social Security's cost has exceeded its non-interest income since 2010.

[1] The definitions of "benefit payments" and other terms appear in the Glossary.

To illustrate the actuarial status of the Social Security program as a whole, the operations of the OASI and DI Trust Funds are often shown on a combined basis as OASDI. However, by law, the two funds are separate entities and therefore the combined fund operations and reserves are hypothetical. The combined reserves are projected to decrease from $2,830 billion at the beginning of 2023 to $590 billion at the end of 2032, the last year of the short-range period.

The reserves of the combined OASI and DI Trust Funds along with projected program income are sufficient to cover projected program cost over the next 10 years under the intermediate assumptions. However, the ratio of reserves to annual cost is projected to decline from 204 percent at the beginning of 2023 to 96 percent at the beginning of 2029 and remain below 100 percent for the remainder of the 10-year short-range period. Because this ratio falls below 100 percent by the end of the 10th projection year, the combined OASI and DI Trust Funds fail the Trustees' test of short-range financial adequacy. Considered separately, the OASI Trust Fund fails this test, but the DI Trust Fund satisfies the test. For last year's report, the combined reserves were projected to be 211 percent of annual cost at the beginning of 2023 and 57 percent at the beginning of 2032.

Long-Range Results (2023-97)

Under the Trustees' intermediate assumptions, OASDI cost is projected to exceed total income in 2023, and the dollar level of the hypothetical combined trust fund reserves declines until reserves become depleted in 2034, one year earlier than projected in last year's report. Figure II.D2 shows the implications of reserve depletion for the combined OASI and DI Trust Funds. Considered separately, the OASI Trust Fund reserves become depleted in 2033, one year earlier than projected in last year's report, and, as in last year's report, the DI Trust Fund reserves do not become depleted within the 75-year long-range projection period.[1]

The DI program continued to have low levels of disability applications and benefit awards through 2022. Disability applications have declined substantially since 2010, and the total number of disabled-worker beneficiaries in current payment status has been falling since 2014. For this report, disability applications are assumed to rise gradually from current low levels, resulting

[1] If the OASI Trust Fund reserves were to become depleted in 2033 as is currently projected, the operations of the hypothetical combined OASI and DI Trust Funds would not reflect the aggregated operation of the OASI Trust Fund and the DI Trust Fund because part of the OASI benefits could not be paid without a change in the law. The values shown for the hypothetical combined trust funds assume the law will have been changed to permit the transfer of resources between funds as needed.

in a rise in the age-sex-adjusted disability incidence rate to an ultimate rate of 4.8 per thousand exposed by the end of the short-range projection period.

OASDI cost has been generally increasing much more rapidly than non-interest income since 2008 and is projected to continue to do so through about 2040. In this period, the retirement of the baby-boom generation is increasing the number of beneficiaries much faster than the increase in the number of covered workers, as subsequent lower-birth-rate generations replace the baby-boom generation at working ages. Between about 2040 and 2055, OASDI cost and non-interest income are projected to generally increase at more similar rates as the cost rate (the ratio of program cost to taxable payroll) roughly stabilizes, reflecting the return to birth rates above 2 children per woman between 1990 and 2008. Between 2055 and 2078, OASDI cost is projected to grow significantly faster than income because of the period of historically low birth rates starting with the recession of 2007-09. From 2078 to 2097, cost is projected to grow somewhat slower than income, as birth rates are assumed to return to a level of 2 children per woman for 2056 and thereafter.

Over the 75-year long-range period 2023-97, the projected OASDI annual cost rate increases from 14.53 percent of taxable payroll for 2023 to 18.50 percent for 2078, and then decreases generally to 17.75 percent for 2097. The projected cost rate for 2097 is 4.35 percent of taxable payroll more than the projected income rate (the ratio of non-interest income to taxable payroll) for 2097. For last year's report, projected OASDI cost for 2097 was 17.65 percent, or 4.26 percent of payroll more than the annual income rate for that year. Expressed in relation to the projected gross domestic product (GDP), OASDI cost generally rises from 5.2 percent of GDP for 2023 to a peak of about 6.3 percent for 2076, and then declines to 6.0 percent by 2097.

The actuarial deficit is 3.61 percent of taxable payroll for the 75-year projection period through 2097, increased from 3.42 percent of taxable payroll for the 75-year projection period through 2096 in last year's report. The closely-related open-group unfunded obligation for OASDI is 3.42 percent of taxable payroll over the 75-year projection period through 2097, increased from 3.24 percent of payroll over the 75-year projection period through 2096 in last year's report. The open-group unfunded obligation for OASDI is $22.4 trillion in present value over the 75-year projection period through 2097 and is $2.0 trillion more than the measured level of $20.4 trillion over the 75-year projection period through 2096 in last year's report. The actuarial deficit rounds to 1.3 percent and the unfunded obligation rounds to 1.2 percent of GDP over the 75-year projection period through 2097, compared to 1.2 percent for the actuarial deficit and 1.1 percent for the unfunded

obligation over the 75-year projection period through 2096 in last year's report.

If the assumptions, methods, starting values, and the law had all remained unchanged, the actuarial deficit would have increased to 3.48 percent of taxable payroll, and the unfunded obligation would have risen to 3.29 percent of taxable payroll and $21.2 trillion in present value due to the change in the valuation date and the extension of the valuation period through an additional year, 2097. The actuarial deficit increased significantly in this year's report primarily due to recent economic experience and changes in near-term economic assumptions, as described in detail in section IV.B.6 of this report. In particular, the level of potential GDP is assumed to be about 0.9 percent lower than the level estimated in last year's report for 2020, widening to about 3.0 percent lower by 2026 and for all years thereafter. This shift was made as the Trustees lowered the levels of GDP and total economy labor productivity in response to recent economic developments, including higher-than-expected inflation rates and lower-than-expected output growth.

To illustrate the magnitude of the 75-year actuarial deficit, consider that for the combined OASI and DI Trust Funds to remain fully solvent throughout the 75-year projection period ending in 2097: (1) revenue would have to increase by an amount equivalent to an immediate and permanent payroll tax rate increase of 3.44 percentage points[1] to 15.84 percent beginning in January 2023; (2) scheduled benefits would have to be reduced by an amount equivalent to an immediate and permanent reduction of 21.3 percent applied to all current and future beneficiaries effective in January 2023, or 25.4 percent if the reductions were applied only to those who become initially eligible for benefits in 2023 or later; or (3) some combination of these approaches would have to be adopted.

If substantial actions are deferred for several years, the changes necessary to maintain Social Security solvency would be concentrated on fewer years and fewer generations. Significantly larger changes would be necessary if action is deferred until the combined trust fund reserves become depleted in 2034. For example, maintaining 75-year solvency through 2097 with changes that begin in 2034 would require: (1) an increase in revenue by an amount equivalent to a permanent 4.15 percentage point payroll tax rate increase to 16.55 percent starting in 2034, (2) a reduction in scheduled benefits by an

[1] The 3.44 percentage point increase in the payroll tax rate required to achieve 75-year solvency through 2097 differs somewhat from the 3.61 percent actuarial deficit. This is primarily because the rate increase required to achieve 75-year solvency reflects a zero trust fund reserve at the end of the period in 2097, whereas the 3.61 percent actuarial deficit incorporates an ending trust fund reserve equal to one year's cost. While such an increase in the payroll tax rate would cause some behavioral changes in earnings and ensuing changes in benefit levels, such changes are not included in these calculations because they are assumed to have roughly offsetting effects on OASDI actuarial status over the 75-year long-range period as a whole.

amount equivalent to a permanent 25.2 percent reduction in all benefits starting in 2034, or (3) some combination of these approaches.

Conclusion

Under the intermediate assumptions, the projected hypothetical combined OASI and DI Trust Fund asset reserves become depleted and unable to pay scheduled benefits in full on a timely basis in 2034. At the time of depletion of these combined reserves, continuing income to the combined trust funds would be sufficient to pay 80 percent of scheduled benefits. The OASI Trust Fund reserves are projected to become depleted in 2033, at which time OASI income would be sufficient to pay 77 percent of OASI scheduled benefits. DI Trust Fund asset reserves are not projected to become depleted during the 75-year period ending in 2097.

Lawmakers have a broad continuum of policy options that would close or reduce Social Security's long-term financing shortfall. Estimates for many such policy options are available at ssa.gov/OACT/solvency/provisions/.

The Trustees recommend that lawmakers address the projected trust fund shortfalls in a timely way in order to phase in necessary changes gradually and give workers and beneficiaries time to adjust to them. Implementing changes sooner rather than later would allow more generations to share in the needed revenue increases or reductions in scheduled benefits. Social Security will play a critical role in the lives of 67 million beneficiaries and 180 million covered workers and their families during 2023. With informed discussion, creative thinking, and timely legislative action, Social Security can continue to protect future generations.

B. TRUST FUND FINANCIAL OPERATIONS IN 2022

Table II.B1 shows the income, cost, and asset reserves for the OASI, the DI, and the combined OASI and DI Trust Funds in calendar year 2022.

Table II.B1.—Summary of 2022 Trust Fund Financial Operations
[In billions]

	OASI	DI	OASDI
Asset reserves at the end of 2021	$2,752.6	$99.4	$2,852.0
Total income in 2022[a]	1,056.7	165.1	1,221.8
Net payroll tax contributions[b]	945.9	160.7	1,106.6
Interest	63.5	2.8	66.4
Taxation of benefits	47.1	1.6	48.6
Total cost in 2022	1,097.5	146.5	1,243.9
Benefit payments	1,088.1	143.6	1,231.7
Administrative expenses	4.0	2.7	6.7
Railroad Retirement financial interchange	5.3	.2	5.5
Net increase in asset reserves in 2022	-40.7	18.6	-22.1
Asset reserves at the end of 2022	2,711.9	118.0	2,829.9

[a] Includes $0.2 billion in reimbursements from the General Fund of the Treasury and less than $50 million in gifts. See section III.A for details.
[b] Includes adjustments for prior calendar years.

Note: Components may not sum to totals because of rounding.

In 2022, net payroll tax contributions accounted for 90.6 percent of total trust fund income. Net payroll tax contributions consist of taxes paid by employees, employers, and the self-employed on earnings covered by Social Security. These taxes are paid on covered earnings up to a specified maximum annual amount, which was $147,000 in 2022. Table II.B2 shows the payroll tax rates for 2022.

Table II.B2.—Payroll Tax Contribution Rates for 2022
[In percent]

	OASI	DI	OASDI
Payroll tax contribution rate for employees	5.3	0.9	6.2
Payroll tax contribution rate for employers	5.3	.9	6.2
Payroll tax contribution rate for self-employed persons	10.6	1.8	12.4

Interest earned on invested trust fund asset reserves accounted for 5.4 percent of OASI and DI combined trust fund income in 2022. Revenue from subjecting up to 50 percent of Social Security benefits to Federal personal income taxation for beneficiaries with income (including half of bene-

fits and all non-taxable interest received) exceeding specified levels accounted for 4.0 percent of OASDI income.

The Department of the Treasury invests all trust fund income in interest-bearing securities issued by the U.S. Government. In 2022, the combined trust fund reserves (the excess of all past income over all past cost) earned interest at an effective annual rate of 2.4 percent.

Retirement, survivor, and disability benefits accounted for 99.0 percent of OASI and DI combined trust fund cost in 2022. The expenses for administering the Social Security program were 0.5 percent of total cost. The net payment to the Railroad Retirement Social Security Equivalent Benefit Account from the combined OASI and DI Trust Funds accounted for 0.4 percent of total OASDI cost.

Trust fund reserves provide the basis for paying benefits. Combined trust fund reserves decreased by $22.1 billion during 2022 because income to the combined funds, including interest earned on trust fund reserves, was less than total cost. In last year's report, combined reserves were projected to decrease by $46.8 billion in 2022. At the end of 2022, the combined reserves of the OASI and the DI Trust Funds were $2,829.9 billion, or 204 percent of estimated cost [1] for 2023. In comparison, the combined reserves at the end of 2021 were 229 percent of actual cost for 2022.

[1] Estimated cost is based on the intermediate set of assumptions.

C. ASSUMPTIONS ABOUT THE FUTURE

The future income and cost of the OASI and DI Trust Funds will depend on many factors, including the size and characteristics of the population receiving benefits, the level of monthly benefit amounts, the size of the workforce, and the level of covered workers' earnings. These factors will depend in turn on future birth rates, death rates, immigration, marriage and divorce rates, retirement-age patterns, disability incidence and termination rates, employment rates, productivity gains, wage increases, inflation, interest rates, and many other demographic, economic, and program-specific factors.

The Trustees set key demographic, economic, and programmatic assumptions for three alternative scenarios. The intermediate assumptions reflect the Trustees' best estimates of future experience. Therefore, most of the results presented in this overview indicate outcomes under the intermediate assumptions only. Any projection of the future is, of course, uncertain. For this reason, results are also presented under low-cost and high-cost alternatives to provide a range of possible future experience. The actual future costs are unlikely to be as extreme as those portrayed by the low-cost or high-cost projections. A separate section on the uncertainty of the projections, beginning on page 19, highlights the implications of these alternative scenarios.

The Trustees reexamine the assumptions each year in light of recent experience and new information. This annual review helps to ensure that the Trustees' assumptions provide the best estimate of future possibilities.

There are several important assumptions about near-term growth rates and parameter levels that have significant effects over both the short-range (10-year) and long-range (75-year) projection periods. The most significant change in the results presented in this year's report derives from a change in the assumed levels of productivity and GDP in the first several years of the projection. Section IV.B.6 provides additional details about this change.

For each of the three alternative scenarios, Table II.C1 presents key demographic, economic, and programmatic assumptions used for projections beyond the tenth projection year.

Table II.C1.—Key Assumptions[a] and Summary Measures for the Last 65 Years of the Long-Range (75-Year) Projection Period

Assumption	Intermediate	Low-cost	High-cost
Demographic:			
Average annual total fertility rate (children per woman)[b]	1.99	2.19	1.69
Average annual percentage reduction in total age-sex-adjusted death rates	.74	.28	1.24
Average annual net lawful permanent resident (LPR) immigration (in thousands)	788	1,000	595
Average annual net other-than-LPR immigration (in thousands)	457	683	234
Economic:			
Average annual percentage change in:			
Productivity (total U.S. economy)	1.63	1.93	1.33
Average wage in covered employment (nominal)	3.56	4.79	2.35
Average wage in covered employment (real)	1.14	1.74	.54
Consumer Price Index (CPI-W)	2.40	3.00	1.80
Unemployment rate (percent, age-sex-adjusted)	4.5	3.5	5.5
Annual trust fund real interest rate (percent)	2.3	2.8	1.8
Programmatic:			
Average annual disability incidence rate (per 1,000 exposed, age-sex-adjusted)	4.8	3.8	5.8
Average annual disability recovery rate (per 1,000 beneficiaries, age-sex-adjusted)	10.4	12.5	8.3

[a] See chapter V for details, including historical and projected values.
[b] The ultimate total fertility rate is 2.00 for the intermediate assumptions, 2.20 for the low-cost assumptions, and 1.70 for the high-cost assumptions. The ultimate rate is reached on a cohort basis over the lifetime of girls attaining age 14 in 2021 and later, so that the ultimate rate on an annual (or period) basis is reached in 2056. See section V.A.1 for additional details.

D. PROJECTIONS OF FUTURE FINANCIAL STATUS

Short-Range Actuarial Estimates

For the short-range period (2023 through 2032), the Trustees measure financial adequacy using trust fund ratios, which compare projected asset reserves at the beginning of a year to projected program cost for the year. Maintaining a trust fund ratio of 100 percent or more—that is, reserves at the beginning of a year at least equal to projected cost for the year—is a good indication that the trust fund can cover most short-term contingencies. The Trustees' test of short-range financial adequacy is met if under the intermediate assumptions (1) the estimated trust fund ratio is at least 100 percent at the beginning of the period and remains at or above 100 percent throughout the 10-year short-range period (from the beginning of 2023 through the end of 2032, which is indicated by the trust fund ratio at the beginning of 2033) or (2) the ratio is initially less than 100 percent, but reaches at least 100 percent within five years and remains at or above 100 percent throughout the remainder of the 10-year short-range period.

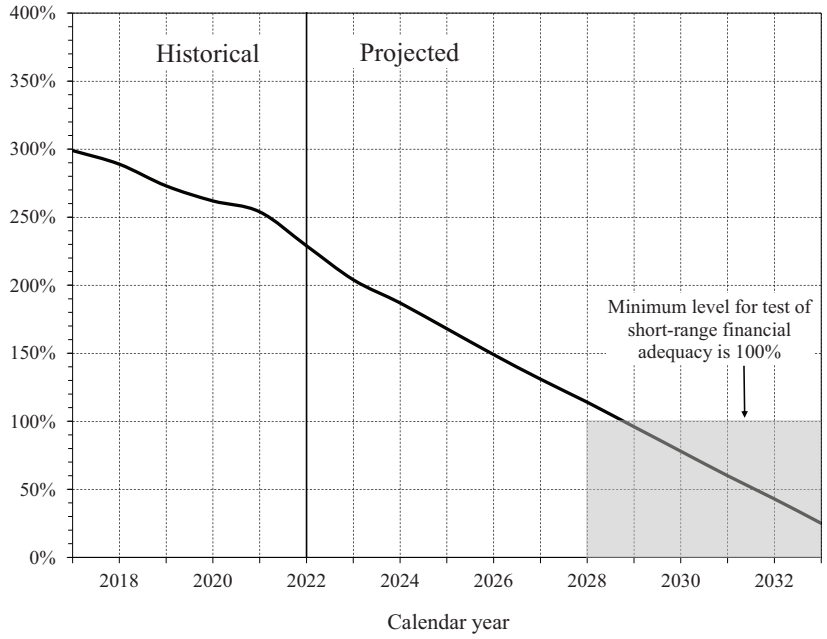
The projected trust fund ratio under the intermediate assumptions for the OASI Trust Fund declines to 91 percent by the beginning of 2029 and remains below 100 percent for the remainder of the short-range period. Therefore, OASI fails the test of short-range financial adequacy.

The DI Trust Fund satisfies the test of short-range financial adequacy because the trust fund ratio, while below 100 percent at the beginning of the projection period, reaches 100 percent within five years and stays above 100 percent throughout the remainder of the 10-year period. The DI trust fund ratio is estimated to be 77 percent at the beginning of 2023. The projected DI trust fund ratio then increases to 107 percent by the beginning of 2026 and continues to increase for the remainder of the short-range period.

On a combined basis, OASDI fails the test of short-range financial adequacy because the OASDI trust fund ratio declines to 96 percent by the beginning of 2029 and remains below 100 percent for the remainder of the short-range period. Figure II.D1 shows that the trust fund ratio for the combined OASI and DI Trust Funds declines steadily after 2010.

For this report, combined reserves are projected to decline in 2023, as they did beginning in 2021, and to continue to decline throughout the remainder of the short-range period.

Figure II.D1.—Short-Range OASI and DI Combined Trust Fund Ratio
[Asset reserves at beginning of year as a percentage of annual cost for the year, under intermediate assumptions]



Long-Range Actuarial Estimates

The Trustees use three types of measures to assess the actuarial status of the program over the long-range period (2023 through 2097): (1) annual cash-flow measures, including income rates, cost rates, and balances; (2) trust fund ratios; and (3) summary measures such as actuarial balances and open-group unfunded obligations. These measures are expressed as percentages of taxable payroll, as percentages of gross domestic product (GDP), or in dollars. Appendix F also presents summary measures over the infinite horizon. The infinite horizon values provide an additional indication of Social Security's very-long-run financial condition.

The Trustees also apply a test of long-range close actuarial balance each year. To satisfy the test, a trust fund must meet two conditions: (1) the trust fund satisfies the test of short-range financial adequacy, and (2) the trust fund ratio stays above zero throughout the 75-year projection period, such that benefits would be payable in a timely manner throughout the period. Under the intermediate assumptions, the OASI Trust Fund and the combined OASI

and DI Trust Funds fail the test of long-range close actuarial balance, while the DI Trust Fund satisfies the test.

Annual Income Rates, Cost Rates, and Balances

Figure II.D2 illustrates the year-by-year relationship among OASDI income (excluding interest), cost (including scheduled benefits), and expenditures (including payable benefits) starting in 2000 and for the full 75-year projection period (2023 through 2097). The figure shows all values as percentages of taxable payroll. Under the intermediate assumptions, demographic factors by themselves cause the projected cost rate to rise rapidly for the next two decades, level off somewhat in about 2040 through 2055, rise temporarily between 2055 and 2078, and then decline somewhat through 2097. The projected income rate is relatively stable at about 13 percent throughout the 75-year period ending in 2097.

Annual OASDI cost has exceeded non-interest income every year beginning with 2010. Cost is projected to continue to exceed non-interest income throughout the 75-year valuation period. Cost is projected to exceed total income in 2023, as it has each year beginning in 2021, and combined OASI and DI Trust Fund reserves decline until they become depleted in 2034. After trust fund reserve depletion, continuing income is sufficient to support expenditures at a level of 80 percent of program cost for the rest of 2034, declining to 74 percent for 2097. Figure II.D2 depicts OASDI operations as a combined whole. However, under current law, the differences between scheduled and payable benefits for OASI would begin in 2033, when the OASI Trust Fund is projected to become depleted. Scheduled benefits equal payable benefits for DI throughout the entire 75-year projection period, because the DI Trust Fund is not projected to become depleted during the period.

Figure II.D2.—OASDI Income, Cost, and Expenditures as Percentages of Taxable Payroll
[Under intermediate assumptions]

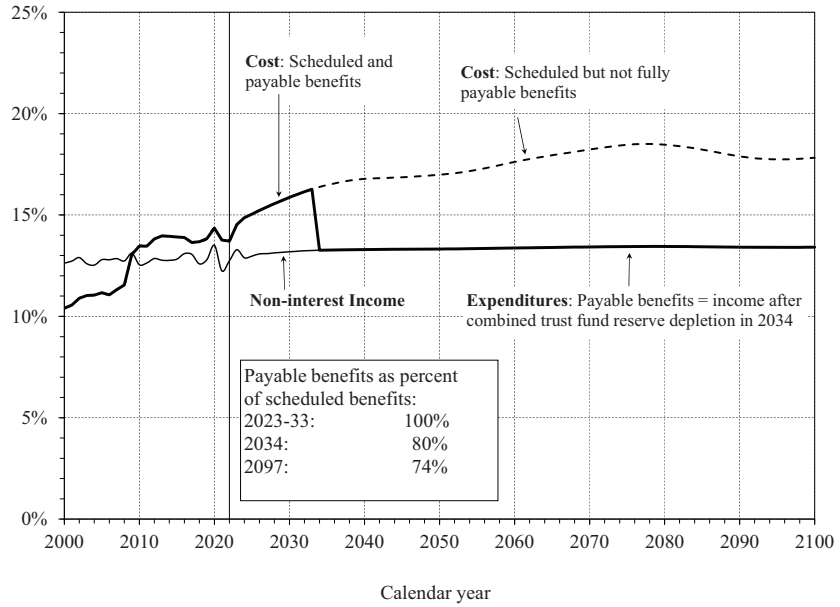
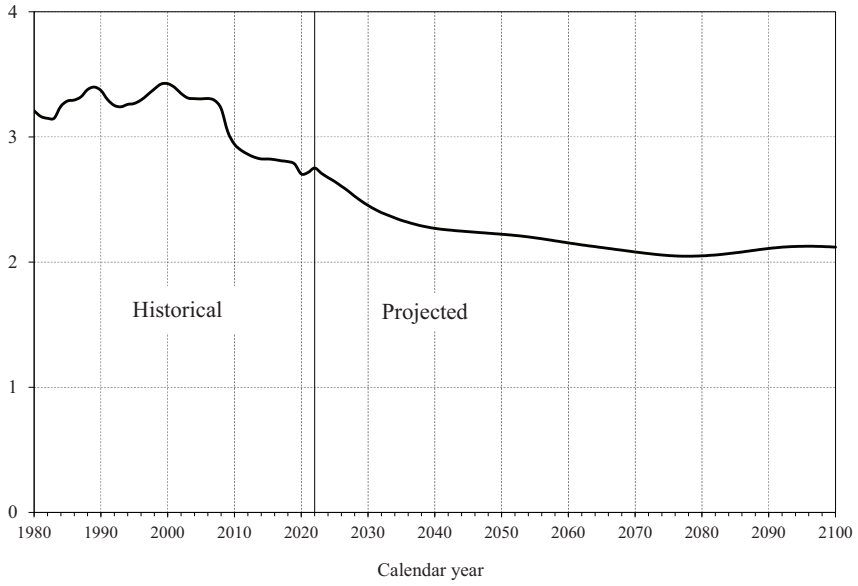


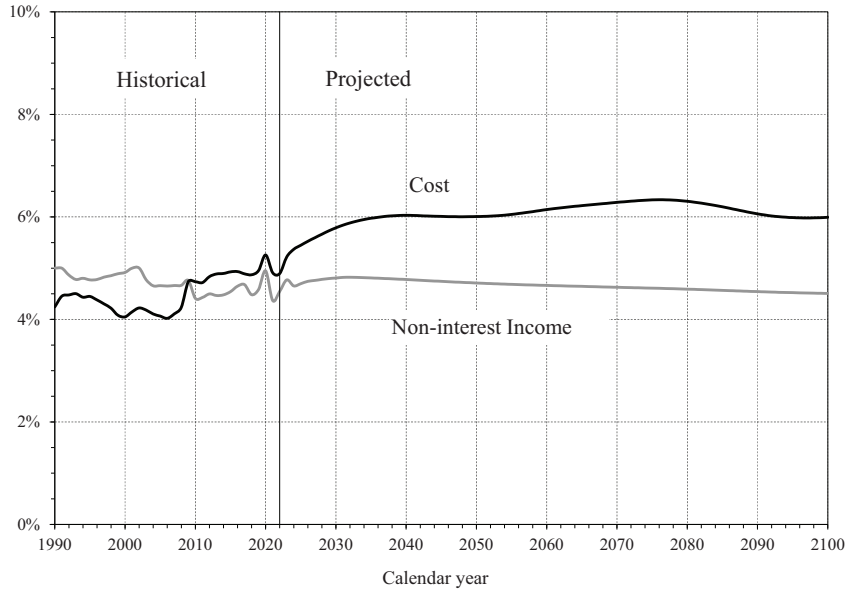
Figure II.D3 shows the estimated number of covered workers per OASDI beneficiary. Figures II.D2 and II.D3 illustrate the inverse relationship between cost rates and the number of workers per beneficiary. In particular, the projected future increase in the cost rate reflects a projected decline in the number of covered workers per beneficiary. There were about 2.8 workers for every OASDI beneficiary in 2022. This ratio had been stable, remaining between 3.2 and 3.4 from 1974 through 2008, and has generally declined since then, initially due to the economic recession of 2007-09 and the beginning of a notable demographic shift. This shift causes the ratio of workers to beneficiaries to decline, as workers of lower-birth-rate generations replace workers of the baby-boom generation. The decline in the ratio slowed substantially between 2013 and 2019 as the recovery of the economy largely offset the demographic shift during that period. The ratio declined slightly in 2020 and then increased slightly by 2022, due to effects of the pandemic-induced recession and recovery on the number of workers. The underlying demographic shift will continue to drive this ratio down over the next 10 to 15 years. The ratio of workers to beneficiaries reaches 2.3 by 2035 when the baby-boom generation will have largely retired, and will generally decline very gradually thereafter due to increasing longevity.

Figure II.D3.—Number of Covered Workers Per OASDI Beneficiary
[Under intermediate assumptions]



Another important way to look at Social Security's future actuarial status is to view its annual cost and non-interest income as a share of U.S. economic output (GDP). As shown in figure II.D4, Social Security's cost as a percent of GDP is generally projected to grow from 5.2 percent in 2023 to a peak of about 6.3 percent for 2076, and then decline to 6.0 percent by 2097. Social Security's non-interest income is projected to decrease from 4.8 percent of GDP in 2023 to 4.7 percent in 2024, and then rise gradually to a peak of about 4.8 percent by 2032. Thereafter, non-interest income as a percent of GDP declines gradually, to about 4.5 percent for 2097.

Figure II.D4.—OASDI Cost and Non-Interest Income as a Percentage of GDP
[Under intermediate assumptions]



Trust Fund Ratios

The trust fund ratio is defined as the asset reserves at the beginning of a year expressed as a percentage of the cost during the year. The trust fund ratio thus represents the proportion of a year's cost which could be paid solely with the accumulated reserves at the beginning of the year. Table II.D1 displays the projected maximum trust fund ratios during the long-range period for the OASI, DI, and combined OASI and DI funds. The table also shows the year of maximum projected trust fund ratio during the long-range projection period (2023 through 2097) and the year of trust fund asset reserve depletion. Trust fund ratios for OASI and combined OASI and DI are projected to decline from their current levels until reserve depletion. For DI, the trust fund ratio is projected to rise to 267 percent of cost in 2043, and then generally decline to 159 percent of cost by 2097.

Table II.D1.—Projected Maximum Trust Fund Ratios During the Long-Range Period and Trust Fund Reserve Depletion Dates
[Under Intermediate Assumptions]

	OASI	DI	OASDI
Maximum projected trust fund ratio (percent)	220	267	204
Year attained	2023	2043	2023
Projected year of trust fund reserve depletion	2033	[a]	2034

[a] The trust fund is not projected to become depleted during the 75-year period ending in 2097.

Summary Measures

The actuarial balance is a summary measure of the program's financial status through the end of the 75-year valuation period. The actuarial balance measure includes the trust fund asset reserves at the beginning of the period, all cost and income during the valuation period, and the cost of reaching a target trust fund reserve of one year's cost by the end of the period. Therefore, the actuarial balance is essentially the difference between the present values of income and cost from 1937 through the end of the valuation period, expressed as a percentage of the taxable payroll for the 75-year valuation period. A negative actuarial balance is called an actuarial deficit. The actuarial deficit represents the average amount of change in income or cost that is needed throughout the valuation period in order to achieve actuarial balance.

In this report, the actuarial deficit for the combined OASI and DI Trust Funds under the intermediate assumptions is 3.61 percent of taxable payroll. The actuarial deficit was 3.42 percent of payroll in the 2022 report. If the assumptions, methods, starting values, and the law had all remained unchanged from last year, the actuarial deficit would have increased to 3.48 percent of payroll solely due to advancing the valuation period by 1 year, from 2022 through 2096 for last year's report to 2023 through 2097 for this year's report. The actuarial deficit is 1.3 percent of GDP in this year's report, increased from 1.2 percent in last year's report.

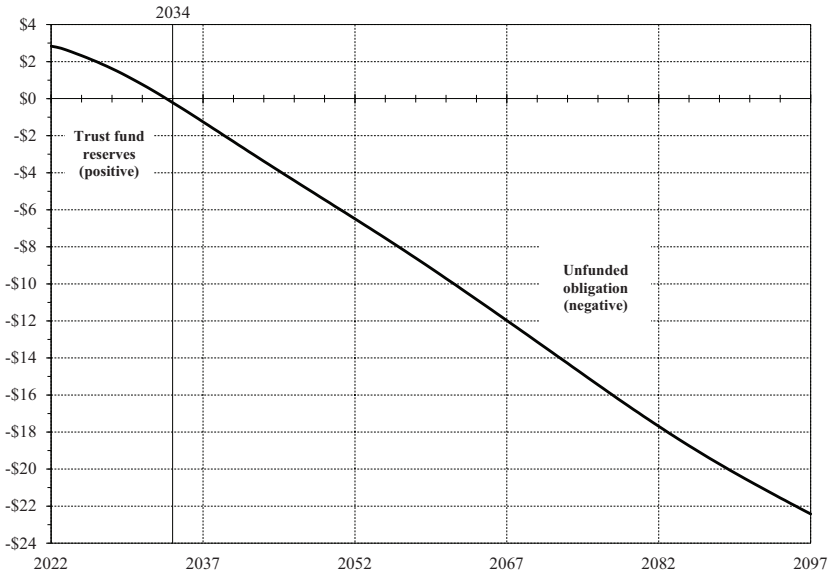
Another way to illustrate the projected financial shortfall of the OASDI program is to examine the cumulative present value of scheduled income less cost. Figure II.D5 shows the present value of cumulative OASDI income less cost from the inception of the program through each of the years from 2022 to 2097. A positive value represents the present value of trust fund reserves at the end of the selected year. A negative value is the unfunded obligation through the selected year. The asset reserves of the combined trust funds were about $2.83 trillion at the end of 2022. The combined trust fund reserves decline on a present value basis after 2022, but remain positive through 2033. However, after 2033 this cumulative amount becomes negative in 2034, which means that the combined OASI and DI Trust Funds have a net unfunded obligation through the end of each year after 2033. Through the end of 2097, the combined funds have a present-value unfunded obligation of $22.4 trillion. If the assumptions, methods, starting values, and the law had all remained unchanged from last year, the unfunded obligation in this year's report would have risen to about $21.2 trillion due to the change in the valuation date and the extension of the valuation period through an additional year, 2097.

This unfunded obligation through 2097 represents 3.42 percent of taxable payroll for 2023 through 2097 (increased from an unfunded obligation through 2096 of 3.24 percent of taxable payroll for 2022 through 2096 in last year's report) and 1.2 percent of GDP over the 75-year valuation period ending in 2097 (increased from 1.1 percent of GDP over the 75-year period ending in 2096 in last year's report). The unfunded obligation as a share of taxable payroll over the period (3.42 percent) and the actuarial deficit (3.61 percent) are similar measures, but differ because the actuarial deficit includes the cost of having an ending trust fund reserve equal to one year's cost.

Figures II.D2, II.D4, and II.D5 show that the program's actuarial status will deteriorate throughout the projection period if current law is not altered. Negative annual balances and increasing cumulative shortfalls toward the end of the 75-year period provide an indication of the additional change that will be needed by that time in order to maintain solvency beyond 75 years. Consideration of summary measures alone for a 75-year period can lead to incorrect perceptions and to policy prescriptions that do not achieve sustainable solvency.[1]

[1] Sustainable solvency for the financing of the program under a specified set of assumptions has been achieved when the projected trust fund ratio is positive throughout the 75-year projection period and is either stable or rising at the end of the period.

Figure II.D5.—Cumulative Scheduled OASDI Income Less Cost, From Program Inception Through Years 2022-2097
[Present value as of January 1, 2023, in trillions, under intermediate assumptions]



Appendix F presents summary measures over the infinite horizon. The infinite horizon values provide an additional indication of Social Security's actuarial status extending indefinitely into the future, but results are subject to much greater uncertainty. Extending the horizon beyond 75 years increases the measured unfunded obligation. Through the infinite horizon, the unfunded obligation, or shortfall, is equivalent to 4.6 percent of future taxable payroll or 1.4 percent of future GDP.

Uncertainty of the Projections

Significant uncertainty surrounds the intermediate assumptions. The Trustees use several methods to help illustrate that uncertainty.

A first approach uses alternative scenarios reflecting intermediate (alternative II), low-cost (alternative I) and high-cost (alternative III) sets of assumptions. The intermediate alternative represents the Trustees' best estimates of future experience. The low-cost alternative includes a higher ultimate total fertility rate, slower improvement in mortality, higher real wage growth, a higher ultimate real interest rate, a higher ultimate annual change in the CPI,

and a lower unemployment rate. The high-cost alternative, in contrast, includes a lower ultimate total fertility rate, more rapid improvement in mortality, lower real wage growth, a lower ultimate real interest rate, a lower ultimate annual change in the CPI, and a higher unemployment rate. These alternatives are not intended to suggest that all parameters would be likely to differ from the intermediate values in the specified directions, but are intended to illustrate the effect of clearly defined scenarios that are, on balance, very favorable or very unfavorable for the program's actuarial status. Actual future costs are unlikely to be as extreme as those portrayed by the low-cost or high-cost projections. The method for constructing the low-cost and high-cost projections does not lend itself to estimating the probability that actual experience will lie within or outside the range they define.

Figure II.D6. shows the projected trust fund ratios for the combined OASI and DI Trust Funds under the intermediate, low-cost, and high-cost assumptions. The figure indicates that the combined trust funds are projected to become depleted in 2034 under the intermediate alternative and in 2031 under the high-cost alternative. Under the low-cost alternative, trust fund reserves are projected to become depleted in 2067, but the trust funds would have sufficient income by the end of 2092 to permit full payment of scheduled benefits thereafter and also to pay in arrears the temporary shortfalls between 2067 and 2092.

Figure II.D6.—Long-Range OASI and DI Combined Trust Fund Ratios Under Alternative Scenarios
[Asset reserves as a percentage of annual cost]

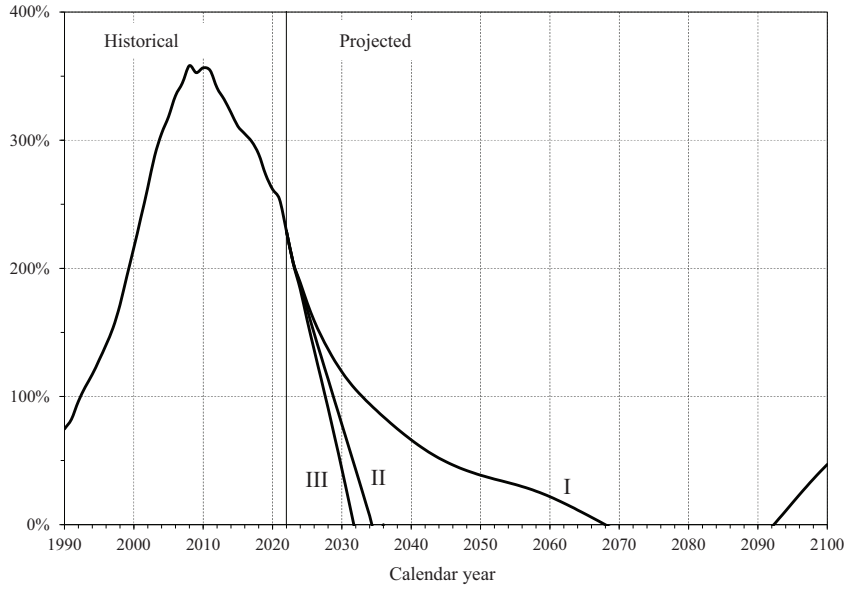
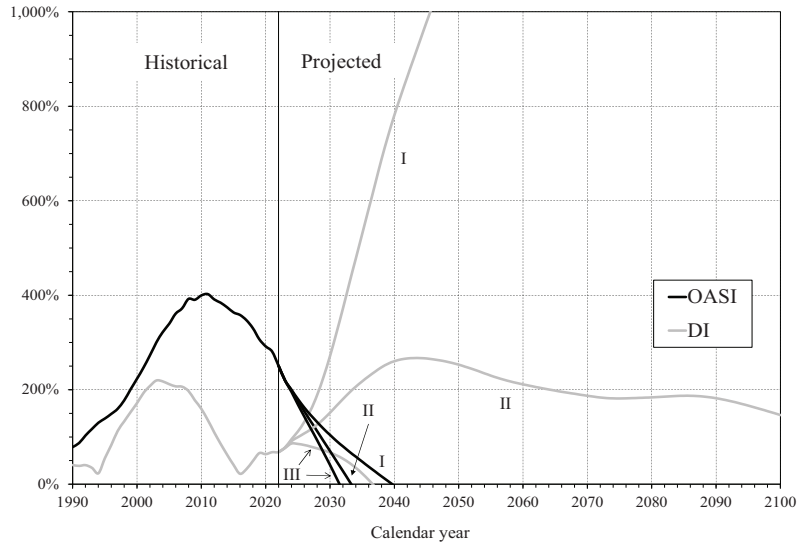


Figure II.D7 shows the projected trust fund ratios separately for OASI and DI Trust Funds under the intermediate, low-cost, and high-cost assumptions. The figure indicates that the OASI reserves are projected to become depleted in 2033 under the intermediate alternative, in 2039 under the low-cost alternative, and in 2031 under the high-cost alternative. The DI reserves are projected to become depleted in 2036 under the high-cost alternative, and are not projected to become depleted under the low-cost and intermediate alternatives. This figure illustrates that OASI reserves are expected to become depleted much sooner than DI reserves, and potentially within the next 10 years.

Figure II.D7.—Long-Range OASI and DI Trust Fund Ratios
[Asset reserves as a percentage of annual cost]



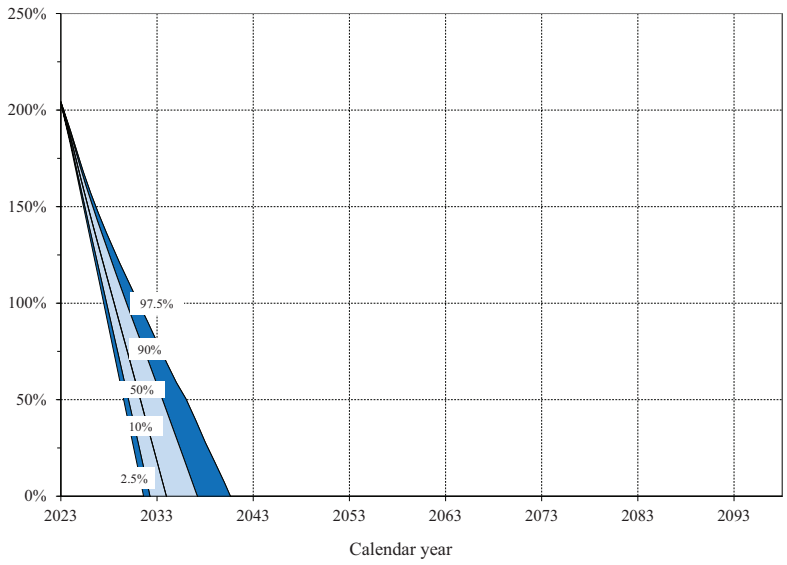
Appendix D of this report presents a second approach using long-range sensitivity analysis for the OASDI program. By varying one parameter at a time, sensitivity analysis provides a second approach for illustrating the uncertainty surrounding projections into the future.

A third approach uses 5,000 independently generated stochastic simulations that reflect randomly assigned annual values and central tendencies for most of the key parameters. These simulations produce a distribution of projected outcomes and corresponding probabilities that future experience will fall

within or outside a given range. The results of the stochastic simulations, discussed in more detail in appendix E, suggest that trust fund reserve depletion (the point at which reserves are insufficient to pay scheduled benefits in full and on time) is very likely before mid-century. In particular, figure II.D8 suggests that based on these stochastic simulations, trust fund reserves will become depleted with 95-percent confidence between 2031 and 2040. In last year's report, this range was between 2031 and 2043. After depletion relatively early in the 75-year projection period, the trust funds are projected not to have sufficient income through 2097 to permit full and timely payment of scheduled benefits.

The stochastic results suggest that trust fund ratios as high as the low-cost alternative or as low as the high-cost alternative are very unlikely.

Figure II.D8.—Long-Range OASI and DI Combined Trust Fund Ratios From Stochastic Modeling



Changes From Last Year's Report

The projected long-range OASDI actuarial deficit increased from 3.42 percent of taxable payroll for last year's report to 3.61 percent of taxable payroll for this year's report. The change in the valuation date and the extension of the 75-year projection period for an additional year, 2097,

would have by itself increased the actuarial deficit to 3.48 percent. Changes in law, methods, starting values, and assumptions combined to increase the actuarial deficit by an additional 0.13 percent of taxable payroll. This increase is mainly attributable to a change in the assumptions for the levels of productivity and GDP in the first several years of the projection. For this year's report, the Trustees assume that the level of potential GDP was about 0.9 percent lower than the level estimated in last year's report for 2020, widening to about 3.0 percent lower by 2026 and for all years thereafter. This shift was made as the Trustees lowered the levels of GDP and total economy labor productivity in response to recent economic developments, including higher-than-expected inflation rates and lower-than-expected output growth. For a detailed description of the specific changes identified in table II.D2, see section IV.B.6.

Table II.D2.—Reasons for Change in the 75-Year Actuarial Balance, Based on Intermediate Assumptions
[As a percentage of taxable payroll]

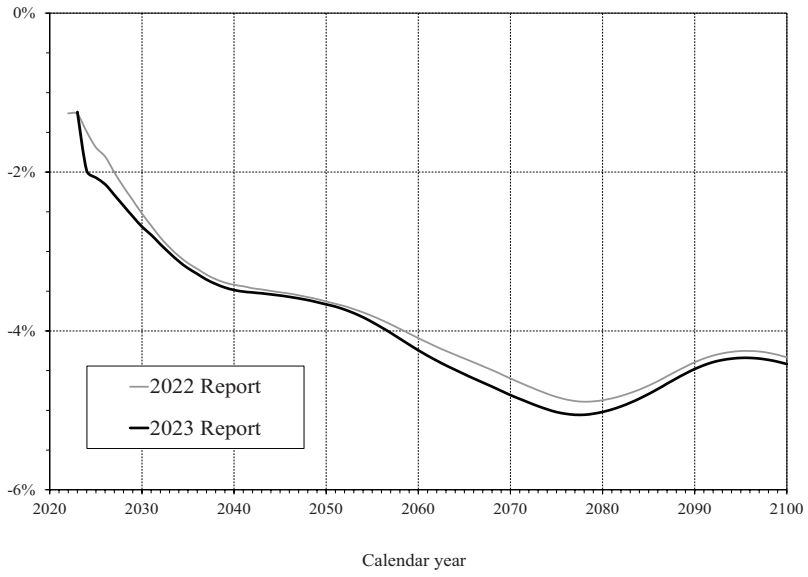
Item	OASI	DI	OASDI
Shown in last year's report:			
Income rate	11.93	1.85	13.78
Cost rate	15.34	1.86	17.20
Actuarial balance	**-3.41**	**-.01**	**-3.42**
Changes in actuarial balance due to changes in:			
Legislation / Regulation	[a]	[a]	[a]
Valuation period[b]	-.05	-.01	-.05
Demographic data and assumptions	-.03	[a]	-.03
Economic data and assumptions	-.04	[a]	-.04
Disability data and assumptions	[a]	.01	.01
Methods and programmatic data	-.08	.02	-.06
Total change in actuarial balance	-.21	.02	-.19
Shown in this report:			
Actuarial balance	**-3.62**	**.01**	**-3.61**
Income rate	11.93	1.85	13.78
Cost rate	15.54	1.84	17.38

[a] Between -0.005 and 0.005 percent of taxable payroll.
[b] The change in the 75-year valuation period from last year's report to this report means that the 75-year actuarial balance now includes the relatively large negative annual balance for 2097. This change in the valuation period results in a larger long-range actuarial deficit. The actuarial deficit includes the trust fund reserve at the beginning of the projection period.

Note: Components may not sum to totals because of rounding.

Figure II.D9 compares this year's projections of annual balances (non-interest income minus cost) to those in last year's report. The annual balance for 2023 is higher (less negative) in this year's report than it was in last year's report. The annual balances are lower (more negative) in this year's report for all years from 2024 through 2097. For the full 75-year projection period, the annual balances are lower, on average, by 0.13 percentage point.

Figure II.D9.—OASDI Annual Balances: 2022 and 2023 Trustees Reports
[As a percentage of taxable payroll, under the intermediate assumptions]



E. CONCLUSION

The data and projections presented in this report continue to include the Trustees' best estimates of the future course of the population, the economy, and all aspects of the OASDI program under current law. Now, more than 3 years after the start of the COVID-19 pandemic, the acute stage of the pandemic appears to be over, but the Trustees expect there will be residual effects on the population and the economy for years to come. Since the assumptions for last year's report were set, the Trustees have reassessed their expectations for the economy in light of recent developments, including updated data on inflation and output, and have revised down the levels of gross domestic product (GDP) and labor productivity by about 3 percent over the projection period. Assumptions for growth are largely unchanged after the first 10 years of the projection period. The intermediate (best estimate) assumptions for this report were set in December 2022. The Trustees will continue to monitor developments and modify the projections in later reports.

Under current law, the projected cost of Social Security generally increases faster than projected income through about 2040 primarily because the ratio of workers paying taxes to beneficiaries receiving benefits will decline as the baby-boom generation continues to retire and is replaced at working ages with subsequent lower birth-rate generations. The effects of the aging baby boom and subsequent lower birth rates will have largely stabilized between about 2040 and 2055, but annual cost is projected to grow significantly faster than income between 2055 and 2078 due to the period of historically low birth rates starting with the recession of 2007-09. Between 2078 and 2097, cost is projected to grow somewhat slower than income, reflecting an assumed return to a stable ultimate birth rate of 2 children per woman for 2056 and thereafter. Based on the Trustees' intermediate assumptions, Social Security's cost exceeds total income in 2023, as it has beginning in 2021, and remains higher throughout the remainder of the 75-year projection period.

The OASI Trust Fund is projected to have sufficient reserves to pay full benefits on time until 2033. The DI Trust Fund is projected to have sufficient reserves to pay full benefits throughout the 75-year projection period ending in 2097. Legislative action will be needed to prevent OASI reserve depletion. In the absence of such legislation, continuing income to the trust funds at the time of reserve depletion would be sufficient to pay 77 percent of OASI benefits.

Social Security's combined trust funds are projected to cover full payment of scheduled benefits on a timely basis until the trust fund reserves become

depleted in 2034. Full payment of benefits until depletion of the hypothetical combined reserves in 2034 implicitly assumes that the law will have been changed to permit the transfer of funds between OASI and DI as needed. At the time of reserve depletion, projected continuing income to the combined trust funds equals about 80 percent of the program cost. By 2097, continuing income equals about 74 percent of the program cost.

The actuarial deficit for the combined trust funds under the intermediate assumptions is 3.61 percent of taxable payroll for the 75-year period through 2097, increased (worsened) from the 3.42 percent deficit for the 75-year period through 2096 in last year's report. To illustrate the magnitude of the deficit, consider that for the combined OASI and DI Trust Funds to remain fully solvent throughout the 75-year projection period ending with 2097: (1) revenue would have to be increased by an amount equivalent to an immediate and permanent payroll tax rate increase of 3.44 percentage points to 15.84 percent; (2) scheduled benefits would have to be reduced by an amount equivalent to an immediate and permanent reduction of 21.3 percent applied to all current and future beneficiaries through 2097, or 25.4 percent if the reductions were applied only to those who become initially eligible for benefits in 2023 or later; or (3) some combination of these approaches would have to be adopted. If actions are deferred for several years, the changes necessary to maintain Social Security solvency through 2097 become concentrated on fewer years and fewer generations.

If lawmakers design legislative solutions only to eliminate the overall actuarial deficit without consideration of year-by-year financing, then a substantial financial imbalance could remain for 2097, the end of the 75-year valuation period. In that case, the long-range sustainability of program financing could still be in doubt. Sustainable solvency for the financing of the program under a specified set of assumptions is achieved when the projected trust fund ratio is positive throughout the 75-year long-range period and is either stable or rising at the end of the period. Making changes now that achieve sustainable solvency could avoid the need for later legislative changes.

Lawmakers have a broad continuum of policy options that would close or reduce Social Security's long-term financing shortfall. Estimates for many such policy options are available at www.ssa.gov/OACT/solvency/provisions/. Broadly speaking, the approaches that lawmakers can take include increasing revenue from workers and employers by raising the tax rate or the maximum level of taxable earnings, or by dedicating revenue from other sources; lowering benefits for some or all beneficiaries by changing certain program parameters; or a combination of these approaches. There

are many variations on these options, including those that vary the timing, magnitude, and other specifics of the changes under consideration.

The Trustees recommend that lawmakers address the projected trust fund shortfalls in a timely way in order to phase in necessary changes gradually and give workers and beneficiaries time to adjust to them. Implementing changes sooner rather than later would allow more generations to share in the needed revenue increases or reductions in scheduled benefits. Social Security will play a critical role in the lives of 67 million beneficiaries and 180 million covered workers and their families during 2023. With informed discussion, creative thinking, and timely legislative action, Social Security can continue to protect future generations.

For further information related to the contents of this report, see the following websites:

- www.ssa.gov/OACT/tr/2023/
- www.ssa.gov/OACT/solvency/provisions/
- www.cms.gov/OACT/TR/2023
- home.treasury.gov/policy-issues/economic-policy/social-security-and-medicare-trustee-reports

III. FINANCIAL OPERATIONS OF THE TRUST FUNDS AND LEGISLATIVE CHANGES IN THE LAST YEAR

A. OPERATIONS OF THE OLD-AGE AND SURVIVORS INSURANCE (OASI) AND DISABILITY INSURANCE (DI) TRUST FUNDS, IN CALENDAR YEAR 2022

This section presents detailed information on the operations of the OASI and DI Trust Funds[1] during calendar year 2022. Chapter IV provides projections for calendar years 2023 through 2100.

1. OASI Trust Fund

Table III.A1 presents a statement of the income and cost of the Federal Old-Age and Survivors Insurance Trust Fund in calendar year 2022, and of the asset reserves in the fund at the beginning and end of the calendar year. As shown in this table, total trust fund income in 2022 amounted to $1,056.7 billion, while cost totaled $1,097.5 billion, resulting in a decrease in trust fund reserves during 2022 of $40.7 billion.

Total income during calendar year 2022 included $950.3 billion in payroll tax contributions. These contributions include initial appropriations of payroll taxes, made on an estimated basis, and adjustments to appropriations for prior years to reflect actual tax income. The OASI fund paid the General Fund $4.4 billion for the estimated amount of employee payroll-tax refunds, partially offsetting these gross contributions. Employees who work for more than one employer during a year and pay contributions on total earnings in excess of the contribution and benefit base are eligible for such refunds. Net payroll tax contributions were therefore $945.9 billion in 2022.

Net reimbursements from the General Fund of the Treasury amounted to $183 million in 2022. As shown in the table, almost all of that amount came from transfers based on Public Law 116-136, the Coronavirus Aid, Relief, and Economic Security Act of 2020 (CARES Act). Section 4003(e) of this act provided for loans to businesses and State and local governments to assist in alleviating losses incurred as a result of the COVID-19 pandemic. This section further specified that a portion of proceeds from repayments of these loans be transferred to the OASI Trust Fund.

Income to the OASI Trust Fund based on the taxation of OASI benefits amounted to $47.1 billion in 2022. As first required by the 1983 Social Security Amendments, this income comes from two separate sources: (1) Federal

[1] See www.ssa.gov/oact/ProgData/fundsQuery.html.

income taxation on up to 50 percent of an individual's or couple's OASI benefits under certain circumstances, and (2) a tax withheld from the benefits paid to certain nonresident alien beneficiaries. For the direct Federal income tax portion, Treasury transfers estimated amounts to the OASI Trust Fund in advance at the beginning of each calendar quarter. Treasury makes subsequent adjustments based on the actual amounts shown on annual income tax records. There were no such adjustments made in 2022. The amount of income from direct Federal income taxation on OASI benefits constituted approximately 99 percent of income from benefit taxation. The remaining one percent of the income from benefit taxation is the amounts withheld from the benefits paid to nonresident aliens.

In 2022, the OASI Trust Fund earned $63.5 billion in net interest, which consisted of: (1) interest earned on the investments held by the trust fund, (2) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (3) interest arising from the revised allocation of administrative expenses among the trust funds, and (4) interest on certain reimbursements to the trust fund.

The remaining income, about $18 thousand, consisted of gifts received under the provisions authorizing the deposit of monetary gifts or bequests in the trust funds.

Table III.A1.—Operations of the OASI Trust Fund, Calendar Year 2022
[In millions]

Total asset reserves, December 31, 2021		$2,752,636
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$950,327	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund[a]	-4,403	
Net payroll tax contributions[a]		945,924
Reimbursements from the General Fund:		
Transfer directed by P.L. 116-136	183	
Reduction in payroll tax contributions due to P.L. 111-312, P.L. 112-78, and P.L. 112-96[a]	[b]	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		183
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	262	
All other, not subject to withholding	46,809	
Total income from taxation of benefits		47,071
Investment income and interest adjustments:		
Interest on investments	63,539	
Interest adjustments[c]	[b]	
Total investment income and interest adjustments		63,539
Gifts		[b]
Total income		1,056,718
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[d]	1,088,170	
Reimbursement from the General Fund for unnegotiated checks	-53	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	23	
Net benefit payments[d]		1,088,140
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		5,316
Administrative expenses:		
Costs incurred by:		
Social Security Administration	3,376	
Department of the Treasury	628	
Offsetting miscellaneous receipts	-1	
Demonstration projects	—	
Miscellaneous reimbursements from the General Fund [e]	-5	
Net administrative expenses		3,999
Total cost		1,097,455
Net increase in asset reserves		-40,737
Total invested assets	2,711,919	
Undisbursed balances [f]	-20	
Total asset reserves, December 31, 2022		2,711,899

[a] Includes adjustments for prior calendar years.

[b] Between -$0.5 and $0.5 million.

[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.

[d] Includes net reductions for the recovery of overpayments.

[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI program.

[f] A negative balance represents a situation where the actual cash payments exceeded the amount of invested securities of the OASI Trust Fund that were redeemed to make such payments. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Components may not sum to totals because of rounding.

Of the $1,097.5 billion in total OASI cost in 2022, $1,088.1 billion was for net benefit payments, including recovered overpayments, reimbursements from the General Fund for unnegotiated checks, and the reimbursable costs of vocational rehabilitation services.[1] Net benefit payments increased by 9.6 percent from calendar year 2021 to calendar year 2022. This increase is due primarily to: (1) an increase in the average number of beneficiaries during the year and (2) an increase in the average monthly benefit amount. The increase in the average benefit amount in 2022 was due in part to the automatic cost-of-living benefit increase of 5.9 percent which became effective for December 2021 under the automatic-adjustment provisions in section 215(i) of the Social Security Act. In addition, new beneficiaries tend to have higher monthly benefit amounts than previous beneficiary cohorts, because their initial benefits are based on average wages, which tend to rise faster than the cost of living.

The Railroad Retirement Act requires an annual financial interchange between the Railroad Retirement program and the OASDI program. The purpose of the interchange is to put the OASI and DI Trust Funds in the same financial position in which they would have been had railroad employment always been covered directly by Social Security. The Railroad Retirement Board and the Social Security Administration calculated an interchange of $5.3 billion from the OASI Trust Fund to the Social Security Equivalent Benefit Account for June 2022.

The remaining $4.0 billion of cost for the OASI Trust Fund was for net administrative expenses. The Social Security Administration charges administrative expenses incurred to administer the OASI program directly to the trust fund on an estimated basis. Periodically, as actual expenses are recorded, adjustments are made to the allocations of administrative expenses for prior periods. These adjustments affect the OASI Trust Fund, the DI Trust Fund, the Hospital Insurance (HI) Trust Fund, the Supplementary Medical Insurance (SMI) Trust Fund, and the General Fund account for the Supplemental Security Income program, and include appropriate interest adjustments. As described earlier, the trust fund accounting records such interest adjustments under investment income.

For 2022, the cost incurred by the Social Security Administration to administer the OASI program was 84 percent of OASI net administrative expenses. The Social Security Administration charged such costs to the trust fund in

[1] Vocational rehabilitation services under the OASI program are furnished to disabled widow(er) beneficiaries and to those children of retired or deceased workers who receive benefits based on disabilities that began before age 22. The trust funds reimburse the providers of such services only in those cases where the services contributed to the successful rehabilitation of the beneficiary.

the amount of $3.4 billion in 2022. In addition, the Department of the Treasury charged the trust fund $0.6 billion in 2022 for services provided in administering the OASI program. A relatively small offset to administrative expenses of $1 million in 2022 represents income from miscellaneous receipts due to the trust fund, which may include refunds, penalties, fees, and other receipts.

Finally, the General Fund of the Treasury makes net reimbursements for administrative costs incurred by the Social Security Administration in performing certain legislatively mandated activities that are not directly related to paying OASI benefits. These reimbursements include $3 million in costs associated with union activities related to administering the OASI program and $2 million in costs of providing information to participants in certain pension plans in 2022. These miscellaneous reimbursements totaled $5 million in 2022.

The asset reserves shown for the OASI Trust Fund at the end of calendar year 2022 totaled $2,711.9 billion, consisting of $2,711.9 billion in U.S. Government obligations and, as an offset, an extension of credit totaling $20 million against securities to be redeemed in the first few days of the following year. The effective annual rate of interest earned by the reserves in the OASI Trust Fund during calendar year 2022 was 2.3 percent, slightly lower than the 2.4 percent earned during calendar year 2021. Table VI.A4, presented in appendix A, shows a detailed listing of OASI Trust Fund holdings by type of security, interest rate, and year of maturity at the end of calendar years 2021 and 2022.

By law, the Department of the Treasury must invest trust fund reserves in interest-bearing securities backed by the full faith and credit of the United States Government. The securities currently held by the OASI Trust Fund are entirely special issue securities sold by the Treasury only to the trust funds. These special issues are of two types: short-term certificates of indebtedness and longer-term bonds. Daily trust fund tax income is invested in the short-term certificates of indebtedness which mature on the next June 30 following the date of issue. The trust fund normally acquires long-term special-issue bonds when special issue securities of either type mature on June 30 and must be reinvested. The amount of long-term bonds acquired on June 30 is equal to the amount of special issue securities maturing (including accrued interest earnings), plus tax income for that day, less amounts required to meet cost on that day.

Section 201(d) of the Social Security Act provides that the obligations issued for purchase by the OASI and DI Trust Funds shall have maturities fixed

with due regard for the needs of the funds. Each year, bond purchases for each trust fund are made on June 30, taking into account the projected reserve depletion date in the most recently issued Trustees Report. The usual practice has been to reinvest the maturing special issue securities, as of each June 30, so that the values of the total portfolio of special issue securities maturing in each of the next 15 years are approximately equal. However, as of June 2022, the most recent projections in the 2022 Trustees Report indicated that the reserves in the OASI Trust Fund would become depleted within 15 years. Therefore, the Department of the Treasury, in consultation with the Chief Actuary of the Social Security Administration, selected the amounts and maturity dates of the OASI special-issue bonds purchased on June 30, 2022, so that the maturity dates of the total portfolio of special issue securities would be spread evenly to the extent possible over the 12-year period 2023 through 2034. The bonds purchased on that date have an interest rate of 3.000 percent, reflecting the average market yield, as of the last business day of the prior month, on all of the outstanding marketable U.S. obligations that are due or callable more than 4 years in the future. Table III.A7 shows additional details on the investment transactions during 2022, including the amounts of bonds purchased on June 30, 2022.

2. DI Trust Fund

Table III.A2 presents a statement of the income and cost of the Federal Disability Insurance Trust Fund in calendar year 2022, and of the asset reserves in the fund at the beginning and end of the calendar year.

Line entries in the DI statement are similar to those in the OASI statement. The explanations of the OASI entries generally apply to DI as well.

Of the $165.1 billion in total income, $160.7 billion was net payroll tax contributions.

Of the $146.5 billion of total cost, $143.6 billion was net benefit payments. The total level of net benefit payments increased by 2.5 percent from calendar year 2021 to calendar year 2022, largely due to increases in average monthly benefit amounts and the total amount of retroactive benefits, partially offset by a decrease in the average number of beneficiaries during the year. DI non-interest income, and total income, exceeded total cost in 2022.

Table III.A2.—Operations of the DI Trust Fund, Calendar Year 2022
[In millions]

Total asset reserves, December 31, 2021		$99,394
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$161,424	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund[a]	-746	
Net payroll tax contributions[a]		160,678
Reimbursements from the General Fund:		
Transfer directed by P.L. 116-136	—	
Reduction in payroll tax contributions due to P.L. 111-312, P.L. 112-78, and P.L. 112-96[a]	b	
Payroll tax credits due to P.L. 98-21[a]	b	
Net General Fund reimbursements[a]		b
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	4	
All other, not subject to withholding	1,549	
Total income from taxation of benefits		1,553
Investment income and interest adjustments:		
Interest on investments	2,831	
Interest adjustments[c]	2	
Total investment income and interest adjustments		2,833
Gifts		b
Total income		165,063
Cost:		
Benefit payments:		
Monthly benefits[d]	143,475	
Reimbursement from the General Fund for unnegotiated checks	-28	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	120	
Net benefit payments[d]		143,567
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		156
Administrative expenses:		
Costs incurred by:		
Social Security Administration	2,634	
Department of the Treasury	110	
Offsetting miscellaneous receipts	—	
Demonstration projects	7	
Miscellaneous reimbursements from the General Fund[e]	-3	
Net administrative expenses		2,747
Total cost		146,470
Net increase in asset reserves		18,594
Total invested assets	118,032	
Undisbursed balances[f]	-44	
Total asset reserves, December 31, 2022		117,988

[a] Includes adjustments for prior calendar years.

[b] Between -$0.5 and $0.5 million.

[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.

[d] Includes net reductions for the recovery of overpayments.

[e] Reimbursements for costs incurred in performing legislatively mandated activities not directly related to administering the DI program.

[f] A negative balance represents a situation where the actual cash payments exceeded the amount of invested securities of the DI Trust Fund that were redeemed to make such payments. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Components may not sum to totals because of rounding.

During 2022, the reserves in the DI Trust Fund increased by $18.6 billion, from $99.4 billion at the end of 2021 to $118.0 billion at the end of 2022. This $118.0 billion consisted of $118.0 billion in U.S. Government obligations and, as an offset, an extension of credit totaling $44 million against securities to be redeemed in the first few days of the following year. The effective annual rate of interest earned by the asset reserves in the DI Trust Fund during calendar year 2022 was 2.7 percent, slightly lower than the 2.8 percent earned during calendar year 2021. Table VI.A5 shows a detailed listing of DI Trust Fund holdings by type of security, interest rate, and year of maturity at the end of calendar years 2021 and 2022.

Section 201(d) of the Social Security Act provides that the Treasury securities issued for purchase by the OASI and DI Trust Funds shall have maturities fixed with due regard for the needs of the funds. Each year, bond purchases for each trust fund are made on June 30, taking into account the projected reserve depletion date in the most recently issued Trustees Report. The usual practice has been to reinvest the maturing special issue securities, as of each June 30, so that the values of the securities maturing in each of the next 15 years are approximately equal. Accordingly, the Department of the Treasury, in consultation with the Chief Actuary of the Social Security Administration, selected the amounts and maturity dates of the DI special-issue bonds purchased on June 30, 2022, so that the maturity dates of the total portfolio of special issue securities would be evenly spread to the extent possible over the 15-year period 2023-37. The bonds purchased have an interest rate of 3.000 percent, reflecting the average market yield, as of the last business day of the prior month, on the outstanding marketable U.S. obligations that are due or callable more than 4 years in the future. Table III.A7 shows details on investment transactions during 2022.

3. OASI and DI Trust Funds, Combined

Table III.A3 presents a statement of the operations of the OASI and DI Trust Funds on a hypothetical combined basis.[1] The entries in this table represent the sums of the corresponding values from tables III.A1 and III.A2. The two preceding subsections that cover OASI and DI provide a description of the nature of these income and cost transactions.

[1] The OASI and DI Trust Funds are distinct legal entities which operate independently. To illustrate the actuarial status of the program as a whole, the fund operations are often combined on a hypothetical basis.

Table III.A3.—Operations of the Combined OASI and DI Trust Funds, Calendar Year 2022
[In millions]

Total asset reserves, December 31, 2021		$2,852,030
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$1,111,751	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund[a]	-5,149	
Net payroll tax contributions[a]		1,106,602
Reimbursements from the General Fund:		
Transfer directed by P.L. 116-136	183	
Reduction in payroll tax contributions due to P.L. 111-312, P.L. 112-78, and P.L. 112-96[a]	[b]	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		183
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	266	
All other, not subject to withholding	48,358	
Total income from taxation of benefits		48,624
Investment income and interest adjustments:		
Interest on investments	66,370	
Interest adjustments[c]	2	
Total investment income and interest adjustments		66,372
Gifts		[b]
Total income		1,221,782
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[d]	1,231,646	
Reimbursement from the General Fund for unnegotiated checks	-81	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	143	
Net benefit payments[d]		1,231,707
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		5,471
Administrative expenses:		
Costs incurred by:		
Social Security Administration	6,010	
Department of the Treasury	738	
Offsetting miscellaneous receipts	-1	
Demonstration projects	7	
Miscellaneous reimbursements from the General Fund[e]	-8	
Net administrative expenses		6,746
Total cost		1,243,925
Net increase in asset reserves		-22,143
Total invested assets	2,829,950	
Undisbursed balances[f]	-63	
Total asset reserves, December 31, 2022		2,829,887

[a] Includes adjustments for prior calendar years.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust funds and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust funds.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI and DI programs.
[f] A negative balance represents a situation where the actual cash payments exceeded the amount of invested securities of the combined OASI and DI Trust Funds that were redeemed to make such payments. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Components may not sum to totals because of rounding.

Table III.A4 compares estimates of total income and total cost for calendar year 2022 from the intermediate projections in the 2018 through 2022 Trustees Reports to the corresponding actual amounts for 2022.

Table III.A4.—Comparison of Actual Calendar Year 2022 Trust Fund Operations With Estimates Made in Prior Reports, Based on Intermediate Assumptions[a]
[Amounts in billions]

	Total income[b]		Total cost	
	Amount	Difference from actual (percent)	Amount	Difference from actual (percent)
OASI Trust Fund:				
Estimate in 2018 report	$1,060.7	0.4	$1,106.5	0.8
Estimate in 2019 report	1,052.1	-.4	1,092.8	-.4
Estimate in 2020 report	1,034.0	-2.1	1,082.3	-1.4
Estimate in 2021 report	1,013.9	-4.1	1,072.5	-2.3
Estimate in 2022 report	1,034.4	-2.1	1,096.2	-.1
Actual amount	1,056.7	—	1,097.5	—
DI Trust Fund:				
Estimate in 2018 report	163.1	-1.2	169.2	15.5
Estimate in 2019 report	163.0	-1.3	159.2	8.7
Estimate in 2020 report	160.8	-2.6	155.4	6.1
Estimate in 2021 report	158.2	-4.1	153.6	4.8
Estimate in 2022 report	161.5	-2.2	146.4	[c]
Actual amount	165.1	—	146.5	—
OASI and DI Trust Funds, combined:				
Estimate in 2018 report	1,223.7	.2	1,275.7	2.6
Estimate in 2019 report	1,215.1	-.5	1,252.0	.6
Estimate in 2020 report	1,194.8	-2.2	1,237.8	-.5
Estimate in 2021 report	1,172.1	-4.1	1,226.1	-1.4
Estimate in 2022 report	1,195.8	-2.1	1,242.7	-.1
Actual amount	1,221.8	—	1,243.9	—

[a] Percentage differences are calculated prior to rounding.
[b] "Actual" income for 2022 reflects adjustments to payroll tax contributions for prior calendar years (see appendix A for description of these adjustments). "Estimated" income also includes such adjustments, but on an estimated basis.
[c] Between -0.05 percent and 0.05 percent.

Note: Components may not sum to totals because of rounding.

A number of factors contribute to differences between estimates and subsequent actual amounts, including: (1) actual values for key demographic, economic, and other variables that differ from earlier assumed levels; and (2) legislation that was enacted or other administrative initiatives that were finalized after the Trustees completed their estimates. In addition, estimates for the 2018 through 2020 Trustees Reports did not anticipate the pandemic and recession, while the actual income and cost for 2022 do reflect the pandemic, contributing to these differences as well.

At the end of calendar year 2022, the OASDI program was providing monthly benefits to about 66.0 million people. The OASI Trust Fund was

providing benefits to about 57.2 million people and the DI Trust Fund was providing benefits to about 8.8 million people. The number of people receiving benefits from the OASI Trust Fund grew by 2.0 percent while the number of people receiving DI benefits fell by 4.1 percent during calendar year 2022. These changes are in large part due to the shifting age distribution of the adult population, with the baby-boom generation (born in 1946-1965) moving increasingly above age 62 for retired worker benefits, and above normal retirement age, where DI benefits are no longer applicable. Table III.A5 shows the estimated distributions of benefit payments in calendar years 2021 and 2022, by type of beneficiary, for each trust fund separately.

Table III.A5.—Distribution of Benefit Payments by Type of Beneficiary or Payment, Calendar Years 2021 and 2022
[Amounts in millions]

	Calendar year 2021		Calendar year 2022	
	Amount	Percentage of total	Amount	Percentage of total
Total OASDI benefit payments	$1,133,164	100.0	$1,231,646	100.0
OASI benefit payments	993,167	87.6	1,088,170	88.4
DI benefit payments	139,996	12.4	143,475	11.6
OASI benefit payments, total	993,167	100.0	1,088,170	100.0
Monthly benefits:				
Retired workers and auxiliaries	861,873	86.8	947,071	87.0
Retired workers	822,440	82.8	906,826	83.3
Spouses	33,050	3.3	33,491	3.1
Children	6,384	.6	6,754	.6
Survivors of deceased workers	131,057	13.2	140,870	12.9
Aged widows and widowers	104,868	10.6	112,339	10.3
Disabled widows and widowers	2,233	.2	2,245	.2
Parents	19	[a]	19	[a]
Children	22,445	2.3	24,674	2.3
Widowed mothers and fathers caring for child beneficiaries	1,492	.2	1,593	.1
Lump-sum death payments	237	[a]	229	[a]
DI benefit payments, total	139,996	100.0	143,475	100.0
Disabled workers	132,401	94.6	135,978	94.8
Spouses	465	.3	458	.3
Children	7,131	5.1	7,039	4.9

[a] Less than 0.05 percent.

Note: Benefits are monthly benefits and lump-sum death payments. Components may not sum to totals because of rounding.

Net administrative expenses of the OASI and DI Trust Funds in calendar year 2022 totaled $6.7 billion, equal to 0.5 percent of total cost and 0.6 percent of total income. Table III.A6 shows corresponding percentages for each trust fund separately and for OASDI as a whole for the last 5 years.

Table III.A6.—Administrative Expenses as a Percentage of Total Income and of Total Cost, Calendar Years 2018-2022

	OASI Trust Fund		DI Trust Fund		OASI and DI Trust Funds, combined	
Calendar year	Total income	Total cost	Total income	Total cost	Total income	Total cost
2018	0.5	0.4	1.7	1.9	0.7	0.7
2019	.4	.4	1.9	1.8	.6	.6
2020	.4	.4	1.7	1.7	.6	.6
2021	.4	.4	1.7	1.7	.6	.6
2022	.4	.4	1.7	1.9	.6	.5

The acquisition and redemption of securities during calendar year 2022 changed the invested reserves of the OASI and DI Trust Funds. Table III.A7 presents investment transactions for each fund separately and combined.

Table III.A7.—Trust Fund Investment Transactions, Calendar Year 2022
[In millions]

	OASI Trust Fund	DI Trust Fund	OASI and DI Trust Funds, combined
Invested asset reserves, December 31, 2021[a]	$2,752,688	$99,438	$2,852,126
Acquisitions:			
Special issue securities:			
Certificates of indebtedness	1,018,446	162,972	1,181,418
Bonds[b]	189,931	26,381	216,311
Total acquisitions	1,208,377	189,352	1,397,729
Redemptions:			
Special issue securities:			
Certificates of indebtedness	884,392	150,684	1,035,076
Bonds	364,755	20,074	384,829
Total redemptions	1,249,147	170,758	1,419,905
Net increase in invested asset reserves	-40,770	18,594	-22,176
Invested asset reserves, December 31, 2022[a]	2,711,919	118,032	2,829,950

[a] Invested asset reserves differ from total asset reserves by the amount of undisbursed balances. See tables VI.A4 and VI.A5 for details.

[b] Purchased on June 30, 2022. The interest rate on these purchases was 3.000 percent.

Note: Investments are shown at par value. Components may not sum to totals because of rounding.

B. CHANGES IN LAW AND POLICY AFFECTING SOCIAL SECURITY SINCE THE 2022 REPORT

Since the Trustees submitted the 2022 report to Congress, there have been no changes in law, policy, or regulation that are expected to have significant financial effects on the OASDI program. However, there have been a number of notable regulatory and judicial developments related to immigration policy.

At the time of the 2022 report, the US Citizenship and Immigration Services had paused processing of first-time applications under the Deferred Action for Childhood Arrivals (DACA) policy but continued to process renewal applications. Since then, there have been several regulatory and judicial developments:

- On August 30, 2022, the Department of Homeland Security (DHS) published a final rule in the Federal Register, establishing regulations to "preserve and fortify" the DACA program in full.
- On October 5, 2022, the US Court of Appeals for the Fifth Circuit affirmed an earlier district court decision that had declared the DACA policy unlawful. The appeals court returned the case to the district court for further review of the DHS regulation.
- On October 14, 2022, the district court issued an order extending the pause in implementing the DACA final rule. As a result, DHS is currently prohibited from processing new DACA applications and related employment authorizations.

Changes in DACA policy affect OASDI program operations because those who apply for and receive deferred action status are eligible for work authorization, which leads to additional workers covered by the OASDI program, increased payroll tax revenue, and subsequently increased benefit cost. The estimates presented in last year's report reflected the assumption that the DACA program would be fully in effect by the middle of 2022, consistent with the Administration's intent. Because of the court challenges, the estimates in this year's report incorporate an additional one-year delay in the resumption of processing new applications, to the middle of 2023. This change is estimated to have negligible financial effects on the OASDI program over both the short-range and long-range projection periods.

Sections IV.A.4 and IV.B.6 of this report provide further description of the magnitude of effects on the financial status of the OASDI program.

IV. ACTUARIAL ESTIMATES

This chapter presents actuarial estimates of the future financial condition of the Social Security program. These estimates show the income, cost, and asset reserves or unfunded obligation of the OASI and DI Trust Funds: (1) in dollars over the 10-year short-range period; and (2) as a percentage of taxable payroll, as a percentage of gross domestic product, and in present-value dollars over the 75-year long-range period. In addition, the chapter discusses a variety of measures of the adequacy of current program financing. This report distinguishes between: (1) the cost (obligations) of the program, which includes all past and future benefits scheduled under current law; and (2) expenditures, which include actual payments for the past plus only the portion of projected program cost that would be payable with the financing provisions in current law.

This chapter presents the estimates and measures of trust fund financial adequacy for the short-range period (2023 through 2032) first, followed by estimates and measures of actuarial status for the long-range period (2023 through 2097). Summary measures are also provided for trust fund status over the infinite horizon. As described in chapter II of this report, these estimates depend upon a broad set of demographic, economic, and programmatic factors. This chapter presents estimates under three sets of assumptions to show a wide range of possible outcomes, because assumptions related to these factors are subject to uncertainty. The intermediate set of assumptions, designated as alternative II, reflects the Trustees' best estimate of future experience; the low-cost alternative I is significantly more optimistic and the high-cost alternative III is significantly more pessimistic for the trust funds' future financial outlook. The tables of this report show the intermediate estimates first, followed by the low-cost and high-cost estimates. Chapter V describes these three sets of assumptions, along with the actuarial methods used to produce the estimates. Appendix D and appendix E present two additional methods to illustrate the uncertainty of the projections. Appendix D presents sensitivity analyses of the effects of variation in individual factors and appendix E presents probability distributions generated by a stochastic model.

A. SHORT-RANGE ESTIMATES

The Trustees consider the trust funds to be solvent at any point in time if the funds can pay scheduled benefits in full on a timely basis. A standard measure for assessing solvency is the "trust fund ratio," which is the reserves in a fund at the beginning of a year (not including advance tax transfers) expressed as a percentage of the cost during the year. A positive trust fund ratio indicates that the trust fund was solvent at the end of the prior year. The

trust fund ratio represents the proportion of a year's cost which the reserves available at the beginning of that year can cover. The Trustees assume that a trust fund ratio of 100 percent of annual program cost provides a reasonable "contingency reserve." Maintaining a reasonable contingency reserve is important because the trust funds do not have borrowing authority. After reserves are depleted, the trust funds would be unable to pay scheduled benefits in full on a timely basis if annual revenue were less than annual cost. Unexpected events, such as severe economic recessions, can quickly diminish reserves. In such cases, a reasonable contingency reserve can maintain the ability to pay scheduled benefits while giving lawmakers time to address possible changes to the program.

The test of short-range financial adequacy applies to the OASI and DI Trust Funds individually and combined on a hypothetical basis.[1] If the estimated trust fund ratio is at least 100 percent at the beginning of the projection period, the test requires that it remain at or above 100 percent throughout the 10-year period. If the ratio is initially less than 100 percent, then it must reach at least 100 percent within 5 years (without reserve depletion at any time during this period) and then remain at or above 100 percent throughout the remainder of the 10-year period. This test is applied using the estimates based on the intermediate assumptions. If either trust fund fails this test, then program solvency in the next 10 years is in question, and lawmakers should take prompt action to improve short-range financial adequacy.

1. Operations of the OASI Trust Fund

This subsection presents projections, based on the assumptions described in chapter V, of the operations and financial status of the OASI Trust Fund for the period 2023 through 2032. These estimates assume that there are no further changes in the statutory provisions and regulations under which the OASDI program currently operates beyond the changes since last year's report indicated in section III.B.[2]

Estimates of the OASI Trust Fund operations presented in table IV.A1 indicate that the asset reserves of the OASI Trust Fund are projected to decrease in years 2023 through 2032 under all three sets of assumptions. Under the intermediate and low-cost assumptions, asset reserves remain positive through the end of the short-range period, but under the high-cost assumptions, asset reserves become depleted in the third quarter of 2031. Trust fund ratios are similarly projected to decline throughout the 10-year projection

[1] The OASI and DI Trust Funds are distinct legal entities which operate independently. To illustrate the actuarial status of the program as a whole, the fund operations are often combined on a hypothetical basis.

[2] The estimates shown in this subsection reflect 12 months of scheduled benefits in each year of the short-range projection period. In practice, the actual payment dates have at times shifted over calendar year boundaries as a result of the statutory requirement for early delivery of benefit payments when the normal check delivery date is a Saturday, Sunday, or legal public holiday.

period under all three sets of assumptions. Based on the intermediate assumptions, the reserves of the OASI Trust Fund drop below 100 percent of annual cost during 2028, to a trust fund ratio of 91 percent at the beginning of 2029, and remain below 100 percent for the remainder of the short-range period. Consequently, the OASI Trust Fund fails the test of short-range financial adequacy. See figure IV.A1 for an illustration of these results.

Table IV.A1.—Operations of the OASI Trust Fund, Calendar Years 2018-2032[a]

[Dollar amounts in billions]

	Income					Cost[b]				Asset Reserves[b]		
Calendar year	Total	Net payroll tax contributions[d]	GF reimbursements[e]	Taxation of benefits[df]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio at start of year[c]
Historical data:												
2018 . . .	$831.0	$715.9	[g]	$34.5	$80.7	$853.5	$844.9	$3.8	$4.8	-$22.4	$2797.9	330
2019 . . .	917.9	805.1	[g]	34.9	77.9	911.4	902.8	3.7	4.9	6.5	2,804.3	307
2020 . . .	968.3	856.0	[g]	39.0	73.3	961.0	952.4	3.7	4.8	7.4	2,811.7	292
2021 . . .	942.9	838.2	[g]	37.2	67.5	1,001.9	993.1	4.0	4.8	-59.1	2,752.6	281
2022 . . .	1,056.7	945.9	$0.2	47.1	63.5	1,097.5	1,088.1	4.0	5.3	-40.7	2,711.9	251
Intermediate:												
2023 . . .	1,153.3	1,040.1	[g]	51.2	62.0	1,235.1	1,225.5	4.1	5.4	-81.7	2,630.2	220
2024 . . .	1,166.0	1,050.3	[g]	56.3	59.4	1,323.5	1,313.2	4.3	6.1	-157.5	2,472.6	199
2025 . . .	1,223.8	1,107.6	[g]	60.2	56.0	1,403.2	1,392.7	4.4	6.1	-179.4	2,293.2	176
2026 . . .	1,286.0	1,157.8	.2	74.6	53.4	1,486.1	1,475.3	4.5	6.3	-200.1	2,093.1	154
2027 . . .	1,341.3	1,209.9	[g]	80.7	50.8	1,571.1	1,560.0	4.7	6.4	-229.8	1,863.3	133
2028 . . .	1,396.6	1,263.0	[g]	86.9	46.7	1,661.5	1,650.2	4.8	6.5	-264.9	1,598.4	112
2029 . . .	1,451.4	1,316.8	[g]	93.8	40.7	1,754.5	1,742.9	5.0	6.6	-303.1	1,295.2	91
2030 . . .	1,505.5	1,370.7	[g]	101.5	33.3	1,849.3	1,837.4	5.1	6.7	-343.7	951.5	70
2031 . . .	1,560.9	1,427.4	[g]	109.6	23.8	1,945.0	1,932.9	5.3	6.8	-384.2	567.4	49
2032 . . .	1,613.2	1,482.7	[g]	118.4	12.0	2,041.5	2,029.1	5.5	6.9	-428.3	139.0	28
Low-cost:												
2023 . . .	1,161.9	1,047.2	[g]	51.2	63.5	1,234.4	1,224.8	4.1	5.4	-72.4	2,639.5	220
2024 . . .	1,210.6	1,090.8	[g]	56.1	63.6	1,318.8	1,308.5	4.3	6.0	-108.2	2,531.2	200
2025 . . .	1,297.3	1,172.9	[g]	60.3	64.2	1,404.5	1,394.0	4.4	6.1	-107.1	2,424.1	180
2026 . . .	1,391.2	1,249.3	.2	74.9	66.8	1,493.8	1,483.0	4.6	6.2	-102.6	2,321.4	162
2027 . . .	1,478.1	1,326.4	[g]	81.4	70.2	1,586.2	1,575.0	4.9	6.3	-108.1	2,213.3	146
2028 . . .	1,568.2	1,407.3	[g]	88.2	72.8	1,684.9	1,673.4	5.1	6.4	-116.7	2,096.6	131
2029 . . .	1,660.7	1,490.7	[g]	95.5	74.4	1,787.4	1,775.5	5.4	6.6	-126.8	1,969.8	117
2030 . . .	1,756.2	1,576.6	[g]	103.9	75.7	1,893.2	1,880.8	5.6	6.7	-137.0	1,832.9	104
2031 . . .	1,856.8	1,667.5	[g]	112.8	76.5	2,001.5	1,988.8	5.9	6.8	-144.7	1,688.2	92
2032 . . .	1,957.7	1,759.2	[g]	122.5	75.9	2,112.4	2,099.4	6.1	7.0	-154.7	1,533.4	80

Table IV.A1.—Operations of the OASI Trust Fund, Calendar Years 2018-2032[a] (Cont.)

[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		Trust fund ratio at start of year[c]
	Total	Net payroll tax contributions[d]	GF reimbursements[e]	Taxation of benefits[df]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
High-cost:												
2023	$1,137.3	$1,024.3	[g]	$51.3	$61.7	$1,235.9	$1,226.3	$4.1	$5.4	-$98.6	$2,613.3	219
2024	1,116.7	1,003.1	[g]	56.8	56.9	1,334.8	1,324.4	4.3	6.1	-218.1	2,395.3	196
2025	1,167.7	1,056.0	[g]	60.9	50.8	1,419.9	1,409.3	4.3	6.3	-252.2	2,143.1	169
2026	1,217.1	1,096.5	$0.2	75.1	45.4	1,497.3	1,486.3	4.5	6.5	-280.1	1,863.0	143
2027	1,255.4	1,134.7	[g]	80.9	39.8	1,576.3	1,565.2	4.6	6.5	-320.9	1,542.1	118
2028	1,287.8	1,168.9	[g]	86.9	32.1	1,660.1	1,648.9	4.7	6.6	-372.3	1,169.8	93
2029	1,317.2	1,200.7	[g]	93.3	23.2	1,745.6	1,734.2	4.8	6.7	-428.4	741.4	67
2030	1,344.6	1,230.7	[g]	100.6	13.3	1,831.8	1,820.2	4.8	6.8	-487.2	254.2	40
2031	[h]	1,261.4	[g]	108.1	[h]	1,918.1	1,906.3	4.9	6.8	[h]	[h]	13
2032	[h]	1,289.7	[g]	116.3	[h]	2,004.1	1,992.2	5.0	6.9	[h]	[h]	[h]

[a] The OASI Trust Fund reserves become depleted in the third quarter of 2031 under the high-cost assumptions. For any period during which reserves would be depleted, scheduled benefits could not be paid in full on a timely basis, income from taxing benefits would be less than would apply to scheduled benefits, and interest on trust fund reserves would be negligible. Appendix A presents a detailed description of the components of income and cost, along with complete historical values.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years occur periodically whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Represents reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year. The trust fund ratio at the beginning of 2033 is projected to be 7 percent for the intermediate, and 69 percent for the low-cost assumptions.

[d] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $30.4 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[e] Includes reimbursements from the General Fund of the Treasury to the OASI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; and (2) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. Also includes transfers of a portion of proceeds from repayments of loans authorized under Public Law 116-136.

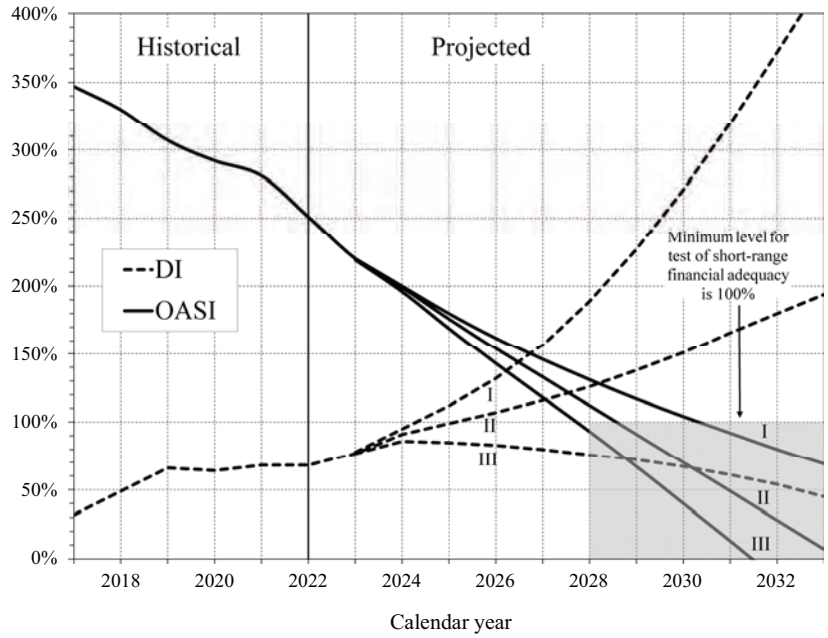
[f] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

[g] Between -$50 million and $50 million.

[h] When the fund reserves are depleted, values under current law would reflect permissible expenditures only, which would be less than the full cost of paying scheduled benefits shown in this table.

Note: Components may not sum to totals because of rounding.

Figure IV.A1.—Short-Range OASI and DI Trust Fund Ratios
[Asset reserves as a percentage of annual cost]



The estimated income shown in table IV.A1 increases annually under each set of assumptions throughout the short-range projection period, with the exception of a small decrease in 2024 for the high-cost alternative. The estimated increases in income result primarily from the projected increases in OASDI taxable payroll. Employment increases in years 2023 through 2032 for all three alternatives, with the exception of small decreases in covered employment in 2023 and 2024 for the high-cost alternative: the number of covered workers increases under alternatives I, II, and III from 181 million during calendar year 2022 to about 192 million, 188 million, and 184 million, respectively, in 2032.[1] The total annual amount of taxable payroll increases in years 2023 through 2032 for each alternative. Total taxable payroll increases from $9,069 billion in 2022 to $16,650 billion, $14,023 billion, and $12,189 billion in 2032, on the basis of alternatives I, II, and III, respectively.[2] These increases in taxable payroll are due primarily to: (1) projected increases in employment levels as the working-age population increases; (2) trend increases in average earnings in covered employment (reflecting both real growth and price inflation); (3) increases in the contribu-

[1] See table IV.B3.
[2] See table VI.G6.

tion and benefit base under the automatic-adjustment provisions; and (4) growth in employment and average earnings.

Interest earnings contribute to the overall projected level of trust fund income during this period. Interest income declines generally at a slow rate under the intermediate assumptions and much faster under the high-cost assumptions, and increases generally under the low-cost assumptions, due to the net effects of changes in reserve levels and the patterns of projected interest rates. Under the intermediate assumptions, interest also declines as a share of total OASI Trust Fund income reaching 1 percent of total trust fund income for 2032, as compared to 6 percent for 2022.

Rising OASI cost from 2022 through 2032 reflects automatic benefit increases each year after initial benefit eligibility and increases each year for those becoming newly eligible based on rising average earnings levels, as well as the upward trend in the number of beneficiaries. The steady growth in the number of OASI beneficiaries in the past and the expected future growth result both from the increase in the aged population and from the increase in the proportion of the population that is insured for benefits.

The Treasury invests OASI income in financial securities, generally special public-debt obligations of the U.S. Government. The revenue used to make these purchases flows to the General Fund of the Treasury. The trust fund earns interest on these securities, and the Treasury invests the proceeds from maturing securities in new securities if not immediately needed to pay program costs. Program expenditures require the redemption of trust fund securities, generally prior to maturity, to cover the payments made by the General Fund of the Treasury on behalf of the trust fund.

2. Operations of the DI Trust Fund

Table IV.A2 shows the projected operations and financial status of the DI Trust Fund during calendar years 2023 through 2032 under the three sets of assumptions, together with values for actual experience during 2018 through 2022. Non-interest income for DI dropped in 2019 from its level in 2018, due to the temporary payroll tax rate reallocation from OASI to DI in 2016 through 2018. For 2022, non-interest income was higher than DI cost. Non-interest income increases generally throughout the short-range projection period under each alternative, due to most of the same factors described previously for the OASI Trust Fund beginning on page 45. DI cost grows steadily throughout the period under each alternative. Under the intermediate and low-cost assumptions, DI reserves increase through 2032. Under the high-cost assumptions, DI reserves increase through 2026 and then decline through 2032.

Table IV.A2.—Operations of the DI Trust Fund, Calendar Years 2018-2032[a]
[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		Trust fund ratio at start of year[c]
	Total	Net payroll tax contributions[d]	GF reimbursements[e]	Taxation of benefits[df]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
Historical data:												
2018 . .	$172.3	$169.2	[g]	$0.5	$2.6	$146.8	$143.7	$2.9	$0.2	$25.6	$97.1	49
2019 . .	143.9	139.4	[g]	1.6	2.9	147.9	145.1	2.7	.1	-4.0	93.1	66
2020 . .	149.7	145.3	[g]	1.7	2.8	146.3	143.6	2.6	.1	3.5	96.6	64
2021 . .	145.5	142.4	[g]	.5	2.6	142.6	140.1	2.5	.1	2.8	99.4	68
2022 . .	165.1	160.7	[g]	1.6	2.8	146.5	143.6	2.7	.2	18.6	118.0	68
Intermediate:												
2023 . .	181.4	176.6	[g]	1.1	3.7	152.9	149.7	3.1	[g]	28.5	146.5	77
2024 . .	184.7	178.4	[g]	1.7	4.6	161.1	158.0	3.0	[g]	23.6	170.2	91
2025 . .	195.5	188.1	[g]	1.9	5.6	171.1	168.0	3.1	[g]	24.4	194.5	99
2026 . .	205.5	196.6	[g]	2.3	6.5	181.1	177.8	3.3	[g]	24.4	218.9	107
2027 . .	215.5	205.4	[g]	2.5	7.6	189.1	185.6	3.4	[g]	26.5	245.4	116
2028 . .	226.1	214.5	[g]	2.6	9.0	194.8	191.2	3.6	[g]	31.3	276.7	126
2029 . .	237.0	223.6	[g]	2.8	10.6	200.7	196.9	3.8	[g]	36.4	313.1	138
2030 . .	248.3	232.8	[g]	2.9	12.6	206.7	202.7	4.0	[g]	41.6	354.7	151
2031 . .	260.4	242.4	[g]	3.1	14.8	214.1	209.9	4.1	.1	46.3	401.0	166
2032 . .	272.5	251.8	[g]	3.4	17.3	222.6	218.2	4.3	.1	49.9	450.9	180
Low-cost:												
2023 . .	182.8	177.8	[g]	1.0	4.0	151.6	148.5	3.1	[g]	31.2	149.2	78
2024 . .	192.5	185.2	[g]	1.7	5.5	157.3	154.2	3.0	[g]	35.2	184.4	95
2025 . .	208.5	199.2	[g]	1.8	7.5	165.1	162.0	3.1	[g]	43.4	227.8	112
2026 . .	224.5	212.1	[g]	2.2	10.2	172.9	169.6	3.3	[g]	51.7	279.4	132
2027 . .	241.1	225.2	[g]	2.3	13.5	178.3	174.8	3.5	[g]	62.8	342.3	157
2028 . .	259.1	239.0	[g]	2.4	17.7	181.3	177.6	3.7	[g]	77.8	420.1	189
2029 . .	278.3	253.1	[g]	2.6	22.6	185.0	181.1	3.9	[g]	93.3	513.4	227
2030 . .	298.9	267.7	[g]	2.7	28.4	189.1	185.0	4.1	[g]	109.7	623.1	271
2031 . .	321.4	283.2	[g]	2.8	35.4	194.7	190.3	4.4	[g]	126.6	749.8	320
2032 . .	345.2	298.7	[g]	3.1	43.4	201.6	197.0	4.6	[g]	143.6	893.4	372

Table IV.A2.—Operations of the DI Trust Fund, Calendar Years 2018-2032[a] (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		Trust fund ratio at start of year[c]
	Total	Net payroll tax contributions[d]	GF reimbursements[e]	Taxation of benefits[df]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
High-cost:												
2023	$178.7	$173.9	[g]	$1.1	$3.7	$154.1	$151.0	$3.1	[g]	$24.6	$142.6	77
2024	176.2	170.3	[g]	1.8	4.1	165.9	162.8	3.0	[g]	10.4	152.9	86
2025	185.6	179.3	[g]	2.0	4.3	179.8	176.6	3.1	[g]	5.9	158.8	85
2026	193.1	186.2	[g]	2.5	4.5	191.4	188.1	3.3	[g]	1.7	160.5	83
2027	199.8	192.7	[g]	2.6	4.5	201.7	198.3	3.4	[g]	-1.9	158.6	80
2028	205.8	198.5	[g]	2.8	4.4	209.4	205.8	3.5	[g]	-3.6	155.0	76
2029	211.3	203.9	[g]	3.0	4.4	216.4	212.7	3.7	[g]	-5.2	149.8	72
2030	216.4	209.0	[g]	3.2	4.2	224.0	220.1	3.8	$0.1	-7.5	142.3	67
2031	221.7	214.2	[g]	3.4	4.0	233.0	229.0	3.9	.1	-11.3	131.0	61
2032	226.4	219.0	[g]	3.7	3.7	242.8	238.7	4.1	.1	-16.4	114.6	54

[a] Appendix A presents a detailed description of the components of income and cost, along with complete historical values.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years occur periodically whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Represents reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year. The trust fund ratio at the beginning of 2033 is projected to be 194 percent for the intermediate, 425 percent for the low-cost, and 45 percent for the high-cost assumptions.

[d] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $5.2 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[e] Includes reimbursements from the General Fund of the Treasury to the DI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; and (2) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[f] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

[g] Between -$50 million and $50 million.

Note: Components may not sum to totals because of rounding.

For the future, DI cost is projected to increase in part due to increases in average benefit levels resulting from: (1) automatic benefit increases and (2) projected increases in the amounts of average monthly earnings on which benefits are based. Future changes in DI cost also reflect changes in the number of DI beneficiaries in current-payment status. In 2022, the number of DI beneficiaries in current-payment status continued the declining trend of the prior eight years. Under the intermediate assumptions, that number of DI beneficiaries is projected to drop further through the end of 2024, then increase through the end of 2032 to a level of about 9 million. The rate of increase after 2024 is much slower than was experienced on average from 1990 to 2010, when the population with the highest disability prevalence rates was growing rapidly due to the aging of the baby-boom generation. See section V.C.5 for further details.

At the beginning of calendar year 2023, the reserves of the DI Trust Fund represented 77 percent of estimated annual cost. Under the intermediate

assumptions, DI trust fund reserves and the trust fund ratio increase throughout the short-range projection period. The trust fund ratio rises to 107 percent at the beginning of the fourth projected year, 2026, and continues to increase for the remainder of the short-range period.

Because the reserves of the DI Trust Fund at the beginning of 2023 were less than the estimated annual cost for 2023, but are projected to increase to above annual cost within five years, and then remain above annual cost throughout the rest of the short-range period under the intermediate assumptions, the DI Trust Fund satisfies the Trustees' test of short-range financial adequacy.

3. Operations of the Combined OASI and DI Trust Funds

Table IV.A3 shows the projected operations and status of the combined OASI and DI Trust Funds for calendar years 2023 through 2032 under the three alternatives, together with actual experience in 2018 through 2022. Income and cost for the OASI Trust Fund represent over 80 percent of the corresponding amounts for the combined OASI and DI Trust Funds. Under the intermediate and low-cost assumptions, the combined OASI and DI Trust Funds would have sufficient financial resources to pay all scheduled benefits through the end of the short-range period, although it is important to note that under current law, one trust fund cannot share financial resources with another trust fund. Under the high-cost assumptions, combined OASI and DI trust fund reserves deplete in the fourth quarter of 2031. The combined OASI and DI Trust Funds do not satisfy the test of short-range financial adequacy because under the intermediate assumptions, trust fund reserves drop below 100 percent of annual cost during 2028, to a trust fund ratio of 96 percent at the beginning of 2029, and remain below 100 percent for the remainder of the short-range period.

Table IV.A3.—Operations of the Combined OASI and DI Trust Funds, Calendar Years 2018-2032[a]

[Dollar amounts in billions]

	Income					Cost[b]				Asset Reserves[b]		
Calendar year	Total	Net payroll tax contributions[d]	GF reimbursements[e]	Taxation of benefits[d f]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio at start of year[c]
Historical data:												
2018	$1,003.4	$885.1	[g]	$35.0	$83.3	$1,000.2	$988.6	$6.7	$4.9	$3.1	$2,894.9	289
2019	1,061.8	944.5	[g]	36.5	80.8	1,059.3	1,047.9	6.4	4.9	2.5	2,897.4	273
2020	1,118.1	1,001.3	[g]	40.7	76.1	1,107.2	1,095.9	6.3	5.0	10.9	2,908.3	262
2021	1,088.3	980.6	[g]	37.6	70.1	1,144.6	1,133.2	6.5	4.9	-56.3	2,852.0	254
2022	1,221.8	1,106.6	$0.2	48.6	66.4	1,243.9	1,231.7	6.7	5.5	-22.1	2,829.9	229
Intermediate:												
2023	1,334.7	1,216.8	[g]	52.3	65.7	1,387.9	1,375.3	7.2	5.4	-53.2	2,776.7	204
2024	1,350.7	1,228.7	[g]	58.1	64.0	1,484.6	1,471.2	7.3	6.1	-133.9	2,642.8	187
2025	1,419.3	1,295.7	[g]	62.1	61.6	1,574.3	1,560.7	7.5	6.2	-155.1	2,487.7	168

Table IV.A3.—Operations of the Combined OASI and DI Trust Funds, Calendar Years 2018-2032[a] (Cont.)

[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		Trust fund ratio at start of year[c]
	Total	Net payroll tax contributions[d]	GF reimbursements[e]	Taxation of benefits[d f]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
Intermediate (Cont.):												
2026 . .	$1,491.5	$1,354.5	$0.2	$76.9	$60.0	$1,667.2	$1,653.1	$7.8	$6.3	-$175.7	$2,312.0	149
2027 . .	1,556.9	1,415.3	[g]	83.1	58.4	1,760.2	1,745.7	8.1	6.4	-203.3	2,108.7	131
2028 . .	1,622.7	1,477.5	[g]	89.6	$55.6	1,856.3	1,841.3	8.4	6.5	-233.6	1,875.1	114
2029 . .	1,688.4	1,540.5	[g]	96.6	51.4	1,955.2	1,939.7	8.8	6.6	-266.8	1,608.3	96
2030 . .	1,753.9	1,603.5	[g]	104.5	45.9	2,056.0	2,040.1	9.1	6.8	-302.1	1,306.2	78
2031 . .	1,821.3	1,669.8	[g]	112.8	38.6	2,159.1	2,142.8	9.4	6.9	-337.9	968.3	60
2032 . .	1,885.7	1,734.5	[g]	121.8	29.3	2,264.1	2,247.3	9.8	7.0	-378.4	589.9	43
Low-cost:												
2023 . .	1,344.8	1,225.1	[g]	52.3	67.4	1,386.0	1,373.3	7.2	5.4	-41.2	2,788.7	204
2024 . .	1,403.0	1,276.1	[g]	57.8	69.1	1,476.1	1,462.8	7.3	6.1	-73.1	2,715.6	189
2025 . .	1,505.8	1,372.1	[g]	62.1	71.7	1,569.6	1,556.0	7.5	6.1	-63.7	2,651.8	173
2026 . .	1,615.7	1,461.4	.2	77.2	77.0	1,666.7	1,652.5	7.9	6.2	-51.0	2,600.9	159
2027 . .	1,719.2	1,551.7	[g]	83.8	83.8	1,764.5	1,749.8	8.4	6.3	-45.3	2,555.6	147
2028 . .	1,827.4	1,646.2	[g]	90.6	90.5	1,866.2	1,851.0	8.8	6.4	-38.9	2,516.7	137
2029 . .	1,939.0	1,743.8	[g]	98.1	97.1	1,972.4	1,956.6	9.3	6.6	-33.5	2,483.3	128
2030 . .	2,055.1	1,844.3	[g]	106.6	104.1	2,082.3	2,065.8	9.7	6.7	-27.2	2,456.0	119
2031 . .	2,178.2	1,950.7	[g]	115.7	111.8	2,196.2	2,179.2	10.2	6.8	-18.1	2,438.0	112
2032 . .	2,302.9	2,058.0	[g]	125.6	119.4	2,314.1	2,296.4	10.7	7.0	-11.1	2,426.8	105
High-cost:												
2023 . .	1,316.0	1,198.3	[g]	52.3	65.4	1,390.0	1377.3	7.2	5.4	-74.0	2,755.9	204
2024 . .	1,293.0	1,173.4	[g]	58.6	61.0	1,500.7	1487.2	7.3	6.1	-207.7	2,548.2	184
2025 . .	1,353.3	1,235.4	[g]	62.9	55.1	1,599.6	1585.9	7.5	6.3	-246.3	2,301.9	159
2026 . .	1,410.2	1,282.6	.2	77.6	49.8	1,688.7	1674.5	7.7	6.5	-278.4	2,023.5	136
2027 . .	1,455.2	1,327.4	[g]	83.6	44.2	1,778.0	1763.5	8.0	6.5	-322.8	1,700.7	114
2028 . .	1,493.6	1,367.4	[g]	89.7	36.5	1,869.5	1,854.7	8.2	6.6	-375.9	1,324.8	91
2029 . .	1,528.5	1,404.6	[g]	96.3	27.6	1,962.0	1,946.9	8.4	6.7	-433.6	891.3	68
2030 . .	1,561.1	1,439.7	[g]	103.8	17.6	2,055.8	2,040.3	8.6	6.8	-494.7	396.5	43
2031 . .	[h]	1,475.6	[g]	111.6	[h]	2,151.0	2,135.3	8.9	6.9	[h]	[h]	18
2032 . .	[h]	1,508.7	[g]	120.0	[h]	2,246.9	2,230.8	9.1	7.0	[h]	[h]	[h]

[a] The OASDI Trust Fund reserves become depleted in the fourth quarter of 2031 under the high-cost assumptions. For any period during which reserves would be depleted, scheduled benefits could not be paid in full on a timely basis, income from taxing benefits would be less than would apply to scheduled benefits, and interest on trust fund reserves would be negligible. Appendix A presents a detailed description of the components of income and cost, along with complete historical values.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years occur periodically whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Represents reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year. The trust fund ratio at the beginning of 2033 is projected to be 25 percent for the intermediate, and 100 percent for the low-cost assumptions.

[d] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $35.5 billion was made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[e] Includes reimbursements from the General Fund of the Treasury to the OASI and DI Trust Funds for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; and (2) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. Also includes transfers of a portion of proceeds from repayments of loans authorized under Public Law 116-136.

[f] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

[g] Between -$50 million and $50 million.

[h] When the fund reserves are depleted, values under current law would reflect permissible expenditures only, which would be less than the full cost of paying scheduled benefits shown in this table.

Note: Components may not sum to totals because of rounding.

4. Factors Underlying Changes in 10-Year Trust Fund Ratio Estimates From Last Year's Report

Table IV.A4 presents an analysis of the factors underlying the changes in the intermediate estimates over the short-range projection period for the OASI, DI, and the combined funds from last year's report to this report.

In the 2022 report under the intermediate assumptions, the trust fund ratio for OASI reached 66 percent at the beginning of 2031—the tenth projection year for that report. The change in the short-range valuation period alone, from 2022 through 2031 to 2023 through 2032, lowered the estimated trust fund ratio for the tenth year by 20 percentage points, to 46 percent. All other changes to reflect modifications in law and regulations since last year's report, the most recent data, adjustments to the assumptions for future years, and changes in projection methods combined for a net decrease in the ratio for the tenth projection year of 18 percentage points. Therefore, the total change in the tenth year projected trust fund ratio from last year's report to this year's report is a reduction of 38 percentage points to 28 percent.

Legislative and regulatory changes since the 2022 report was published did not have a significant effect on the projected tenth year OASI trust fund ratio. Changes in demographic assumptions over the short-range period increased the projected tenth year trust fund ratio for OASI by 4 percentage points. Several changes in economic data and assumptions combined to cause a net reduction in the OASI trust fund ratio of 21 percentage points by the beginning of 2032. The large decrease due to economic factors is primarily due to the Trustees revising down the levels of GDP and labor productivity over the projection period. The reduced level of productivity reduces the projected growth in average earnings relative to the CPI. As a result, higher assumed growth in CPI and average benefits in the short-range period is not matched with comparable increases in average earnings underlying payroll tax collections. Incorporating recent programmatic data and assumptions, including actual average benefits and beneficiary counts for 2022, resulted in a decrease of 1 percentage point in the tenth year OASI trust fund ratio. Finally, the tenth year trust fund ratio was not affected significantly by changes in the short-range methodology for this report.

Table IV.A4 also shows corresponding estimates of the factors underlying the changes in the financial projections for the DI Trust Fund and for the combined OASI and DI Trust Funds. The 35-percentage-point increase in the DI trust fund ratio from the beginning of 2031 in last year's report to the beginning of 2032 in this year's report is the net effect of increases and decreases from the factors described above for the OASI Trust Fund, combined with other changes that are significant for DI but not OASI. The large increase of 33 points due to programmatic data and assumptions reflects

lower recent disabled-worker application and incidence rates, and a more gradual return of initial disability application rates to their ultimate levels from recent lows.

Table IV.A4.—Reasons for Change in Trust Fund (Unfunded Obligation) Ratios at the Beginning of the Tenth Year of Projection Under Intermediate Assumptions
[In percent]

Item	OASI Trust Fund	DI Trust Fund	OASI and DI Trust Funds, combined
Trust fund ratio shown in last year's report for calendar year 2031	66	145	74
Change in trust fund ratio due to changes in:			
Legislation and regulations	[a]	[a]	[a]
Valuation period	-20	12	-17
Demographic data and assumptions	4	[a]	4
Economic data and assumptions	-21	-8	-20
Programmatic data and assumptions	-1	33	2
Projection methods and data	[a]	-2	[a]
Total change in trust fund ratio	-38	35	-31
Trust fund ratio shown in this report for calendar year 2032	28	180	43

[a] Between -0.5 and 0.5 percent.

Note: Components may not sum to totals because of rounding.

B. LONG-RANGE ESTIMATES

The Trustees use three types of financial measures to assess the actuarial status of the Social Security trust funds under the financing approach specified in current law: (1) annual cash-flow measures, including income rates, cost rates, and balances; (2) trust fund ratios; and (3) summary measures such as actuarial balances and unfunded obligations.

The difference between the annual income rate and annual cost rate, both expressed as percentages of taxable payroll, is the annual balance. The level and trend of the annual balances at the end of the 75-year projection period are factors used to assess the actuarial status of the program.

The trust fund ratio for a year is the proportion of the year's projected cost that could be paid with fund reserves available at the beginning of the year. Critical factors considered in assessing actuarial status include: (1) the year of depletion of the fund reserves and the percent of scheduled benefits that is still payable after reserves are depleted, (2) the stability of the trust fund ratio at the end of the long-range period, and (3) the level and year of maximum trust fund ratio.

Solvency at any point in time requires that sufficient financial resources are available to pay all scheduled benefits at that time. Solvency is generally indicated by a positive trust fund ratio. "Sustainable solvency" for the financing of the program under a specified set of assumptions is achieved when the projected trust fund ratio is positive throughout the 75-year projection period and is either stable or rising at the end of the period.

Total income and cost are summarized over valuation periods that extend through 75 years and over the infinite horizon.[1] This section presents several summarized measures, including the actuarial balance and the open- group unfunded obligation. The actuarial balance indicates the size of any surplus or shortfall as a percentage of taxable payroll over the period. The open-group unfunded obligation indicates the size of any shortfall in present-value dollars.

This section also includes additional information that is used to assess the actuarial status of the Social Security program, including: (1) a comparison of the number of beneficiaries to the number of covered workers, (2) the test of long-range close actuarial balance, and (3) the reasons for the change in the actuarial balance from the last report.

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[1] See appendix F.

1. Annual Income Rates, Cost Rates, and Balances

The concepts of income rate and cost rate, expressed as percentages of taxable payroll, are important in the consideration of the long-range actuarial status of the trust funds. The annual income rate is the ratio of all non-interest income to the OASDI taxable payroll for the year. Non-interest income includes payroll taxes, taxes on scheduled benefits, and any General Fund transfers or reimbursements. The OASDI taxable payroll consists of the total earnings subject to OASDI taxes with some relatively small adjustments.[1] The annual cost rate is the ratio of the cost of the program to the taxable payroll for the year. The cost includes scheduled benefits, administrative expenses, net interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. For any year, the annual income rate minus the annual cost rate is the annual "balance" for the year.

Table IV.B1 presents a comparison of the estimated annual income rates and cost rates by trust fund and alternative. Table IV.B2 shows the separate components of the annual income rates.

Under the intermediate assumptions, the OASI income rate will increase from 10.95 percent of payroll for 2022 to 11.42 percent of payroll for 2023 and then decrease to 11.08 percent of payroll for 2024. The income rate for 2023 is relatively high because of an estimated large positive adjustment to payroll tax contributions to be made in June 2023. This adjustment is unusually large because payroll tax revenue credited to the trust fund in 2022 was based on estimates that did not anticipate the stronger-than-expected recovery from the pandemic-induced recession. The OASI income rate then generally gradually rises thereafter, reaching 11.57 percent of taxable payroll for 2097. Income from taxation of benefits causes this gradual increase in the OASI income rate for two main reasons: (1) total scheduled benefits are rising faster than payroll; and (2) the ratio of total income tax on benefits to total benefits increases over time for reasons discussed in detail on page 153.

The OASI cost rate rises rapidly from 2022 to about 2040. During this period, the retirement of the baby-boom generation will increase the number of beneficiaries much faster than the number of workers increases, as subsequent lower-birth-rate generations continue to replace the baby-boom generation at working ages. From 2040 to 2046, the cost rate declines because the aging baby-boom generation is gradually replaced at retirement ages by the

[1] Adjustments include adding deemed wage credits based on military service for 1983-2001 and reflecting the lower effective tax rates (as compared to the combined employee-employer rate) that apply to multiple-employer "excess wages." Lower rates also applied to net earnings from self-employment before 1984 and to income from tips before 1988.

lower-birth-rate generations that followed. The OASI cost rate then rises from 15.01 percent for 2046 to 16.65 percent for 2078, largely because of the period of reduced birth rates starting with the recession of 2007-09, and then generally declines to 15.82 percent for 2097.

Projections of income rates under the low-cost and high-cost sets of assumptions are similar to those projected for the intermediate assumptions, because income rates are largely a reflection of the payroll tax rates specified in the law, with the changes from taxation of benefits noted above. In contrast, OASI cost rates for the low-cost and high-cost assumptions are significantly different from those projected for the intermediate assumptions. For the low-cost assumptions, the OASI cost rate generally declines from 12.77 percent for 2023 to 12.03 percent for 2053, rises to 12.33 percent for 2070, and then generally declines to 11.06 percent for 2097, at which point the income rate reaches 11.27 percent. For the high-cost assumptions, the OASI cost rate rises from 13.26 percent for 2023 to 24.89 percent for 2088 and then declines gradually to 24.73 percent for 2097, at which point the income rate reaches 12.13 percent.

The pattern of the projected OASI annual balance is important in the analysis of the actuarial status of the program. Under the intermediate assumptions, the annual balance is negative throughout the projection period. The annual deficit increases from 1.15 percent of taxable payroll for 2022 to 1.50 percent for 2023 and to 2.17 percent for 2024. After 2024, the annual deficit continues to rise to 3.59 percent for 2040. It then declines to 3.53 percent of payroll for 2046, rises to 5.03 percent for 2078, and generally declines thereafter, reaching 4.25 percent of taxable payroll for 2097.

Under the low-cost assumptions, the OASI annual deficit increases from 1.41 percent of payroll for 2023 to 1.66 percent for 2024, and then generally declines to 0.72 percent of payroll for 2053. After 2053, the annual deficit rises to 0.99 percent for 2070. After 2070, the OASI annual balance generally improves, turning positive in 2089, and reaching 0.21 percent of payroll for 2097. Under the high-cost assumptions, the OASI annual deficit rises from 1.72 percent for 2023 to 12.76 percent for 2088, and then declines relatively modestly to 12.60 percent for 2097.

Table IV.B1.—Annual Income Rates, Cost Rates, and Balances, Calendar Years 1990-2100
[As a percentage of taxable payroll]

Calendar year	OASI			DI			OASDI		
	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]
Historical data:									
1990.....	11.47	9.65	1.82	1.18	1.09	0.10	12.65	10.74	1.91
1995.....	10.65	10.23	.42	1.87	1.44	.43	12.52	11.67	.85
2000.....	10.85	8.98	1.87	1.78	1.42	.36	12.62	10.40	2.23
2005.....	10.96	9.31	1.65	1.84	1.85	-.02	12.80	11.16	1.63
2010.....	10.75	11.06	-.30	1.79	2.41	-.62	12.54	13.47	-.92
2015.....	11.02	11.64	-.62	1.81	2.27	-.47	12.82	13.91	-1.09
2016.....	10.70	11.69	-.99	2.39	2.20	.19	13.09	13.89	-.80
2017.....	10.63	11.56	-.92	2.42	2.09	.33	13.06	13.64	-.59
2018.....	10.27	11.68	-1.41	2.32	2.01	.31	12.59	13.68	-1.10
2019.....	10.97	11.90	-.93	1.84	1.93	-.09	12.81	13.83	-1.02
2020.....	11.60	12.45	-.85	1.91	1.90	.01	13.51	14.35	-.85
2021.....	10.52	12.05	-1.52	1.72	1.71	[c]	12.24	13.76	-1.52
2022.....	10.95	12.10	-1.15	1.79	1.62	.17	12.74	13.72	-.98
Intermediate:									
2023.....	11.42	12.93	-1.50	1.86	1.60	.26	13.29	14.53	-1.24
2024.....	11.08	13.25	-2.17	1.80	1.61	.19	12.89	14.87	-1.98
2025.....	11.16	13.41	-2.25	1.82	1.64	.18	12.97	15.04	-2.07
2026.....	11.26	13.58	-2.32	1.82	1.65	.16	13.08	15.23	-2.15
2027.....	11.28	13.73	-2.45	1.82	1.65	.16	13.09	15.38	-2.29
2028.....	11.31	13.92	-2.61	1.82	1.63	.19	13.13	15.55	-2.42
2029.....	11.34	14.11	-2.76	1.82	1.61	.21	13.16	15.72	-2.56
2030.....	11.37	14.28	-2.91	1.82	1.60	.22	13.18	15.87	-2.69
2031.....	11.39	14.42	-3.02	1.82	1.59	.23	13.21	16.00	-2.79
2032.....	11.42	14.56	-3.14	1.82	1.59	.23	13.24	16.14	-2.91
2035.....	11.45	14.85	-3.40	1.82	1.63	.19	13.27	16.48	-3.21
2040.....	11.47	15.06	-3.59	1.82	1.72	.10	13.30	16.78	-3.48
2045.....	11.48	15.01	-3.53	1.83	1.85	-.02	13.31	16.86	-3.55
2050.....	11.49	15.06	-3.57	1.83	1.92	-.09	13.32	16.99	-3.67
2055.....	11.51	15.27	-3.76	1.83	1.96	-.13	13.34	17.23	-3.89
2060.....	11.54	15.69	-4.14	1.83	1.93	-.10	13.37	17.62	-4.24
2065.....	11.57	16.03	-4.46	1.83	1.91	-.08	13.40	17.95	-4.54
2070.....	11.59	16.33	-4.74	1.83	1.90	-.07	13.42	18.23	-4.81
2075.....	11.61	16.59	-4.98	1.83	1.87	-.04	13.44	18.46	-5.02
2080.....	11.61	16.62	-5.00	1.83	1.85	-.02	13.45	18.47	-5.02
2085.....	11.60	16.38	-4.78	1.83	1.85	-.01	13.43	18.23	-4.79
2090.....	11.58	16.01	-4.43	1.83	1.89	-.05	13.41	17.89	-4.48
2095.....	11.57	15.82	-4.25	1.83	1.92	-.09	13.40	17.74	-4.34
2100.....	11.58	15.89	-4.31	1.84	1.94	-.10	13.41	17.83	-4.42
First year balance becomes negative and remains negative throughout the 75-year projection period.....			2010	.....		2044	.....		2010

Table IV.B1.—Annual Income Rates, Cost Rates, and Balances, Calendar Years 1990-2100 (Cont.)
[As a percentage of taxable payroll]

Calendar year	OASI			DI			OASDI		
	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]
Low-cost:									
2023	11.36	12.77	-1.41	1.85	1.57	0.28	13.22	14.34	-1.12
2024	11.09	12.75	-1.66	1.81	1.52	.29	12.90	14.27	-1.38
2025	11.12	12.67	-1.54	1.81	1.49	.32	12.93	14.15	-1.22
2026	11.21	12.64	-1.43	1.81	1.46	.35	13.02	14.11	-1.08
2027	11.21	12.63	-1.42	1.81	1.42	.39	13.03	14.05	-1.03
2028	11.24	12.66	-1.42	1.81	1.36	.45	13.05	14.02	-.97
2029	11.26	12.69	-1.43	1.81	1.31	.50	13.07	14.00	-.93
2030	11.27	12.70	-1.43	1.81	1.27	.55	13.09	13.97	-.88
2031	11.29	12.69	-1.40	1.81	1.23	.58	13.10	13.93	-.82
2032	11.30	12.69	-1.39	1.81	1.21	.60	13.11	13.90	-.78
2035	11.32	12.71	-1.39	1.81	1.20	.62	13.13	13.90	-.77
2040	11.32	12.58	-1.26	1.82	1.22	.59	13.14	13.80	-.66
2045	11.31	12.27	-.96	1.82	1.29	.53	13.13	13.56	-.43
2050	11.31	12.08	-.77	1.82	1.32	.50	13.13	13.39	-.27
2055	11.31	12.05	-.74	1.82	1.32	.50	13.13	13.38	-.25
2060	11.33	12.22	-.89	1.82	1.29	.53	13.15	13.51	-.36
2065	11.34	12.31	-.97	1.82	1.27	.55	13.16	13.58	-.42
2070	11.34	12.33	-.99	1.82	1.26	.56	13.16	13.58	-.42
2075	11.34	12.30	-.96	1.82	1.23	.59	13.16	13.53	-.37
2080	11.33	12.05	-.73	1.82	1.22	.60	13.14	13.27	-.12
2085	11.30	11.61	-.31	1.82	1.22	.60	13.12	12.83	.29
2090	11.27	11.15	.12	1.82	1.26	.56	13.09	12.41	.68
2095	11.26	11.02	.24	1.82	1.29	.54	13.08	12.30	.78
2100	11.27	11.17	.11	1.82	1.29	.53	13.09	12.45	.64
First year balance becomes negative and remains negative throughout the 75-year projection period			[d]			[e]			[d]
High-cost:									
2023	11.54	13.26	-1.72	1.88	1.65	.22	13.41	14.91	-1.49
2024	11.03	13.88	-2.86	1.79	1.73	.06	12.82	15.61	-2.79
2025	11.20	14.24	-3.04	1.82	1.80	.02	13.02	16.04	-3.02
2026	11.31	14.45	-3.14	1.82	1.85	-.03	13.13	16.30	-3.17
2027	11.33	14.69	-3.36	1.82	1.88	-.06	13.15	16.58	-3.42
2028	11.38	15.04	-3.66	1.82	1.90	-.07	13.20	16.94	-3.74
2029	11.42	15.40	-3.98	1.83	1.91	-.08	13.24	17.31	-4.07
2030	11.45	15.76	-4.31	1.83	1.93	-.10	13.28	17.69	-4.41
2031	11.50	16.10	-4.60	1.83	1.96	-.13	13.32	18.05	-4.73
2032	11.53	16.44	-4.91	1.83	1.99	-.16	13.36	18.43	-5.07

Table IV.B1.—Annual Income Rates, Cost Rates, and Balances, Calendar Years 1990-2100 (Cont.)
[As a percentage of taxable payroll]

Calendar year	OASI			DI			OASDI		
	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]
High-cost (Cont.):									
2035	11.58	17.12	-5.54	1.83	2.12	-0.29	13.41	19.24	-5.83
2040	11.64	17.93	-6.29	1.83	2.31	-.47	13.48	20.24	-6.76
2045	11.68	18.47	-6.78	1.84	2.53	-.69	13.52	21.00	-7.48
2050	11.73	19.12	-7.39	1.84	2.69	-.84	13.58	21.81	-8.23
2055	11.79	19.90	-8.11	1.85	2.79	-.95	13.63	22.69	-9.06
2060	11.85	20.88	-9.03	1.85	2.79	-.95	13.70	23.68	-9.98
2065	11.92	21.80	-9.88	1.85	2.80	-.95	13.77	24.60	-10.83
2070	11.98	22.71	-10.73	1.85	2.81	-.96	13.83	25.52	-11.69
2075	12.04	23.66	-11.61	1.85	2.77	-.92	13.89	26.43	-12.53
2080	12.09	24.39	-12.30	1.85	2.73	-.88	13.94	27.12	-13.18
2085	12.12	24.81	-12.69	1.85	2.69	-.84	13.97	27.51	-13.53
2090	12.13	24.87	-12.74	1.85	2.69	-.84	13.98	27.56	-13.58
2095	12.13	24.76	-12.63	1.85	2.74	-.89	13.98	27.50	-13.52
2100	12.13	24.74	-12.61	1.85	2.77	-.92	13.98	27.51	-13.53
First year balance becomes negative and remains negative throughout the 75-year projection period			2010			2026			2010

[a] Income rates include certain reimbursements from the General Fund of the Treasury.

[b] Benefit payments scheduled to be paid on January 3 are actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[c] Between 0 and 0.005 percent of taxable payroll.

[d] The annual balance is projected to be negative for a temporary period and then become positive before the end of the projection period.

[e] The annual balance is projected to be positive throughout the entire 75-year projection period.

Notes:
1. The income rate excludes interest income.
2. Revisions of taxable payroll may change some historical values.
3. Components may not sum to totals because of rounding.

Under the intermediate assumptions, the projected DI cost rate is 1.60 percent for 2023. After 2023, the cost rate fluctuates, reaching 1.59 percent for 2031. Then the DI cost rate increases gradually to 1.96 percent for 2055. Thereafter, the cost rate remains relatively stable, decreasing slowly to 1.84 percent for 2083, and then increasing to 1.93 percent for 2097. The DI income rate increases from 1.79 percent for 2022 to 1.86 percent for 2023, decreases to 1.80 percent for 2024, and is relatively stable thereafter, reaching 1.83 percent for 2097. The annual balance increases from 0.17 percent of payroll for 2022 to 0.26 percent for 2023, decreases to 0.16 percent for 2026 and then increases to 0.23 percent for 2031. After 2031, the annual balance declines and becomes negative for 2044. After 2044, the annual deficit increases to 0.13 percent for 2055, decreases to 0.01 percent for 2083, and then increases to 0.10 percent of payroll for 2097.

Under the low-cost assumptions, the projected DI cost rate declines from 1.57 percent of payroll for 2023 to 1.20 percent for 2035 and then increases to 1.32 percent for 2054. The cost rate then declines through 2082 and increases slowly thereafter, reaching 1.29 percent for 2097. The annual balance is positive throughout the long-range period, reaching 0.53 percent of payroll for 2097. Under the high-cost assumptions, the DI cost rate rises from 1.65 percent of payroll for 2023 to 2.80 percent for 2057 and fluctuates thereafter, reaching 2.75 percent for 2097. The DI annual balance declines from 0.22 percent of payroll for 2023 and becomes negative for 2026, with a 0.03 percent annual deficit for 2026. After 2026, annual deficits increase to 0.96 percent of payroll for 2057 and fluctuate thereafter, reaching 0.90 percent for 2097.

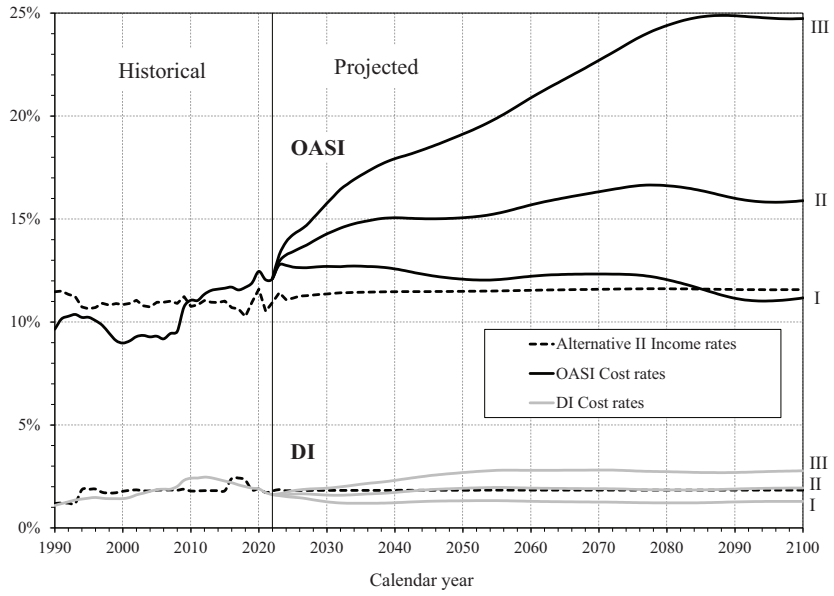
Figure IV.B1 shows the patterns of the historical and projected OASI and DI annual cost rates. The patterns in projected OASI and DI cost rates are described earlier in this chapter. Historical annual OASI cost rates shifted upward starting in 2008 and have remained at relatively high levels since then, primarily due to the changing age distribution of the adult population with the retirement of the baby-boom generation and entry of lower birth-rate generations into working ages. Historical annual DI cost rates rose substantially between 1990 and 2010 in large part due to: (1) aging of the working population as the baby-boom generation moved from ages 25-44 in 1990, where disability prevalence is low, to ages 45-64 in 2010, where disability prevalence is much higher; (2) a substantial increase in the percentage of women insured for DI benefits as a result of increased and more consistent rates of employment; and (3) increased disability incidence rates for women to a level similar to those for men by 2010. As of 2010, these three factors have largely stabilized. Other factors that are not yet fully understood, including the changing nature of work, have caused age-sex-adjusted incidence rates and cost rates to decline from 2010 to 2022. Figure IV.B1 shows only the income rates for alternative II because the variation in income rates by alternative is very small. Income rates generally increase slowly for each of the alternatives over the long-range period. Taxation of benefits, which is a small portion of income, is the main source of the increases in the income rate and the variation among the alternatives.

Table IV.B1 shows the annual balances for OASI, DI, and OASDI. The pattern of the annual balances is important to the analysis of the actuarial status of the Social Security program as a whole. As seen in figure IV.B1, the magnitude of each of the positive annual balances is the distance between the appropriate cost-rate curve and the income-rate curve above it. The magnitude of each of the annual deficits is the distance between the appropriate cost-rate curve and the income-rate curve below it. Annual balances follow closely the pattern of annual cost rates after 1990 because the payroll tax rate

for the OASDI program has not changed and will not under current law, with only small variations in the allocation between DI and OASI except for changes due to the 1994 and the 2016-18 payroll tax rate reallocations.

In the future, the costs of OASI, DI, and the combined OASDI programs as a percentage of taxable payroll are unlikely to fall outside the range encompassed by alternatives I and III because alternatives I and III define a wide range of demographic, economic, and program-specific conditions.

Figure IV.B1.—Long-Range OASI and DI Annual Income Rates and Cost Rates
[As a percentage of taxable payroll]



Long-range OASDI cost and income are most often expressed as percentages of taxable payroll. However, cost and income are also presented as shares of gross domestic product (GDP), the value of goods and services produced during the year in the United States. Under alternative II, the OASDI cost increases from about 5.2 percent of GDP for 2023 to about 6.0 percent for 2040. After 2040, OASDI cost as a percentage of GDP declines slightly through 2048, increases to a peak of 6.3 percent for 2076, and thereafter decreases slowly, reaching about 6.0 percent by 2097. Appendix G presents full estimates of income and cost relative to GDP.

Table IV.B2 contains historical and projected annual income rates and their components by trust fund and alternative. The annual income rates consist of

the scheduled payroll tax rates, the rates of income from taxation of scheduled benefits, and the rates of income from General Fund reimbursements. Projected income from taxation of benefits increases over time for reasons discussed on page 153.

Table IV.B2.—Components of Annual Income Rates, Calendar Years 1990-2100
[As a percentage of taxable payroll]

	OASI				DI				OASDI			
Calendar year	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]
Historical data:												
1990 . .	11.29	0.21	-0.03	11.47	1.21	0.01	-0.03	1.18	12.50	0.21	-0.06	12.65
1995 . .	10.46	.19	-.01	10.65	1.87	.01	-.01	1.87	12.33	.20	-.01	12.52
2000 . .	10.56	.29	[d]	10.85	1.78	.02	-.02	1.78	12.34	.31	-.02	12.62
2005 . .	10.68	.29	-.01	10.96	1.81	.02	[d]	1.84	12.49	.31	-.01	12.80
2010 . .	10.30	.42	.04	10.75	1.75	.04	.01	1.79	12.05	.45	.05	12.54
2015 . .	10.54	.47	[d]	11.02	1.79	.02	[d]	1.81	12.33	.49	.01	12.82
2016 . .	10.22	.48	[d]	10.70	2.37	.02	[d]	2.39	12.59	.49	[d]	13.09
2017 . .	10.12	.51	[d]	10.63	2.39	.03	[d]	2.42	12.51	.54	[d]	13.06
2018 . .	9.79	.47	[d]	10.27	2.31	.01	[d]	2.32	12.11	.48	[d]	12.59
2019 . .	10.51	.46	[d]	10.97	1.82	.02	[d]	1.84	12.33	.48	[d]	12.81
2020 . .	11.09	.51	[d]	11.60	1.88	.02	[d]	1.91	12.98	.53	[d]	13.51
2021 . .	10.08	.45	[d]	10.52	1.71	.01	[d]	1.72	11.79	.45	[d]	12.24
2022 . .	10.43	.52	[d]	10.95	1.77	.02	[d]	1.79	12.20	.54	[d]	12.74
Intermediate:												
2023 . .	10.89	.54	[d]	11.42	1.85	.01	[d]	1.86	12.74	.55	[d]	13.29
2024 . .	10.52	.56	[d]	11.08	1.79	.02	[d]	1.80	12.30	.58	[d]	12.89
2025 . .	10.58	.58	[d]	11.16	1.80	.02	[d]	1.82	12.38	.59	[d]	12.97
2026 . .	10.58	.68	[d]	11.26	1.80	.02	[d]	1.82	12.38	.70	[d]	13.08
2027 . .	10.57	.70	[d]	11.28	1.80	.02	[d]	1.82	12.37	.73	[d]	13.09
2028 . .	10.58	.73	[d]	11.31	1.80	.02	[d]	1.82	12.38	.75	[d]	13.13
2029 . .	10.59	.75	[d]	11.34	1.80	.02	[d]	1.82	12.38	.78	[d]	13.16
2030 . .	10.58	.78	[d]	11.37	1.80	.02	[d]	1.82	12.38	.81	[d]	13.18
2031 . .	10.58	.81	[d]	11.39	1.80	.02	[d]	1.82	12.38	.84	[d]	13.21
2032 . .	10.57	.84	[d]	11.42	1.80	.02	[d]	1.82	12.37	.87	[d]	13.24
2035 . .	10.57	.87	[d]	11.45	1.80	.03	[d]	1.82	12.37	.90	[d]	13.27
2040 . .	10.57	.90	[d]	11.47	1.80	.03	[d]	1.82	12.37	.93	[d]	13.30
2045 . .	10.57	.91	[d]	11.48	1.80	.03	[d]	1.83	12.37	.94	[d]	13.31
2050 . .	10.57	.92	[d]	11.49	1.80	.03	[d]	1.83	12.37	.95	[d]	13.32
2055 . .	10.57	.94	[d]	11.51	1.80	.04	[d]	1.83	12.37	.97	[d]	13.34
2060 . .	10.57	.97	[d]	11.54	1.80	.04	[d]	1.83	12.37	1.01	[d]	13.37
2065 . .	10.57	.99	[d]	11.57	1.80	.04	[d]	1.83	12.37	1.03	[d]	13.40
2070 . .	10.57	1.02	[d]	11.59	1.80	.04	[d]	1.83	12.37	1.05	[d]	13.42
2075 . .	10.57	1.04	[d]	11.61	1.80	.04	[d]	1.83	12.37	1.07	[d]	13.44
2080 . .	10.57	1.04	[d]	11.61	1.80	.04	[d]	1.83	12.37	1.08	[d]	13.45
2085 . .	10.57	1.03	[d]	11.60	1.80	.04	[d]	1.83	12.37	1.07	[d]	13.43
2090 . .	10.57	1.01	[d]	11.58	1.80	.04	[d]	1.83	12.37	1.05	[d]	13.41
2095 . .	10.57	1.00	[d]	11.57	1.80	.04	[d]	1.83	12.37	1.04	[d]	13.40
2100 . .	10.57	1.00	[d]	11.58	1.80	.04	[d]	1.84	12.37	1.04	[d]	13.41
Low-cost:												
2023 . .	10.83	.53	[d]	11.36	1.84	.01	[d]	1.85	12.67	.54	[d]	13.22
2024 . .	10.55	.54	[d]	11.09	1.79	.02	[d]	1.81	12.34	.56	[d]	12.90
2025 . .	10.58	.54	[d]	11.12	1.80	.02	[d]	1.81	12.37	.56	[d]	12.93
2026 . .	10.57	.63	[d]	11.21	1.80	.02	[d]	1.81	12.37	.65	[d]	13.02
2027 . .	10.57	.65	[d]	11.21	1.79	.02	[d]	1.81	12.36	.67	[d]	13.03

Table IV.B2.—Components of Annual Income Rates, Calendar Years 1990-2100 (Cont.)
[As a percentage of taxable payroll]

Calendar year	OASI				DI				OASDI			
	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]
Low-cost (Cont.):												
2028 . .	10.58	0.66	[d]	11.24	1.80	0.02	[d]	1.81	12.37	0.68	[d]	13.05
2029 . .	10.58	.68	[d]	11.26	1.80	.02	[d]	1.81	12.38	.70	[d]	13.07
2030 . .	10.57	.70	[d]	11.27	1.80	.02	[d]	1.81	12.37	.72	[d]	13.09
2031 . .	10.57	.72	[d]	11.29	1.80	.02	[d]	1.81	12.37	.73	[d]	13.10
2032 . .	10.57	.74	[d]	11.30	1.79	.02	[d]	1.81	12.36	.75	[d]	13.11
2035 . .	10.57	.75	[d]	11.32	1.79	.02	[d]	1.81	12.36	.77	[d]	13.13
2040 . .	10.57	.76	[d]	11.32	1.79	.02	[d]	1.82	12.36	.78	[d]	13.14
2045 . .	10.57	.75	[d]	11.31	1.79	.02	[d]	1.82	12.36	.77	[d]	13.13
2050 . .	10.57	.74	[d]	11.31	1.79	.02	[d]	1.82	12.36	.77	[d]	13.13
2055 . .	10.57	.75	[d]	11.31	1.79	.03	[d]	1.82	12.36	.77	[d]	13.13
2060 . .	10.57	.76	[d]	11.33	1.79	.03	[d]	1.82	12.36	.79	[d]	13.15
2065 . .	10.57	.77	[d]	11.34	1.79	.03	[d]	1.82	12.36	.79	[d]	13.16
2070 . .	10.57	.77	[d]	11.34	1.79	.03	[d]	1.82	12.36	.80	[d]	13.16
2075 . .	10.57	.77	[d]	11.34	1.79	.02	[d]	1.82	12.36	.80	[d]	13.16
2080 . .	10.57	.76	[d]	11.33	1.79	.02	[d]	1.82	12.36	.78	[d]	13.14
2085 . .	10.57	.73	[d]	11.30	1.79	.03	[d]	1.82	12.36	.76	[d]	13.12
2090 . .	10.57	.70	[d]	11.27	1.79	.03	[d]	1.82	12.36	.73	[d]	13.09
2095 . .	10.57	.70	[d]	11.26	1.79	.03	[d]	1.82	12.36	.72	[d]	13.08
2100 . .	10.57	.71	[d]	11.27	1.79	.03	[d]	1.82	12.36	.73	[d]	13.09
High-cost:												
2023 . .	10.99	.55	[d]	11.54	1.87	.01	[d]	1.88	12.85	.56	[d]	13.41
2024 . .	10.43	.59	[d]	11.03	1.77	.02	[d]	1.79	12.21	.61	[d]	12.82
2025 . .	10.59	.61	[d]	11.20	1.80	.02	[d]	1.82	12.39	.63	[d]	13.02
2026 . .	10.59	.72	[d]	11.31	1.80	.02	[d]	1.82	12.38	.75	[d]	13.13
2027 . .	10.58	.75	[d]	11.33	1.80	.02	[d]	1.82	12.37	.78	[d]	13.15
2028 . .	10.59	.79	[d]	11.38	1.80	.03	[d]	1.82	12.39	.81	[d]	13.20
2029 . .	10.59	.82	[d]	11.42	1.80	.03	[d]	1.83	12.39	.85	[d]	13.24
2030 . .	10.59	.87	[d]	11.45	1.80	.03	[d]	1.83	12.39	.89	[d]	13.28
2031 . .	10.59	.91	[d]	11.50	1.80	.03	[d]	1.83	12.39	.94	[d]	13.32
2032 . .	10.58	.95	[d]	11.53	1.80	.03	[d]	1.83	12.38	.98	[d]	13.36
2035 . .	10.58	1.00	[d]	11.58	1.80	.03	[d]	1.83	12.37	1.04	[d]	13.41
2040 . .	10.58	1.06	[d]	11.64	1.80	.04	[d]	1.83	12.38	1.10	[d]	13.48
2045 . .	10.58	1.10	[d]	11.68	1.80	.04	[d]	1.84	12.38	1.15	[d]	13.52
2050 . .	10.58	1.15	[d]	11.73	1.80	.05	[d]	1.84	12.38	1.20	[d]	13.58
2055 . .	10.58	1.21	[d]	11.79	1.80	.05	[d]	1.85	12.38	1.26	[d]	13.63
2060 . .	10.58	1.27	[d]	11.85	1.80	.05	[d]	1.85	12.38	1.33	[d]	13.70
2065 . .	10.58	1.34	[d]	11.92	1.80	.05	[d]	1.85	12.38	1.39	[d]	13.77
2070 . .	10.58	1.40	[d]	11.98	1.80	.05	[d]	1.85	12.38	1.45	[d]	13.83
2075 . .	10.58	1.46	[d]	12.04	1.80	.05	[d]	1.85	12.38	1.52	[d]	13.89
2080 . .	10.58	1.51	[d]	12.09	1.80	.05	[d]	1.85	12.38	1.57	[d]	13.94
2085 . .	10.58	1.54	[d]	12.12	1.80	.05	[d]	1.85	12.38	1.60	[d]	13.97
2090 . .	10.58	1.55	[d]	12.13	1.80	.05	[d]	1.85	12.38	1.60	[d]	13.98
2095 . .	10.58	1.55	[d]	12.13	1.80	.05	[d]	1.85	12.38	1.60	[d]	13.98
2100 . .	10.58	1.55	[d]	12.13	1.80	.06	[d]	1.85	12.38	1.60	[d]	13.98

[a] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

[b] Includes payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96, and other miscellaneous reimbursements. Also includes transfers of a portion of the proceeds from repayments of loans authorized under Public Law 116-136.

[c] Values exclude interest income.

[d] Between 0 and 0.005 percent of taxable payroll.

Note: Components may not sum to totals because of rounding.

2. Comparison of Workers to Beneficiaries

Under the intermediate assumptions, the OASDI cost rate will rise rapidly between 2023 and about 2040, primarily because the number of beneficiaries rises much more rapidly than the number of covered workers as the baby-boom generation continues to retire and is replaced at working ages by lower birth-rate generations. The ratio of OASDI beneficiaries to workers is dominated by the OASI program because all workers eventually die or retire, but only a relatively small minority become eligible for benefits under the DI program. The trends described below are primarily due to demographic changes and thus affect the DI program roughly 20 years earlier than the OASI and OASDI programs. The baby-boom generation had lower fertility rates than their parents, and lower fertility rates are expected to persist for all future generations; therefore, the ratio of OASDI beneficiaries to workers will rise rapidly and reach a permanently higher level after all of the baby-boom generation has retired. Due to increasing longevity, the ratio of beneficiaries to workers will generally rise slowly thereafter. Table IV.B3 provides a comparison of the numbers of covered workers and beneficiaries.

Table IV.B3.—Covered Workers and Beneficiaries, Calendar Years 1945-2100

Calendar year	Covered workers[a] (in thousands)	Beneficiaries[b] (in thousands)			Covered workers per OASDI beneficiary	OASDI beneficiaries per 100 covered workers
		OASI	DI	OASDI[c]		
Historical data:						
1945	46,390	1,106	-	1,106	41.9	2
1950	48,280	2,930	-	2,930	16.5	6
1955	65,066	7,564	-	7,564	8.6	12
1960	72,371	13,740	522	14,262	5.1	20
1965	80,539	18,509	1,648	20,157	4.0	25
1970	92,963	22,618	2,568	25,186	3.7	27
1975	100,193	26,998	4,125	31,123	3.2	31
1980	112,651	30,384	4,734	35,117	3.2	31
1985	120,437	32,763	3,874	36,636	3.3	30
1990	133,004	35,255	4,204	39,459	3.4	30
1995	140,797	37,364	5,731	43,096	3.3	31
2000	154,701	38,556	6,606	45,162	3.4	29
2005	159,027	39,961	8,172	48,133	3.3	30
2010	157,047	43,440	9,958	53,398	2.9	34
2015	168,135	48,663	10,881	59,543	2.8	35
2016	170,640	49,811	10,728	60,539	2.8	35
2017	172,710	50,962	10,517	61,480	2.8	36
2018	175,065	52,168	10,296	62,464	2.8	36
2019	176,970	53,508	10,063	63,570	2.8	36
2020	174,938	54,843	9,844	64,686	2.7	37
2021	176,579	55,546	9,486	65,032	2.7	37
2022	180,510	56,544	9,070	65,614	2.8	36
Intermediate:						
2023	180,394	57,815	8,754	66,569	2.7	37
2025	183,051	60,666	8,580	69,247	2.6	38
2030	187,120	67,175	9,132	76,307	2.5	41
2035	189,379	71,544	9,612	81,156	2.3	43
2040	191,158	73,886	10,351	84,237	2.3	44
2045	193,564	74,985	11,320	86,305	2.2	45
2050	196,862	76,607	11,985	88,592	2.2	45

Table IV.B3.—Covered Workers and Beneficiaries, Calendar Years 1945-2100 (Cont.)

Calendar year	Covered workers[a] (in thousands)	Beneficiaries[b] (in thousands) OASI	DI	OASDI[c]	Covered workers per OASDI beneficiary	OASDI beneficiaries per 100 covered workers
Intermediate (Cont.):						
2055	200,653	78,990	12,476	91,467	2.2	46
2060	204,569	82,429	12,585	95,014	2.2	46
2065	208,232	85,673	12,736	98,409	2.1	47
2070	211,659	88,828	12,908	101,736	2.1	48
2075	215,233	91,925	12,957	104,881	2.1	49
2080	219,424	93,951	13,105	107,056	2.0	49
2085	224,505	94,841	13,414	108,254	2.1	48
2090	230,262	95,170	14,024	109,194	2.1	47
2095	236,146	96,466	14,610	111,076	2.1	47
2100	241,705	99,028	15,040	114,068	2.1	47
Low-cost:						
2023	181,468	57,801	8,736	66,537	2.7	37
2025	186,149	60,583	8,396	68,979	2.7	37
2030	191,067	66,824	8,168	74,991	2.5	39
2035	194,307	70,627	8,048	78,675	2.5	40
2040	197,257	72,281	8,362	80,643	2.4	41
2045	201,895	72,718	8,994	81,712	2.5	40
2050	208,227	73,654	9,434	83,088	2.5	40
2055	215,323	75,420	9,783	85,203	2.5	40
2060	222,535	78,298	9,879	88,177	2.5	40
2065	229,494	81,013	10,040	91,053	2.5	40
2070	236,460	83,570	10,260	93,830	2.5	40
2075	244,161	86,018	10,442	96,460	2.5	40
2080	253,253	87,396	10,753	98,149	2.6	39
2085	263,935	87,725	11,258	98,983	2.7	38
2090	275,491	88,000	12,065	100,066	2.8	36
2095	286,865	90,335	12,760	103,095	2.8	36
2100	297,638	94,544	13,281	107,825	2.8	36
High-cost:						
2023	179,078	57,833	8,771	66,604	2.7	37
2025	179,805	60,779	8,776	69,555	2.6	39
2030	183,399	67,668	10,033	77,701	2.4	42
2035	184,679	72,822	11,106	83,929	2.2	45
2040	185,419	76,135	12,220	88,356	2.1	48
2045	185,446	78,281	13,497	91,778	2.0	49
2050	185,380	80,949	14,368	95,316	1.9	51
2055	185,388	84,231	14,982	99,213	1.9	54
2060	185,467	88,444	15,059	103,503	1.8	56
2065	185,215	92,382	15,127	107,508	1.7	58
2070	184,454	96,227	15,128	111,355	1.7	60
2075	183,298	99,984	14,860	114,844	1.6	63
2080	181,986	102,661	14,592	117,252	1.6	64
2085	180,956	104,039	14,354	118,392	1.5	65
2090	180,338	104,117	14,316	118,433	1.5	66
2095	179,997	103,553	14,494	118,046	1.5	66
2100	179,732	103,318	14,624	117,942	1.5	66

[a] Workers who are paid at some time during the year for employment on which OASDI taxes are due.
[b] Beneficiaries with monthly benefits in current-payment status as of June 30.
[c] This column is the sum of OASI and DI beneficiaries. A small number of beneficiaries receive benefits from both funds.

Notes:

1. The number of beneficiaries does not include uninsured individuals who received benefits under section 228 of the Social Security Act. The General Fund of the Treasury reimbursed the trust funds for the costs of most of these individuals.

2. Historical covered worker and beneficiary data are subject to revision.

3. Components may not sum to totals because of rounding.

The effect of the demographic shift under the three alternatives on the OASDI cost rates is clear when one considers the projected number of OASDI beneficiaries per 100 covered workers. Compared to the 2022 level of 36 beneficiaries per 100 covered workers, this ratio is projected to rise to 44 by 2038 under the intermediate assumptions because the growth in beneficiaries greatly exceeds the growth in workers. This projected ratio continues to rise through 2078 and then generally declines, reaching 47 under the intermediate assumptions by 2100. Under the high-cost assumptions, this ratio generally rises to 66 by 2100. Under the low-cost assumptions, this ratio rises to 41 by 2038 and then generally declines, reaching 36 by 2100. Figure IV.B2 shows beneficiaries per 100 covered workers.

For each alternative, the curve in figure IV.B2 is strikingly similar to the corresponding cost-rate curve in figure IV.B1. This similarity emphasizes the extent to which the cost rate is determined by the age distribution of the population. The cost rate is essentially the product of the number of beneficiaries and their average benefit, divided by the product of the number of covered workers and their average taxable earnings. For this reason, the pattern of the annual cost rates is similar to that of the annual ratios of beneficiaries to workers.

Figure IV.B2.—Number of OASDI Beneficiaries Per 100 Covered Workers

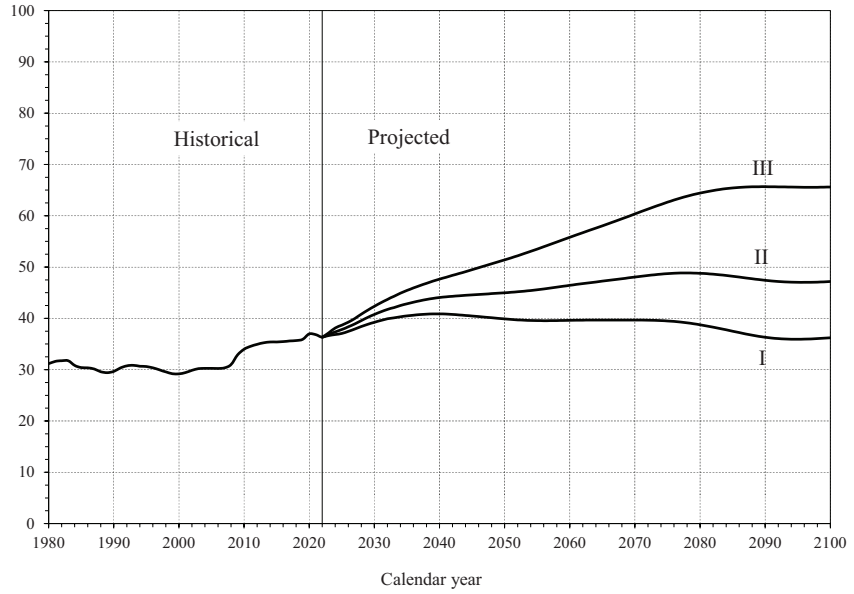


Table IV.B3 also shows the number of covered workers per OASDI beneficiary, which was about 2.8 for 2022. Under the intermediate assumptions,

this ratio declines generally throughout the long-range period, reaching 2.3 for 2038 and 2.1 by 2100. Under the low-cost assumptions, this ratio declines to 2.4 for 2038, then generally rises to 2.8 by 2100. Under the high-cost assumptions, this ratio generally decreases to 1.5 by 2100.

3. Trust Fund Ratios and Test of Long-Range Close Actuarial Balance

Trust fund ratios are critical indicators of the adequacy of the financial resources of the Social Security program. The trust fund ratio for a year is the amount of asset reserves in a fund at the beginning of a year expressed as a percentage of the cost for the year. Under current law, the OASI and DI Trust Funds do not have the authority to borrow other than in the form of advance tax transfers. If reserves held in either trust fund become depleted during a year, and continuing revenue falls short of the cost of scheduled benefits, then full scheduled benefits would not be payable on a timely basis. For this reason, the trust fund ratio is a critical financial measure.

The trust fund ratio serves an additional important purpose in assessing the actuarial status of the program. If the projected trust fund ratio is positive throughout the period and is either level or increasing at the end of the period, then projected adequacy for the long-range period is likely to continue for subsequent reports. Under these conditions, the program has achieved sustainable solvency.

Table IV.B4 shows the projections of trust fund ratios by alternative, without regard to advance tax transfers that would be effected, for the separate and combined OASI and DI Trust Funds. The table also shows the years of trust fund reserve depletion and the percentage of scheduled benefits that would be payable thereafter, by alternative.

Under the intermediate assumptions, the OASI trust fund ratio is projected to decline from 220 percent at the beginning of 2023 until the trust fund reserves become depleted in 2033 (one year earlier than projected in last year's report), at which time 77 percent of scheduled benefits would be payable. The change in reserve depletion year to 2033, compared to 2034 in last year's report, is due primarily to changes in recent economic data and near-term assumptions.

The DI Trust Fund remains solvent throughout the long-range period under the intermediate assumptions, as in last year's report. The DI trust fund ratio increases from 77 percent at the beginning of 2023 to a peak of 267 percent for 2043. After 2043, the DI trust fund ratio generally declines throughout the remainder of the long-range period, reaching 155 percent for 2098.

Under the intermediate assumptions, the trust fund ratio for the combined OASI and DI Trust Funds declines from 204 percent at the beginning of

2023 until the combined fund reserves become depleted in 2034 (one year earlier than projected in last year's report), at which time 80 percent of scheduled benefits would be payable.

Under the low-cost assumptions, the trust fund ratio for the DI program increases from 2023 throughout the projection period, from 78 percent at the beginning of 2023 to the extremely high level of 3,574 percent for 2098. For the OASI program, the trust fund ratio declines steadily, from 220 percent for 2023 until the reserves become depleted in 2039, at which time 89 percent of scheduled benefits would be payable. For the combined OASDI program, the trust fund ratio declines from 204 percent for 2023 until the combined fund reserves become depleted in 2067. However, the trust funds would have sufficient income by the end of 2092 to permit full payment of scheduled benefits thereafter and also to pay in arrears the temporary shortfalls between 2067 and 2092. By 2093, trust fund reserves become positive and the trust fund ratio increases thereafter, to a ratio of 36 percent for 2098. Because the DI trust fund ratio is positive throughout the projection period and increasing at the end of the period, under the low-cost assumptions, only the DI program achieves sustainable solvency.

Under the high-cost assumptions, the OASI trust fund ratio declines from 219 percent for 2023 until reserves become depleted in 2031, at which time 70 percent of scheduled benefits would still be payable. The DI trust fund ratio increases from 77 percent for 2023 to 86 percent for 2024, and then declines until the reserves become depleted in 2036. At that time, 85 percent of scheduled benefits would still be payable. The combined OASI and DI trust fund ratio declines from 204 percent for 2023 until reserves become depleted in 2031, at which time 72 percent of scheduled benefits would still be payable.

Trust fund reserve depletion occurs within the 75-year projection period for the OASI Trust Fund under the low-cost, intermediate, and high-cost assumptions, and for the DI Trust Fund under the high-cost assumptions. It is therefore very likely that lawmakers will need to increase income, reduce program costs, or both, in order to maintain solvency for the OASI Trust Fund. The stochastic projections discussed in appendix E suggest that OASI and combined OASI and DI Trust Fund reserve depletion is highly probable before mid-century.

In the 2022 report, the combined trust fund reserves were projected to become depleted in 2031 and 2035 under the high-cost and intermediate assumptions, respectively, and become temporarily depleted between 2069 and 2088 under the low-cost assumptions.

Table IV.B4.—Trust Fund Ratios, Calendar Years 2023-2100[a]
[In percent]

Calendar year	Intermediate			Low-cost			High-cost		
	OASI	DI	OASDI	OASI	DI	OASDI	OASI	DI	OASDI
2023	220	77	204	220	78	204	219	77	204
2024	199	91	187	200	95	189	196	86	184
2025	176	99	168	180	112	173	169	85	159
2026	154	107	149	162	132	159	143	83	136
2027	133	116	131	146	157	147	118	80	114
2028	112	126	114	131	189	137	93	76	91
2029	91	138	96	117	227	128	67	72	68
2030	70	151	78	104	271	119	40	67	43
2031	49	166	60	92	320	112	13	61	18
2032	28	180	43	80	372	105	[b]	54	[b]
2035	[b]	218	[b]	48	530	89	[b]	23	[b]
2040	[b]	260	[b]	[b]	781	66	[b]	[b]	[b]
2045	[b]	266	[b]	[b]	978	49	[b]	[b]	[b]
2050	[b]	253	[b]	[b]	1,174	39	[b]	[b]	[b]
2055	[b]	230	[b]	[b]	1,378	31	[b]	[b]	[b]
2060	[b]	211	[b]	[b]	1,635	22	[b]	[b]	[b]
2065	[b]	198	[b]	[b]	1,908	9	[b]	[b]	[b]
2070	[b]	187	[b]	[b]	2,190	[b]	[b]	[b]	[b]
2075	[b]	181	[b]	[b]	2,510	[b]	[b]	[b]	[b]
2080	[b]	184	[b]	[b]	2,822	[b]	[b]	[b]	[b]
2085	[b]	187	[b]	[b]	3,083	[b]	[b]	[b]	[b]
2090	[b]	182	[b]	[b]	3,242	[b]	[b]	[b]	[b]
2095	[b]	166	[b]	[b]	3,430	17	[b]	[b]	[b]
2100	[b]	146	[b]	[b]	3,680	47	[b]	[b]	[b]
Trust fund reserves permanently become depleted in	2033	[c]	2034	2039	[c]	[d]	2031	2036	2031
Payable benefits as percent of scheduled benefits:									
At the time of permanent reserve depletion	77	[c]	80	89	[c]	[d]	70	85	72
For 2097	71	[c]	74	100	[c]	[d]	46	67	48

[a] Benefit payments scheduled to be paid on January 3 are actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund ratios reflect the 12 months of benefits scheduled for payment each year.

[b] Trust fund reserves would be depleted at the beginning of this year.

[c] Trust fund reserves would not be depleted within the projection period.

[d] Trust fund reserves would be depleted for a temporary period, and return to positive levels before the end of the period.

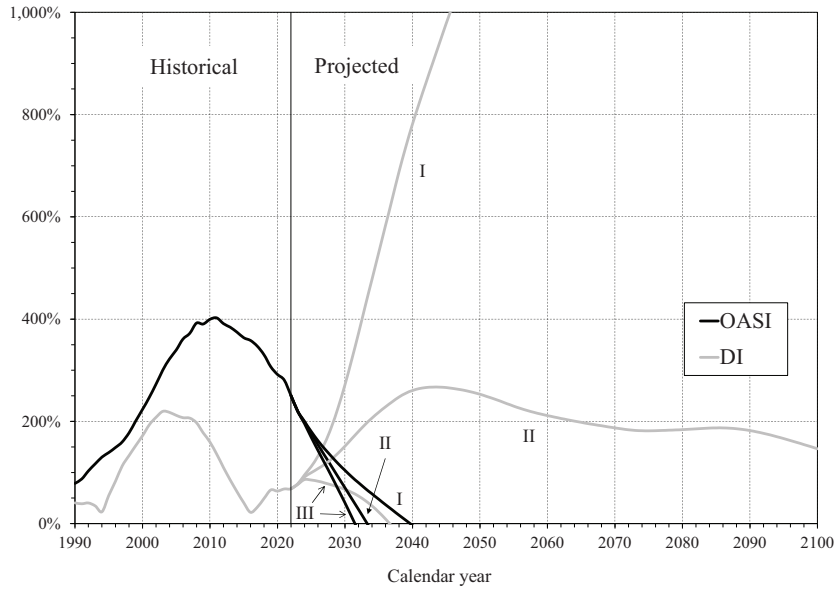
Note: The definition of trust fund ratio appears in the Glossary. The ratios shown for the combined trust funds for years after reserve depletion of either the DI or OASI Trust Fund are hypothetical.

Since 2013, when the Trustees last modified the test of long-range close actuarial balance, the standard for each trust fund requires meeting two conditions: (1) the test of short-range financial adequacy is satisfied; and (2) the trust fund ratios stay above zero throughout the 75-year projection period, allowing scheduled benefits to be paid in a timely manner throughout the period. Both the long-range test and the short-range test are applied based on

the intermediate set of assumptions. As discussed in section IV.A, the DI Trust Fund passes the test of short-range financial adequacy because the trust fund ratio, while below 100 percent at the beginning of the projection period, reaches 100 percent within 5 years and stays above 100 percent throughout the remainder of the 10-year period. The OASI and combined OASI and DI Trust Funds fail the test of short-range financial adequacy because the trust fund ratios drop below 100 percent by the end of the 10-year period. Under the intermediate assumptions, the OASI Trust Fund reserves become depleted in 2033, DI Trust Fund reserves stay positive throughout the 75-year period, and the combined OASI and DI Trust Fund reserves become depleted in 2034. Therefore, the OASI and combined OASI and DI Trust Funds fail the test of long-range close actuarial balance, and the DI program passes the test of long-range close actuarial balance.

Figure IV.B3 illustrates the trust fund ratios for the separate OASI and DI Trust Funds for each of the alternative sets of assumptions. DI Trust Fund status is more uncertain than OASI Trust Fund status because there is a high degree of uncertainty associated with future disability prevalence. A graph of the trust fund ratios for the combined trust funds appears in figure II.D6.

Figure IV.B3.—Long-Range OASI and DI Trust Fund Ratios
[Asset reserves as a percentage of annual cost]



4. Summarized Income Rates, Summarized Cost Rates, and Actuarial Balances

Summarized values for the full 75-year period are useful in analyzing the program's long-range actuarial status over the period as a whole, both under current law and under proposed modifications to the law. All annual amounts included in a summarized value are present-value discounted to the valuation date. It is important to note that the actuarial balance indicates the solvency status of the fund only for the very end of the period.

Table IV.B5 presents summarized income rates, summarized cost rates, and actuarial balances for 25-year, 50-year, and 75-year valuation periods. Summarized income rates are the sum of the present value of non-interest income for a period (which includes scheduled payroll taxes, the projected income from the taxation of scheduled benefits, and reimbursements from the General Fund of the Treasury) and the starting trust fund asset reserves, expressed as a percentage of the present value of taxable payroll over the period. Under current law, the total OASDI payroll tax rate will remain at 12.4 percent in the future. In contrast, income from taxation of benefits, expressed as a percentage of taxable payroll, is expected to increase in most years of the long-range period for the reasons discussed on page 153. Summarized cost rates are the sum of the present value of cost for a period (which includes scheduled benefits, administrative expenses, net interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries) and the present value of the cost of reaching a target trust fund of 100 percent of annual cost at the end of the period, expressed as a percentage of the present value of taxable payroll over the period.

The actuarial balance for a valuation period is equal to the difference between the summarized income rate and the summarized cost rate for the period. An actuarial balance of zero for any period indicates that cost for the period could be met for the period as a whole (but not necessarily at all points within the period), with a remaining trust fund reserve at the end of the period equal to 100 percent of the following year's cost. A negative actuarial balance for a period indicates that the present value of income to the program plus the existing trust fund is less than the present value of the cost of the program plus the cost of reaching a target trust fund reserve of one year's cost by the end of the period. Generally, a trust fund is deemed to be adequately financed for a period as a whole if the actuarial balance is zero or positive, meaning that the reserves at the end of the period are at least

equal to annual cost. Note that solvency is possible at the end of the period with a small negative actuarial balance where reserves are still positive.[1]

Table IV.B5 contains summarized rates for the intermediate, low-cost, and high-cost assumptions. The low-cost and high-cost assumptions define a wide range of possibilities. Financial outcomes as good as the low-cost scenario or as bad as the high-cost scenario are unlikely to occur.

For the 25-year valuation period, the OASDI program has an actuarial balance of -0.31 percent of taxable payroll under the low-cost assumptions, -2.50 percent under the intermediate assumptions, and -4.89 percent under the high-cost assumptions. These balances indicate that the program is not adequately financed for the 25-year valuation period under any of these three sets of assumptions.

For the 50-year valuation period, the OASDI program has actuarial balances of -0.29 percent under the low-cost assumptions, -3.24 percent under the intermediate assumptions, and -6.97 percent under the high-cost assumptions. These actuarial balances mean that the OASDI program is not adequately financed for the 50-year valuation period under any of these three sets of assumptions.

For the entire 75-year valuation period, the combined OASDI program has actuarial balances of -0.10 percent of taxable payroll under the low-cost assumptions, -3.61 percent under the intermediate assumptions, and -8.37 percent under the high-cost assumptions. These balances indicate that the combined OASDI program is not adequately financed for the 75-year valuation period under any of these three sets of assumptions.

Assuming the intermediate assumptions accurately capture future demographic, economic, and program-specific trends, solvency for the program over the next 75 years could be restored using a variety of approaches. For example, revenue could be increased in a manner equivalent to an immediate and permanent increase in the combined Social Security payroll tax rate from 12.40 percent to 15.84 percent (a relative increase of 27.7 percent),[2] cost could be reduced in a manner equivalent to an immediate and permanent

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[1] A program is solvent over any period for which the trust fund maintains a positive level of asset reserves. In contrast, the actuarial balance for a period includes the cost of having a target fund equal to 100 percent of the following year's cost at the end of the period. Therefore, if a program ends the period with reserves that are positive but not sufficient to cover the following year's costs, it will be solvent at the end of the period and yet still have a small negative actuarial balance for that period.

[2] The 3.44 percentage point increase in the payroll tax rate required to achieve 75-year solvency differs somewhat from the 3.61 percent actuarial deficit. This is primarily because the rate increase required to achieve 75-year solvency reflects a zero trust fund reserve at the end of the period, whereas the 3.61 percent actuarial deficit incorporates an ending trust fund reserve equal to one year's cost. While such an increase in the payroll tax rate would cause some behavioral changes in earnings and ensuing changes in benefit levels, such changes are not included in these calculations because they are assumed to have roughly offsetting effects on OASDI actuarial status over the 75-year long-range period as a whole.

reduction in scheduled benefits of 21.3 percent, or some combination of approaches could be used.

However, eliminating the actuarial deficit for the next 75-year valuation period requires raising payroll taxes or lowering benefits by more than is required just to achieve solvency, because the actuarial deficit includes the cost of attaining a target trust fund equal to 100 percent of annual program cost by the end of the period. The actuarial deficit could be eliminated for the 75-year period by increasing revenue in a manner equivalent to an immediate and permanent increase in the combined payroll tax from 12.40 percent to 16.01 percent (a relative increase of 29.1 percent),[1] reducing cost in a manner equivalent to an immediate reduction in scheduled benefits of 22.1 percent, or some combination of approaches could be used.

Under the intermediate assumptions, the OASDI program has large annual deficits toward the end of the long-range period that reach 4.35 percent of payroll for 2097 (see table IV.B1). These large deficits indicate that annual cost continues to exceed non-interest income after 2097, so continued adequate financing would require larger changes than those needed to maintain solvency for the 75-year period. Over the period extending through the infinite horizon, the actuarial deficit is 4.6 percent of payroll under the intermediate assumptions.

Table IV.B5.—Components of Summarized Income Rates and Cost Rates, Calendar Years 2023-2097
[As a percentage of taxable payroll]

	Summarized income rate			Summarized cost rate			
Valuation period	Non-interest income	Beginning asset reserves[a]	Total	Cost[a]	Ending target fund[a]	Total	Actuarial balance
OASI:							
Intermediate:							
2023-47.	11.41	1.06	12.47	14.51	0.57	15.09	-2.62
2023-72.	11.48	.57	12.05	15.03	.28	15.31	-3.26
2023-97.	11.51	.41	11.93	15.38	.16	15.54	-3.62
Low-cost:							
2023-47.	11.30	.94	12.24	12.58	.49	13.07	-.83
2023-72.	11.32	.49	11.81	12.39	.23	12.63	-.82
2023-97.	11.32	.34	11.66	12.16	.14	12.30	-.64
High-cost:							
2023-47.	11.53	1.18	12.72	16.60	.67	17.28	-4.56
2023-72.	11.67	.67	12.35	18.40	.34	18.74	-6.39
2023-97.	11.78	.51	12.29	19.82	.20	20.02	-7.73

[1] The calculation of the payroll tax rate increase required to eliminate the actuarial deficit also does not include the effects of behavioral changes, because they are assumed to have roughly offsetting effects.

Table IV.B5.—Components of Summarized Income Rates and Cost Rates, Calendar Years 2023-2097 (Cont.)
[As a percentage of taxable payroll]

	Summarized income rate			Summarized cost rate			
Valuation period	Non-interest income	Beginning asset reserves[a]	Total	Cost[a]	Ending target fund[a]	Total	Actuarial balance
DI:							
Intermediate:							
2023-47.	1.82	0.05	1.87	1.69	0.07	1.76	0.11
2023-72.	1.83	.02	1.85	1.80	.03	1.83	.02
2023-97.	1.83	.02	1.85	1.82	.02	1.84	.01
Low-cost:							
2023-47.	1.82	.04	1.86	1.29	.05	1.34	.51
2023-72.	1.82	.02	1.84	1.29	.02	1.31	.53
2023-97.	1.82	.01	1.83	1.28	.02	1.29	.54
High-cost:							
2023-47.	1.83	.05	1.88	2.12	.09	2.22	-.33
2023-72.	1.84	.03	1.87	2.40	.04	2.44	-.58
2023-97.	1.84	.02	1.86	2.48	.02	2.50	-.64
OASDI:							
Intermediate:							
2023-47.	13.24	1.10	14.34	16.20	.65	16.85	-2.50
2023-72.	13.31	.60	13.90	16.83	.31	17.14	-3.24
2023-97.	13.34	.43	13.78	17.20	.18	17.38	-3.61
Low-cost:							
2023-47.	13.12	.98	14.10	13.87	.54	14.42	-.31
2023-72.	13.14	.51	13.65	13.69	.26	13.94	-.29
2023-97.	13.14	.35	13.49	13.44	.15	13.59	-.10
High-cost:							
2023-47.	13.36	1.24	14.60	18.73	.77	19.49	-4.89
2023-72.	13.51	.70	14.22	20.80	.38	21.18	-6.97
2023-97.	13.62	.54	14.16	22.30	.22	22.52	-8.37

[a] Benefit payments scheduled to be paid on January 3 are actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

5. Open-Group Unfunded Obligation

Consistent with practice since 1965, this report focuses on a 75-year open-group valuation to evaluate the long-range actuarial status of the OASDI program. The open-group valuation includes non-interest income and cost for past, current, and future participants through the year 2097. The open-group unfunded obligation measures the adequacy of financing over the period as a whole for a program financed on a pay-as-you-go basis. On this basis, payroll taxes and scheduled benefits for all participants are included through 2097.

The open-group unfunded obligation increased from $20.4 trillion shown in last year's report to $22.4 trillion in this report. If there had been no changes in starting values, assumptions, laws, or methods for this report, then the open-group unfunded obligation would have increased to $21.2 trillion

solely due to the change in the valuation period. This expected increase in the unfunded obligation occurs because: (1) the unfunded obligation is now discounted to January 1, 2023, rather than to January 1, 2022, which tends to increase the unfunded obligation by the annual nominal interest rate; and (2) the unfunded obligation now includes an additional year (2097). However, changes in the law, assumptions, methods, and starting values resulted in a net $1.2 trillion increase in the unfunded obligation.

The 75-year unfunded obligation is equivalent to 3.42 percent of OASDI taxable payroll and 1.2 percent of GDP for 2023-97.[1] These percentages were 3.24 and 1.1, respectively, for last year's report. The 75-year unfunded obligation as a percentage of taxable payroll is less than the actuarial deficit, because the unfunded obligation excludes the cost of having an ending target trust fund value.

The actuarial deficit was 3.42 percent of payroll in last year's report, and was expected to increase to a deficit of 3.48 percent of payroll solely due to the change in the valuation period. Changes in the law, assumptions, methods, and starting values combined to account for a 0.13 percentage point increase (worsening) in the actuarial deficit to 3.61 percent of payroll. The actuarial deficit is 1.3 percent of GDP in this year's report, 0.1 percent higher than in last year's report.

As mentioned above, the open-group unfunded obligation expressed in dollars is higher than it would have been if only the valuation period had been changed. This net increase occurred for a variety of reasons described in the next section, in particular changes in recent economic data and near-term assumptions, and changes in programmatic data and methods.

Table IV.B6 presents the components and the calculation of the long-range (75-year) actuarial balance under the intermediate assumptions. The present value of future cost less future non-interest income over the long-range period, minus the amount of trust fund asset reserves at the beginning of the projection period, is $22.4 trillion for the OASDI program. This amount is the 75-year "open-group unfunded obligation" (see row H). The actuarial deficit (which is the negative of the actuarial balance) combines this unfunded obligation with the present value of the ending target trust fund and expresses the total as a percentage of the present value of the taxable payroll for the period. The present value of future non-interest income minus cost, plus starting trust fund reserves, minus the present value of the ending target trust fund, is -$23.6 trillion for the OASDI program.

[1] The present value of taxable payroll for 2023-97 is $655.0 trillion. The present value of GDP for 2023-97 is $1,865.3 trillion. In last year's report, the present value of taxable payroll for 2022-96 was $631.6 trillion and the present value of GDP was $1,817.7 trillion.

Table IV.B6.—Components of 75-Year Actuarial Balance and Unfunded Obligation Under Intermediate Assumptions

Item	OASI	DI	OASDI
Present value as of January 1, 2023 (in billions):			
A. Payroll tax revenue	$69,343	$11,775	$81,118
B. Reimbursements from general revenue	[a]	[a]	[a]
C. Taxation of benefits revenue	6,076	214	6,290
D. Non-interest income (A + B + C)	75,419	11,989	87,408
E. Cost	100,744	11,916	112,660
F. Cost minus non-interest income (E - D)	25,325	-73	25,252
G. Trust fund asset reserves at start of period	2,712	118	2,830
H. Open-group unfunded obligation (F - G)	22,613	-191	22,422
I. Ending target trust fund[b]	1,070	131	1,201
J. Income minus cost, plus reserves at start of period, minus ending target trust fund (D - E + G - I = - H - I)	-23,683	61	-23,623
K. Taxable payroll	655,013	655,013	655,013
Percent of taxable payroll:			
Actuarial balance (100 × J ÷ K)	-3.62	.01	-3.61

[a] Less than $0.5 billion.

[b] The calculation of the actuarial balance includes the cost of accumulating a target trust fund reserve equal to 100 percent of annual cost at the end of the period.

Note: Components may not sum to totals because of rounding.

Consideration of summary measures alone (such as the actuarial balance and open-group unfunded obligation) for a 75-year period can lead to incorrect perceptions and to policy prescriptions that do not achieve sustainable solvency. These concerns can be addressed by considering the trend in trust fund ratios toward the end of the period. (See the discussion of "sustainable solvency" beginning on page 53.)

Another measure of trust fund finances, discussed in appendix F, is the infinite horizon unfunded obligation, which takes account of all annual balances, even those after 75 years. The extension of the time period past 75 years assumes that the current-law OASDI program and the demographic, economic, and program-specific trends used for the 75-year projection continue indefinitely. This infinite horizon unfunded obligation is estimated to be 4.6 percent of taxable payroll or 1.4 percent of GDP. These percentages were 4.5 and 1.4, respectively, for last year's report. Of course, the degree of uncertainty associated with estimates increases substantially for years further in the future.

6. Reasons for Change in Actuarial Balance From Last Report

Table IV.B7 shows the effects of changes on the long-range actuarial balance under the intermediate assumptions, by category, between last year's report and this report.

Table IV.B7.—Reasons for Change in the 75-Year Actuarial Balance, Based on Intermediate Assumptions
[As a percentage of taxable payroll]

Item	OASI	DI	OASDI
Shown in last year's report:			
Income rate	11.93	1.85	13.78
Cost rate	15.34	1.86	17.20
Actuarial balance	**-3.41**	**-.01**	**-3.42**
Changes in actuarial balance due to changes in:			
Legislation / Regulation	[a]	[a]	[a]
Valuation period[b]	-.05	-.01	-.05
Demographic data and assumptions	-.03	[a]	-.03
Economic data and assumptions	-.04	[a]	-.04
Disability data and assumptions	[a]	.01	.01
Methods and programmatic data	-.08	.02	-.06
Total change in actuarial balance	-.21	.02	-.19
Shown in this report:			
Actuarial balance	**-3.62**	**.01**	**-3.61**
Income rate	11.93	1.85	13.78
Cost rate	15.54	1.84	17.38

[a] Between -0.005 and 0.005 percent of taxable payroll.
[b] The change in the 75-year valuation period from last year's report to this report means that the 75-year actuarial balance now includes the relatively large negative annual balance for 2097. This change in the valuation period results in a larger long-range actuarial deficit. The actuarial deficit includes the trust fund reserve at the beginning of the projection period.

Note: Components may not sum to totals because of rounding.

If the law, data, assumptions, and methods had all remained unchanged from last year's Trustees Report, the long-range OASDI actuarial balance would have decreased (worsened) by 0.05 percent of taxable payroll solely due to the change in the valuation period. However, as described below, projections in this report also reflect new data and changes in law, assumptions, and methods. These changes, including the change in the valuation period, combine to decrease (worsen) the long-range OASDI actuarial balance by 0.19 percentage point, from -3.42 percent of taxable payroll in last year's report to -3.61 percent in this report.

Legislation/Regulation

Changes in law, regulations, and policy have a negligible effect on the long-range OASDI actuarial balance.

Since the last report, there have been a number of notable regulatory and judicial developments related to immigration policy. On August 30, 2022, the Department of Homeland Security (DHS) published a final rule in the Federal Register, establishing regulations to "preserve and fortify" the Deferred Action for Childhood Arrivals (DACA) program in full. On October 5, 2022, the US Court of Appeals for the Fifth Circuit affirmed an earlier district court decision that had declared the DACA policy unlawful. The appeals court returned the case to the district court for further review of the

DHS regulation. On October 14, 2022, the district court issued an order extending the pause in implementing the DACA final rule. As a result, DHS is currently prohibited from processing new DACA applications and related employment authorizations.

Changes in DACA policy affect OASDI program operations because those who apply for and receive deferred action status are eligible for work authorization, which leads to additional workers covered by the OASDI program, increased payroll tax revenue, and subsequently increased benefit cost. The estimates presented in last year's report reflected the assumption that the DACA program would be fully in effect by the middle of 2022, consistent with the Administration's intent. Because of the court challenges, the estimates presented in this year's report incorporate an additional one-year delay in the resumption of processing new applications, to the middle of 2023. This one-year delay has a negligible effect on the actuarial balance.

Valuation Period

As mentioned above, changing the 75-year valuation period from 2022 through 2096 for last year's report to 2023 through 2097 for this report decreases the projected long-range OASDI actuarial balance by 0.05 percent of taxable payroll. This decrease occurs because (1) the annual balances after 2022 are now discounted to January 1, 2023, rather than to January 1, 2022, and (2) the relatively large negative annual balance for 2097 is now included in this year's 75-year projection period. Note that the actuarial balance calculation includes trust fund reserves at the beginning of the projection period. These reserves reflect the program's net financial flows for all past years, including 2022, up to the start of the valuation period.

Demographic Data and Assumptions

New demographic data and changes in demographic assumptions combine to decrease (worsen) the long-range OASDI actuarial balance by 0.03 percent of taxable payroll.

The ultimate demographic assumptions are unchanged for this year's report. However, updates to recent demographic data and near-term assumptions result in significant changes in the long-range actuarial balance.

First, final birth data for calendar year 2021, the base year for the fertility rate projections, indicate a total fertility rate very slightly higher than the rate assumed in last year's report for 2021. However, incorporating the updated base year data into the regression used to project birth rates during the transition to the ultimate level led to generally slightly lower birth rates during the

transition period. This change in assumed birth rates during the transition period decreases the actuarial balance by 0.01 percent of taxable payroll.

Second, updates to near-term mortality assumptions to reflect the effects of the COVID-19 pandemic increase the long-range actuarial balance by 0.02 percent of taxable payroll. Final mortality data are now available for all age groups for calendar year 2020 and for ages 65 and older for 2021. Based on preliminary data available to date, assumed death rates were increased for ages 0 to 64 for 2021 and for ages 0 to 84 for 2022, compared to the rates used for last year's report. Death rates are assumed to continue to be elevated in 2023 and 2024, above the levels that were assumed in last year's report. Projected death rates for years after 2024 are assumed to be unchanged from the levels that would have been projected in the absence of the pandemic.

Third, updates to data for the historical population, other-than-lawful permanent resident immigration, and marriage and divorce—including updates related to incorporating 2020 and 2021 data from the American Community Survey—combine to decrease the actuarial balance by 0.04 percent of taxable payroll.

Economic Data and Assumptions

New economic data and changes in economic assumptions, in combination, decrease the long-range OASDI actuarial balance by 0.04 percent of taxable payroll.

One ultimate economic assumption was updated for this year's report. The annual percentage change in the average OASDI covered wage, adjusted for inflation, is assumed to average 1.14 percentage points over the last 65 years of the 75-year projection period. This is 0.02 percentage point higher than the value assumed for last year's report. This change in the real wage growth assumption was made because the difference between the growth in earnings and employee compensation has been extraordinarily low across the last three economic cycles and is expected to remain slightly lower in the future than was assumed for last year's report. This assumption change increases the long-range actuarial balance by 0.03 percent of taxable payroll.

In addition, updates to recent economic data and near-term assumptions result in significant changes in the long-range actuarial balance.

First, in response to recent economic developments, including higher-than-expected inflation rates and lower-than-expected output growth, the Trustees revised the levels of GDP and labor productivity down by about 3.0 percent by 2026 and for all years thereafter. This change decreases the actuarial balance by roughly 0.13 percent of taxable payroll.

Second, while the ultimate real interest rate assumption remains at 2.3 percent for this year's report, the assumed real interest rates over the first 10 years of the projection period are generally higher than those assumed for last year's report, consistent with recent experience and expectations. These higher near-term real interest rates increase the actuarial balance by 0.02 percent of payroll.

Other changes to historical data and near-term economic assumptions combine for a net increase in the actuarial balance of about 0.03 percent of taxable payroll.

Disability Data and Assumptions

New disability data and changes in disability assumptions combine to increase the long-range OASDI actuarial balance by 0.01 percent of taxable payroll. This increase is due to the combined effects of actual disability data for 2022 and generally slightly lower assumed incidence rates in the first 10 years of the projection period. The ultimate disability incidence rate assumption remains at 4.8 per thousand exposed for this report.

Methods and Programmatic Data

The projections in this report also reflect several methodological improvements and updates based on new program-specific data. These methodological changes, programmatic data updates, and interactions combine to decrease the long-range OASDI actuarial balance by 0.06 percent of taxable payroll. Descriptions of four significant methodological changes and programmatic data updates follow.

First, the method for projecting the age distributions of lawful permanent resident (LPR) new arrival and adjustment-of-status immigrants was updated, reflecting recent data showing a slightly older population at the time of attaining LPR status than had previously been estimated. These updated age distributions decrease the actuarial balance by 0.02 percent of taxable payroll.

Second, the method for estimating the level of OASDI taxable wages for historical years 2000-21 was improved by adopting a more consistent approach for estimating completed values across various types of wages, including regular wages, farm wages, employer-reported tips, and self-reported wages and tips. Taxable wages are based on tabulations of wages reported to date on IRS Forms 941 (Employer's Quarterly Federal Tax Return), but because of reporting lags and corrections, the reported amounts are initially incomplete for a given tax year and additional amounts continue to arrive for sev-

eral subsequent years. This method improvement increases the actuarial balance by 0.01 percent of payroll.

Third, the sample of retired-worker and disabled-worker beneficiaries who have become newly entitled for benefits used in the long-range model for projecting average benefit levels was updated. This model uses a large sample of 10 percent of all newly entitled retired-worker beneficiaries in a recent year. The sample used in last year's report was for worker beneficiaries newly entitled in 2018, while this year's report uses the results from worker beneficiaries newly entitled in 2019. This update results in a decrease in the actuarial balance of 0.03 percent of payroll.

The fourth significant change is updating the post-entitlement benefit adjustment factors based on new programmatic data. Post-entitlement factors are used to account for changes in benefit levels, primarily due to differential mortality by benefit level and earnings after initial benefit entitlement. This data update decreases the actuarial balance by 0.03 percent of payroll.

In addition to these four methodological changes and programmatic data updates, changes in starting levels and projected levels of OASI and DI beneficiaries and benefit amounts over the first 10 years of the projection period, updating other programmatic data, other small methodological improvements, and interactions among the various method changes and updates to programmatic experience combine to increase the long-range actuarial balance by 0.01 percent of payroll.

Figure IV.B4.—OASDI Annual Balances: 2022 and 2023 Trustees Reports
[As a percentage of taxable payroll, under intermediate assumptions]

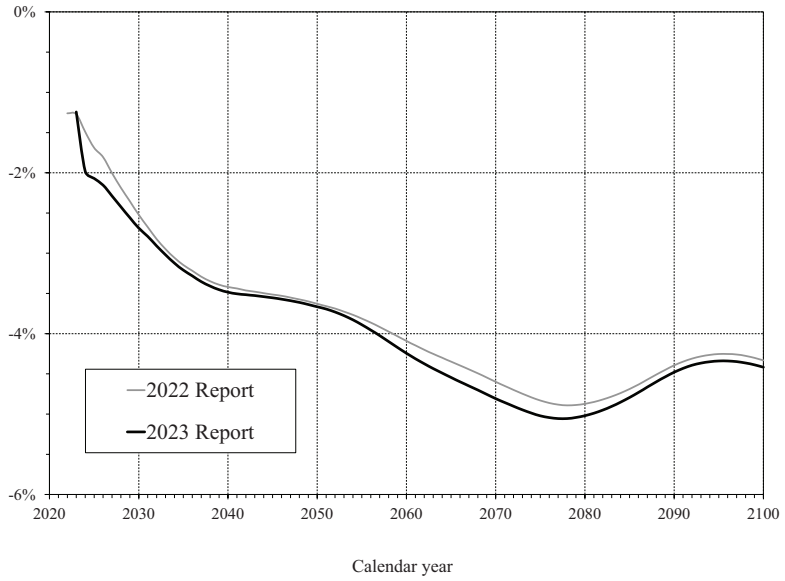

Figure IV.B4 compares the annual balances for this report and the prior year's report for the combined OASDI program over the long-range (75-year) projection period. The figure illustrates the annual effects of the changes described earlier in this section.

The annual balances in this year's report are lower (more negative) in all years after 2023, primarily due to the changes in economic factors and methodological improvements described above. For the full 75-year projection period (2023-97), the annual balances average 0.13 percentage point lower in this year's report. For 2097, the projected annual deficit is 4.35 percent of taxable payroll in this report, compared to 4.26 percent in last year's report.

V. ASSUMPTIONS AND METHODS UNDERLYING ACTUARIAL ESTIMATES

The future income and cost of the OASDI program will depend on many demographic, economic, and program-specific factors. Trust fund income will depend on how these factors affect the size and composition of the working population as well as the level and distribution of earnings. Similarly, program cost will depend on how these factors affect the size and composition of the beneficiary population as well as the general level of benefits.

The Trustees make basic assumptions for several of these factors based on analysis of historical trends, historical conditions, and expected future conditions. These factors include fertility, mortality, immigration, marriage, divorce, productivity, inflation, average earnings, unemployment, real interest rates, and disability incidence and termination. Other factors depend on these basic assumptions. These other, often interdependent, factors include total population, life expectancy, labor force participation, gross domestic product, and program-specific factors. Each year, the Trustees reexamine these assumptions and methods in light of new information and make appropriate revisions.

Future levels of these factors and their interrelationships are inherently uncertain. To address these uncertainties, this report uses three sets of assumptions, designated as intermediate (alternative II), low-cost (alternative I), and high-cost (alternative III). The intermediate set represents the Trustees' best estimate of the future course of the population and the economy as of the time assumptions were set in December 2022. With regard to the net effect on the actuarial status of the OASDI program, the low-cost set is more optimistic and the high-cost set is more pessimistic. The low-cost and high-cost sets of assumptions reflect significant potential changes in the interrelationships among factors, as well as changes in the values for individual factors.

While it is unlikely that all of the factors and interactions will differ in the specified directions from the intermediate values, many combinations of individual differences in the factors could have a similar overall effect. Outcomes with overall long-range cost as low as the low-cost scenario or as high as the high-cost scenario are very unlikely. This report also includes a section on sensitivity analysis, where factors are changed one at a time (see appendix D), and a section on stochastic projections, which provides a probability distribution of possible future outcomes, with most of the key factors being varied around the intermediate alternative (see appendix E).

Readers should interpret the estimates based on the three sets of alternative assumptions with care. These estimates are not specific predictions of the future financial status of the OASDI program. Rather, they are intended to provide a reasonable range of future income and cost.

All of the key demographic, economic, and program-specific assumptions reach their long-range ultimate values within the next 25 years. For extrapolations beyond the 75-year long-range period, the ultimate levels or trends reached by the end of the 75-year period remain unchanged. The assumed ultimate values represent average annual experience or growth rates. Actual future values will exhibit fluctuations or cyclical patterns, as in the past.

At this time, there is no consensus on what the lasting effects of the COVID-19 pandemic on long-term demographic, economic, and program-specific trends will be. The Trustees continue to assume that the pandemic will have no net effect on the individual long-range ultimate assumptions. However, the Trustees assume that the pandemic and other evolving international events, like the war in Ukraine, will have consequential effects on the future structure of the economy and the level of productivity.

The following sections briefly discuss the various assumptions and methods used in making the estimates of trust fund actuarial status, which are the focus of this report.[1] There are, of course, many interrelationships among these factors that are important but are beyond the scope of this discussion.

A. DEMOGRAPHIC ASSUMPTIONS AND METHODS

This section of the report provides a brief overview of the demographic historical data and the assumptions used for the projections.

1. Fertility Assumptions

Birth rates by single year of age, for girls and women aged 14 to 49,[2] are the basis for the fertility assumptions. These rates apply to the total number of women, across all marital statuses, in the midyear population at each age. Table V.A1 displays the historical and projected total fertility rates.[3]

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[1] Actuarial Studies published by the Office of the Chief Actuary, Social Security Administration, contain further details about the assumptions, methods, and actuarial estimates. A complete list of available studies may be found at www.ssa.gov/OACT/NOTES/actstud.html. This entire report, along with supplemental year-by-year tables and additional documentation on assumptions and methods, may be found at www.ssa.gov/OACT/TR/2023/.

[2] Birth rates at age 14 include births to girls aged 14 and under, and birth rates at age 49 include births to women aged 49 and over.

[3] The total fertility rate may be interpreted as the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, a specified year, and if she were to survive the entire childbearing period. A rate of about 2.1 would ultimately result in a nearly constant population if immigration and emigration were both zero, and if death rates were to remain at current levels.

Historically, birth rates in the United States have fluctuated widely. The total fertility rate decreased from 3.31 children per woman at the end of World War I (1918) to 2.15 during the Great Depression (1936). After 1936, the total fertility rate rose to 3.68 in 1957 and then fell to 1.74 by 1976. After 1976, the total fertility rate rose above 2.00 by 1990, where it generally remained through 2009, but it dropped below 1.90 for 2011 and has been at relatively low levels since then. It reached an all-time low of 1.64 for 2020 but went up slightly to 1.66 for 2021.

As in last year's report, the Trustees assume that the COVID-19 pandemic will not have any significant net effect on fertility rates in either the near term or the long term.

The variations in the historical total fertility rate resulted from changes in many factors, including social attitudes, economic conditions, birth-control practices, and the racial/ethnic composition of the population. Since the baby-boom era (1946-65), women have had higher educational attainment, higher labor force participation, an older average age at first marriage, and a higher propensity to be unmarried. All of these factors are consistent with continued lower total fertility rates than those experienced during the baby-boom era. It is still too early to tell whether the 2022 Supreme Court decision (Dobbs v. Jackson Women's Health Organization) and changes being made and considered in states regarding abortion policy will have a significant effect on future fertility rates. Based on consideration of these factors, the Trustees expect the ultimate total fertility rate to be relatively close to the average level since the end of the baby-boom era. The assumed ultimate total fertility rates are 2.20, 2.00, and 1.70 children per woman for the low-cost, intermediate, and high-cost assumptions, respectively. These are the same ultimate rates as those assumed for last year's report.

The 2023 Trustees Report uses a cohort-based projection approach that incorporates a gradual shift to older ages of childbearing for birth cohorts who have not yet reached age 49. The ultimate total fertility rate is reached on a cohort basis over the lifetime of girls attaining age 14 in 2021 and later. For the intermediate assumptions, the projected total fertility rate gradually increases on a period (annual) basis through the year the ultimate period value is reached (2056). The assumed low-cost and high-cost total fertility rates trend away from the intermediate path, also reaching their ultimate period values in 2056.

2. Mortality Assumptions

Mortality projections are developed by assuming ultimate average annual percentage reductions in future mortality rates by age group and cause of death. The assumptions are used to estimate future central death rates by age group, sex, and cause of death.

Adjustments were made to the assumed death rates for 2021, 2022, 2023, and 2024 to account for the effects of the pandemic period. The table below shows the multiplicative factors that were applied to the probabilities of death that would have been projected in the absence of the pandemic. Factors for 2020 are not necessary, as actual final data are available. Similarly, factors were not applied for ages 65 and over in 2021 because actual data are available for those ages.

Year	Age 0	Ages 1-14	Ages 15-64	Ages 65-84	Ages 85 and older
2021	1.00	1.08	1.33	[a] 1.18	[a] 1.08
2022	1.00	1.05	1.11	1.12	1.05
2023	1.00	1.01	1.03	1.03	1.01
2024	1.00	1.00	1.01	1.01	1.00

[a] Based on actual data.

Provisional death rates were particularly high in 2021 for those aged 15-64, relative to the rates that would have been expected in the absence of the pandemic. The factors for this age group in 2022-24 are more in line with the other age groups based on provisional death data in 2022. Compared to the death rates used for last year's report, the factors in the table above result in higher total death rates in 2021 through 2024.

From the estimated central death rates, probabilities of death by single year of age and sex were calculated. Projected death rates for years after 2024 are unchanged from the levels that would have been projected in the absence of the pandemic, under the assumption that increased deaths from the residual effects of living through the pandemic (both physiological and psychological) will be roughly offset by decreased deaths that instead happened sooner (during the pandemic).

Historical death rates were calculated for years 1900 through 2020 for ages below 65 (and for all ages for years prior to 1968) using data from the National Center for Health Statistics (NCHS).[1] For ages 65 and over, final Medicare data on deaths for years 1968 through 2019 and preliminary data

[1] These rates reflect NCHS data on deaths and Census estimates of population.

for 2020 and 2021 were used.[1] Death rates by cause of death were produced for all ages for years 1979-2020 using data from the NCHS. Note, however, that regressions used for the model projections do not include data for 2020 and 2021 due to the elevated death rates caused by COVID-19.

The total age-sex-adjusted death rate[2] declined at an average annual rate of 1.02 percent between 1900 and 2019. Between 1979 and 2019, the period for which death rates were analyzed by cause, the total age-sex-adjusted death rate, for all causes combined, declined at an average rate of 0.85 percent per year.

Death rates have declined substantially in the U.S. since 1900, with rapid declines over some periods and slow or no improvement over the other periods. Many factors are responsible for historical reductions in death rates, including medical advances, increased availability of health-care services, and improvements in sanitation and nutrition. Historical death rates generally declined more slowly for older ages and more rapidly for children and infants than for the rest of the population. Between 1900 and 2019, the age-sex-adjusted death rate declined at an average rate of 0.78 percent per year for ages 65 and over, and 2.97 percent per year for ages under 15.

Mortality assumptions differ for the low-cost, intermediate, and high-cost scenarios. Throughout the projection period, the low-cost scenario contains annual percentage reductions that are smaller than those in the intermediate scenario, while those in the high-cost scenario are larger. The ultimate annual percentage reductions for each of the three alternatives are unchanged from last year's report.

The trends in the annual reductions in central death rates were calculated for the period from 2008 to 2019 for both the NCHS and Medicare data, by age group, sex, and cause of death.[3] These trends are the starting reductions for alternative II. For alternatives I and III, 50 and 150 percent of the starting reductions are used, respectively. These annual reductions, by alternative, are assumed to transition rapidly from the starting reductions until they reach the ultimate annual percentage reductions assumed for 2047 and later.

Table V.A1 contains historical and projected age-sex-adjusted death rates for the total population (all ages), for ages under 65, and for ages 65 and over. Age-sex adjustment eliminates the effect of a changing distribution of population by age and sex, allowing the pure effects of changes in death rates to

[1] These rates reflect Medicare data on deaths and enrollments.

[2] Based on the enumerated total population as of April 1, 2010, if that population were to experience the death rates by age and sex for the selected year.

[3] Cause of death is only available for the NCHS data.

be observed. Under the intermediate assumptions, projected age-sex-adjusted death rates are very slightly higher than the rates in last year's report after 2024. These changes result from incorporating final 2019 Medicare data and a method improvement to use single-year-of-age data instead of five-year age group data.

The projected average annual rate of decline for the total age-sex-adjusted death rate is about 0.39 percent, 0.86 percent, and 1.40 percent between 2022 and 2097 for alternatives I, II, and III, respectively. In keeping with the patterns observed in the historical data, the assumed future rates of decline are greater for younger ages than for older ages, but to a substantially lesser degree than in the past. Accordingly, the projected age-sex-adjusted death rates for ages 65 and over decline at average annual rates of about 0.37 percent, 0.79 percent, and 1.24 percent between 2022 and 2097 for alternatives I, II, and III, respectively. The projected age-sex-adjusted death rates for ages under 15 decline at average annual rates of about 0.54 percent, 1.54 percent, and 2.96 percent between 2022 and 2097 for alternatives I, II, and III, respectively. It should be noted that these average annual rates of decline between 2022 and 2097 are not directly comparable with the rates of decline between 2021 and 2096 in last year's report, because the 75-year period used for last year's report included the pandemic year of 2021, and the death rate assumptions for 2022-24 were revised for this year's report to better reflect the current expected course of the pandemic.

Demographers express a wide range of views on the likely rate of future decline in death rates. For example, some believe that the long-standing historical tendency for mortality to decline more slowly at the oldest ages will cease in the future. Others believe that biological factors, social factors, and limitations on health care spending may slow future rates of decline in mortality.

Table V.A1.—Fertility and Mortality Assumptions,[a] Calendar Years 1940-2100

Calendar year	Total fertility rate[b]	Age-sex-adjusted death rate[c] per 100,000		
		Total	Under 65	65 and over
Historical data:				
1940	2.23	1,919.8	750.1	9,718.8
1945	2.42	1,716.6	674.8	8,662.9
1950	3.03	1,561.9	570.2	8,173.7
1955	3.50	1,453.8	508.2	7,758.4
1960	3.61	1,454.3	503.2	7,795.6
1965	2.88	1,428.8	495.2	7,653.9
1970	2.43	1,340.0	485.7	7,036.3
1975	1.77	1,204.8	426.6	6,393.6
1980	1.82	1,136.9	384.3	6,154.3
1985	1.83	1,081.0	353.3	5,932.9
1990	2.07	1,022.9	333.6	5,618.9
1995	1.98	1,002.7	317.9	5,568.6
2000	2.05	961.5	281.0	5,498.9
2005	2.06	901.9	270.7	5,110.3
2010	1.93	820.8	248.5	4,636.1
2015	1.85	815.4	255.3	4,549.7
2016	1.82	808.7	260.9	4,461.0
2017	1.76	812.8	261.6	4,487.7
2018	1.73	803.7	258.7	4,437.4
2019	1.70	792.9	257.7	4,361.0
2020	1.64	[d]922.4	305.7	[d]5,034.2
2021	1.66	[e]937.6	[f]341.5	[e]4,912.0
2022	[f]1.69	[f]860.3	[f]285.7	[f]4,691.2
Intermediate:				
2025	1.74	768.2	254.0	4,196.9
2030	1.86	738.4	243.8	4,036.1
2035	1.92	708.5	232.6	3,881.9
2040	1.97	679.9	221.5	3,736.3
2045	2.00	652.8	210.8	3,599.6
2050	2.00	627.3	200.7	3,471.3
2055	2.00	603.3	191.2	3,350.9
2060	2.00	580.7	182.2	3,237.9
2065	2.00	559.4	173.7	3,131.6
2070	2.00	539.4	165.6	3,031.5
2075	2.00	520.5	158.0	2,937.3
2080	2.00	502.7	150.9	2,848.5
2085	2.00	485.9	144.1	2,764.6
2090	2.00	469.9	137.6	2,685.4
2095	2.00	454.9	131.6	2,610.5
2100	2.00	440.6	125.8	2,539.6

Table V.A1.—Fertility and Mortality Assumptions,[a] Calendar Years 1940-2100 (Cont.)

Calendar year	Total fertility rate[b]	Age-sex-adjusted death rate[c] per 100,000		
		Total	Under 65	65 and over
Low-cost:				
2025	1.87	794.3	263.4	4,333.9
2030	2.05	785.5	261.4	4,279.8
2035	2.12	775.0	257.7	4,223.7
2040	2.18	764.1	253.7	4,167.7
2045	2.20	753.3	249.5	4,112.6
2050	2.20	742.7	245.3	4,058.6
2055	2.20	732.2	241.2	4,005.7
2060	2.20	722.0	237.2	3,954.0
2065	2.20	712.0	233.3	3,903.4
2070	2.20	702.2	229.5	3,853.9
2075	2.20	692.6	225.7	3,805.4
2080	2.20	683.2	222.0	3,758.1
2085	2.20	674.0	218.4	3,711.7
2090	2.20	665.0	214.8	3,666.3
2095	2.20	656.1	211.3	3,621.9
2100	2.20	647.5	207.9	3,578.4
High-cost:				
2025	1.56	736.5	242.3	4,031.0
2030	1.59	680.5	221.9	3,737.8
2035	1.63	628.2	201.7	3,471.7
2040	1.67	581.2	183.2	3,235.3
2045	1.70	539.4	166.5	3,026.0
2050	1.70	502.2	151.5	2,840.5
2055	1.70	469.0	138.1	2,675.5
2060	1.70	439.4	126.1	2,528.2
2065	1.70	412.8	115.3	2,396.1
2070	1.70	388.9	105.7	2,277.3
2075	1.70	367.3	96.9	2,169.8
2080	1.70	347.7	89.1	2,072.2
2085	1.70	329.9	82.0	1,983.2
2090	1.70	313.7	75.6	1,901.7
2095	1.70	298.9	69.7	1,826.9
2100	1.70	285.3	64.4	1,757.9

[a] This table contains basic assumptions along with key summary values that are derived from basic assumptions.

[b] The total fertility rate for any year is the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, the selected year, and if she were to survive the entire childbearing period.

[c] Based on the enumerated total population as of April 1, 2010, if that population were to experience the death rates by age and sex observed in, or assumed for, the selected year.

[d] Estimated using final data for ages below 65 and preliminary data for ages 65 and older.

[e] Estimated using the intermediate assumptions for ages below 65 and preliminary data for ages 65 and older.

[f] Estimated, intermediate alternative.

3. Immigration Assumptions

Projections of the total Social Security area population reflect assumptions for the following four annual immigration flows:

- Lawful permanent resident (LPR) immigration: Persons who enter the Social Security area and are granted LPR status, or who are already in the Social Security area and adjust their status to become LPRs.[1]
- Legal emigration: LPRs and citizens who leave the Social Security area population.
- Other-than-LPR immigration: Persons who enter the Social Security area and stay to the end of the year without being granted LPR status, such as undocumented immigrants, and foreign workers and students entering with temporary visas.
- Other-than-LPR emigration: Other-than-LPR immigrants who leave the Social Security area population or who adjust their status to become LPRs.

Net LPR immigration is the difference between LPR immigration and legal emigration. Net other-than-LPR immigration is the difference between other-than-LPR immigration and other-than-LPR emigration. Total net immigration refers to the sum of net LPR immigration and net other-than-LPR immigration.

Immigration assumptions differ for the low-cost, intermediate, and high-cost scenarios. The low-cost scenario includes higher annual net immigration and the high-cost scenario includes lower annual net immigration. Table V.A2 contains historical and projected levels of various immigration flows.

LPR immigration has increased significantly since World War II, due to various factors and legislative changes, including the Immigration Act of 1965 and the Immigration Act of 1990.

LPR new arrival immigration dropped significantly in 2020 and 2021. LPR new arrival immigration levels in 2020 and 2021 are estimated to be about 280,000 persons lower and 235,000 persons lower, respectively, than would have been expected in the absence of the pandemic. For all three alternatives, the LPR new arrival immigration levels for 2022 are assumed to be the same as would have been assumed in the absence of the pandemic. LPR new arrival immigration levels for 2023 and 2024 are assumed to be higher than would have been assumed in the absence of the pandemic, fully making up for the lower levels in 2020 and 2021. These pandemic effects on LPR new arrival immigration levels are slightly larger than the assumed pandemic effects in last year's report.

[1] Persons who enter the country with legal visas but without LPR status, such as temporary foreign workers and students, are not included in the "LPR immigration" category.

For the intermediate alternative, the ultimate level of annual LPR immigration, which includes residents who adjust their status to become LPRs, is assumed to be 1,050,000 persons for 2025 and later. For alternative I, ultimate annual LPR immigration is assumed to be 1,250,000 persons for 2025 and later, and for alternative III, ultimate annual LPR immigration is assumed to be 850,000 persons for 2025 and later. The ultimate levels of LPR immigration are unchanged from last year's report.

The assumed ratios of annual legal emigration to LPR immigration are 20, 25, and 30 percent for alternatives I, II, and III, respectively. This range is consistent with the limited historical data for legal emigration from the Social Security area. These ratios are unchanged from last year's report. Under the intermediate alternative, by combining the ultimate annual LPR immigration and legal emigration assumptions, ultimate annual net LPR immigration is about 788,000 persons. For the low-cost and high-cost scenarios, ultimate annual net LPR immigration is 1,000,000 persons and 595,000 persons, respectively.

The estimated number of other-than-LPR immigrants residing in the Social Security area and the annual level of other-than-LPR immigration were affected significantly by the economic recession of 2007-09. Although other-than-LPR immigration was greatly reduced during the economic downturn and immediate years thereafter, it returned to higher levels for most years from 2014 through 2019, reflecting a recovery from levels experienced during the recession. The COVID-19 pandemic began to affect other-than-LPR immigration in 2020; the estimated level of other-than-LPR immigration in 2020 is about 747,000, which is 453,000 lower than would have been estimated in the absence of the pandemic.

The Trustees assume that the pandemic will continue to affect other-than-LPR immigration in years 2021 through 2024. For each of the three alternatives, the assumed other-than-LPR immigration level for 2021 is 350,000 lower than would have been assumed in the absence of the pandemic. The other-than-LPR immigration levels for 2022 are assumed to be the same as would have been assumed in the absence of the pandemic. Other-than-LPR immigration levels for 2023 and 2024 are assumed to be higher than would have been assumed in the absence of the pandemic, fully making up for the lower levels in 2020 and 2021. These pandemic effects on other-than-LPR immigration levels are all smaller than the assumed pandemic effects in last year's report.

The ultimate annual levels of other-than-LPR immigration are 1,350,000 persons for alternative II, 1,850,000 persons for alternative I, and 850,000 persons for alternative III. These ultimate levels are unchanged from those used

in last year's report. The ultimate levels are attained in 2025 for all three alternatives.

Emigration from the other-than-LPR immigrant population includes those who leave the Social Security area and those who adjust their status to become LPRs. This other-than-LPR immigrant population is highly mobile and far more likely to leave the Social Security area than is the citizen or LPR population. However, as other-than-LPR immigrants stay in the country for longer periods of time, they generally become less likely to leave the country.

Under the intermediate assumptions, the total annual number of other-than-LPR immigrants who leave the Social Security area averages about 426,000 through the 75-year projection period. The ultimate annual number of other-than-LPR immigrants who adjust status to become LPRs is assumed to be 450,000 for the intermediate assumptions, and is unchanged from last year's report. For the low-cost and high-cost scenarios, the total annual number of other-than-LPR emigrants averages about 585,000 and 265,000, respectively, through the 75-year projection period. The ultimate annual number of people adjusting status to LPR status is assumed to be 550,000 persons and 350,000 persons, for the low-cost and high-cost scenarios, respectively, and is unchanged from last year's report.

Under the assumptions described above, the projected size of the other-than-LPR immigrant population grows substantially, from about 15.6 million by the end of 2023 to about 35.6 million by the end of 2097. This growth reflects the excess of annual immigration over the combined annual numbers of emigrants (including adjustments of status) and deaths that occur within the other-than-LPR immigrant population.

Under the intermediate assumptions, projected net other-than-LPR immigration gradually decreases over time. Because the projected number of other-than-LPR immigrants leaving the Social Security area is based on rates of departure, an increase in the number of other-than-LPR immigrants residing in the Social Security area results in an increase in the number who emigrate out of the area. All other components of net other-than-LPR immigration are assumed to be stable after 2024, and thus do not contribute toward any change in annual net other-than-LPR immigration. Under the intermediate assumptions, the projected average annual level of net other-than-LPR immigration over the 75-year projection period is about 485,000 persons. For the low-cost and high-cost assumptions, projected average annual net other-than-LPR immigration is about 726,000 persons and 245,000 persons, respectively.

The projected average annual level of total net immigration (LPR and other-than-LPR, combined) is about 1,277,000 persons per year during the 75-year projection period under the intermediate assumptions. For the low-cost and high-cost assumptions, projected average annual total net immigration is about 1,732,000 persons and 845,000 persons, respectively.

Demographers express a wide range of views about the future course of immigration for the United States. Some believe that net immigration will increase substantially in the future. Others believe that potential immigrants may be increasingly attracted to other countries, that the number of potential immigrants may be lower due to lower birth rates in many countries, or that changes in the law or enforcement of the law will reduce immigration.

Table V.A2.—Immigration Assumptions,[a] Calendar Years 1940-2100
[In thousands]

Calendar year	LPR immigration				Other-than-LPR immigration[b]				Total net immigration
	LPR in	Legal out	Adjustments of status[c d]	Net LPR	Other-than-LPR in	Other-than-LPR out	Adjustments of status[c d]	Net other-than-LPR	
Historical data:									
1940	61	15	-	46	-	-	-	-	-
1945	73	18	-	55	-	-	-	-	-
1950	227	57	-	171	-	-	-	-	-
1955	280	70	-	210	-	-	-	-	-
1960	268	67	-	201	-	-	-	-	-
1965	261	77	49	232	-	-	49	-	-
1970	307	93	65	279	-	-	65	-	-
1975	340	98	53	294	-	-	53	-	-
1980	430	135	112	406	-	-	112	203	609
1985	458	144	118	432	-	-	118	261	693
1990	548	166	1,061	1,443	-	-	1,061	-318	1,125
1995	511	192	258	578	-	-	258	560	1,137
2000	482	224	413	672	1,358	366	413	579	1,251
2005	561	290	597	869	1,644	32	597	1,015	1,884
2010	622	262	426	786	642	199	426	17	802
2015	689	271	395	813	1,206	147	395	665	1,478
2016	763	292	407	877	1,125	710	407	8	886
2017	722	280	398	840	885	227	398	260	1,099
2018	678	270	403	810	747	483	403	-139	672
2019	508	238	443	713	1,039	893	443	-298	415
2020	320	179	396	537	747	80	396	271	808
2021	[e]365	[e]209	[e]471	[e]627	[f]950	[e]229	[e]471	[f]250	[f]877
2022	[f]600	[f]263	[f]450	[f]788	[f]1,350	[f]236	[f]450	[f]664	[f]1,452
Intermediate:									
2025	600	263	450	788	1,350	302	450	598	1,385
2030	600	263	450	788	1,350	339	450	561	1,348
2035	600	263	450	788	1,350	369	450	531	1,318
2040	600	263	450	788	1,350	396	450	504	1,291
2045	600	263	450	788	1,350	416	450	484	1,271
2050	600	263	450	788	1,350	430	450	470	1,258
2055	600	263	450	788	1,350	439	450	461	1,249
2060	600	263	450	788	1,350	446	450	454	1,241
2065	600	263	450	788	1,350	454	450	446	1,234
2070	600	263	450	788	1,350	460	450	440	1,228
2075	600	263	450	788	1,350	464	450	436	1,223
2080	600	263	450	788	1,350	468	450	432	1,220
2085	600	263	450	788	1,350	470	450	430	1,217
2090	600	263	450	788	1,350	472	450	428	1,216
2095	600	263	450	788	1,350	473	450	427	1,214
2100	600	263	450	788	1,350	474	450	426	1,214

Table V.A2.—Immigration Assumptions,[a] Calendar Years 1940-2100 (Cont.)
[In thousands]

Calendar year	LPR immigration				Other-than-LPR immigration[b]				Total net immigration
	LPR in	Legal out	Adjustments of status[c d]	Net LPR	Other-than-LPR in	Other-than-LPR out	Adjustments of status[c d]	Net other-than-LPR	
Low-cost:									
2025	700	250	550	1,000	1,850	343	550	957	1,957
2030	700	250	550	1,000	1,850	412	550	888	1,888
2035	700	250	550	1,000	1,850	470	550	830	1,830
2040	700	250	550	1,000	1,850	521	550	779	1,779
2045	700	250	550	1,000	1,850	562	550	738	1,738
2050	700	250	550	1,000	1,850	591	550	709	1,709
2055	700	250	550	1,000	1,850	612	550	688	1,688
2060	700	250	550	1,000	1,850	629	550	671	1,671
2065	700	250	550	1,000	1,850	643	550	657	1,657
2070	700	250	550	1,000	1,850	653	550	647	1,647
2075	700	250	550	1,000	1,850	661	550	639	1,639
2080	700	250	550	1,000	1,850	667	550	633	1,633
2085	700	250	550	1,000	1,850	670	550	630	1,630
2090	700	250	550	1,000	1,850	673	550	627	1,627
2095	700	250	550	1,000	1,850	674	550	626	1,626
2100	700	250	550	1,000	1,850	675	550	625	1,625
High-cost:									
2025	500	255	350	595	850	263	350	237	832
2030	500	255	350	595	850	267	350	233	828
2035	500	255	350	595	850	269	350	231	826
2040	500	255	350	595	850	271	350	229	824
2045	500	255	350	595	850	270	350	230	825
2050	500	255	350	595	850	268	350	232	827
2055	500	255	350	595	850	264	350	236	831
2060	500	255	350	595	850	262	350	238	833
2065	500	255	350	595	850	263	350	237	832
2070	500	255	350	595	850	263	350	237	832
2075	500	255	350	595	850	264	350	236	831
2080	500	255	350	595	850	265	350	235	830
2085	500	255	350	595	850	265	350	235	830
2090	500	255	350	595	850	266	350	234	829
2095	500	255	350	595	850	266	350	234	829
2100	500	255	350	595	850	267	350	233	828

[a] This table contains basic assumptions along with key summary values that are derived from basic assumptions.

[b] Historical other-than-LPR immigration and emigration estimates depend on a residual method. The Office of the Chief Actuary developed these estimates, as well as the resulting other-than-LPR January 1 stock estimates, for years through 2000. For years 2001 and later, the residual method uses stock estimates. For 2001 through 2004, the stock is set to values that linearly grade from the 2000 stock estimate to the 2005 stock estimate. Stock estimates are developed by the Office of the Chief Actuary, based on the latest methods used by DHS.

[c] Estimates include persons who attained LPR status under the special one-time provisions of the Immigration Reform and Control Act of 1986.

[d] Adjustments of status are a positive for net LPR immigration and a negative for net other-than-LPR immigration.

[e] Estimated.

[f] Estimated, intermediate alternative.

Note: Components may not sum to totals because of rounding.

4. Total Population Estimates

The starting Social Security area population for December 31, 2020, is derived from the Census Bureau's estimate of the residents of the 50 States and D.C. and U.S. Armed Forces overseas. Adjustments are made to reflect mortality assumptions for the aged population since 2010 that are consistent with Medicare and Social Security data, net immigration assumptions for the aged population since 2010, estimates of the net undercount in the 2010 census, inclusion of U.S. citizens living abroad (including residents of U.S. territories), and inclusion of non-citizens living abroad who are insured for Social Security benefits. The Office of the Chief Actuary projects the population in the Social Security area by age, sex, and marital status for December 31 of each year from 2021 through 2097 by combining the assumptions for future fertility, mortality, and immigration with assumptions for marriage and divorce. Previous sections of this chapter present the assumptions for future fertility, mortality, and immigration. Assumptions for future rates of marriage and divorce reflect historical data from the National Center for Health Statistics, the Census Bureau, and selected individual States.

This report presents a July 1 (i.e., midyear) population for each year, which is derived from surrounding December populations. Table V.A3 shows the historical and projected population for July 1 by broad age group, for the three alternatives. It also shows the aged and total dependency ratios (see table footnotes for definitions).

Table V.A3.—Social Security Area Population on July 1 and Dependency Ratios, Calendar Years 1945-2100

Calendar year	Population (in thousands)				Dependency ratio	
	Under 20	20-64	65 and over	Total	Aged[a]	Total[b]
Historical data:						
1945	49,107	87,891	10,886	147,883	0.124	0.683
1950	53,918	92,190	12,789	158,897	.139	.724
1955	63,337	96,003	15,161	174,501	.158	.818
1960	72,915	99,752	17,323	189,990	.174	.905
1965	80,002	104,863	19,153	204,018	.183	.946
1970	80,856	112,953	21,007	214,815	.186	.902
1975	78,577	122,594	23,370	224,541	.191	.832
1980	74,841	134,029	26,315	235,184	.196	.755
1985	72,892	144,585	29,129	246,607	.201	.706
1990	74,791	152,731	31,926	259,449	.209	.699
1995	79,287	160,735	34,294	274,317	.213	.707
2000	81,980	170,139	35,500	287,619	.209	.690
2005	83,906	180,823	37,123	301,853	.205	.669
2010	85,673	188,274	41,044	314,990	.218	.673
2015	84,427	193,533	47,768	325,727	.247	.683
2016	84,400	194,256	49,264	327,920	.254	.688
2017	84,260	194,749	50,784	329,793	.261	.693
2018	83,992	195,104	52,358	331,455	.268	.699
2019	83,653	195,036	53,982	332,671	.277	.706
2020[c]	83,298	194,877	55,493	333,667	.285	.712
2021[d]	82,893	194,834	56,852	334,578	.292	.717
2022[d]	82,723	194,907	58,367	335,997	.299	.724
Intermediate:						
2025	82,861	197,082	63,420	343,362	.322	.742
2030	82,828	200,212	70,995	354,034	.355	.768
2035	85,114	203,819	75,441	364,374	.370	.788
2040	88,689	207,392	77,896	373,977	.376	.803
2045	92,732	210,257	79,585	382,575	.379	.820
2050	95,086	213,249	81,948	390,283	.384	.830
2055	96,280	216,458	85,080	397,818	.393	.838
2060	97,298	219,807	88,922	406,027	.405	.847
2065	99,029	223,674	92,471	415,174	.413	.856
2070	101,697	226,944	96,192	424,833	.424	.872
2075	104,716	229,517	100,175	434,408	.436	.893
2080	107,286	233,759	102,562	443,607	.439	.898
2085	109,129	239,433	104,013	452,575	.434	.890
2090	110,652	246,086	104,972	461,710	.427	.876
2095	112,417	251,691	107,207	471,315	.426	.873
2100	114,662	256,318	110,479	481,459	.431	.878

Table V.A3.—Social Security Area Population on July 1 and Dependency Ratios, Calendar Years 1945-2100 (Cont.)

Calendar year	Population (in thousands)				Dependency ratio	
	Under 20	20-64	65 and over	Total	Aged[a]	Total[b]
Low-cost:						
2025	84,418	198,745	63,296	346,458	0.318	0.743
2030	87,253	203,791	70,476	361,520	.346	.774
2035	92,920	209,278	74,306	376,504	.355	.799
2040	100,023	214,663	76,000	390,686	.354	.820
2045	106,934	219,951	76,896	403,781	.350	.836
2050	111,039	226,626	78,526	416,191	.346	.836
2055	113,963	233,994	81,050	429,007	.346	.833
2060	117,406	241,543	84,410	443,359	.349	.836
2065	122,333	249,500	87,555	459,388	.351	.841
2070	128,470	257,005	90,841	476,316	.353	.853
2075	134,696	264,362	94,311	493,369	.357	.866
2080	139,946	274,208	96,193	510,347	.351	.861
2085	144,201	286,248	97,169	527,618	.339	.843
2090	148,393	299,069	98,298	545,760	.329	.825
2095	153,341	309,943	101,804	565,088	.328	.823
2100	159,119	319,668	106,719	585,506	.334	.832
High-cost:						
2025	81,094	195,509	63,586	340,189	.325	.740
2030	77,541	196,823	71,689	346,053	.364	.758
2035	75,687	198,661	76,970	351,318	.387	.768
2040	74,922	200,530	80,458	355,910	.401	.775
2045	75,517	200,820	83,231	359,568	.414	.790
2050	75,991	199,521	86,595	362,106	.434	.815
2055	75,444	197,825	90,547	363,816	.458	.839
2060	74,065	196,139	95,002	365,206	.484	.862
2065	72,628	195,037	98,988	366,654	.508	.880
2070	71,842	193,179	103,102	368,123	.534	.906
2075	71,694	190,053	107,489	369,235	.566	.943
2080	71,724	187,720	110,214	369,657	.587	.969
2085	71,443	185,982	111,904	369,329	.602	.986
2090	70,744	185,631	112,105	368,480	.604	.985
2095	69,896	185,620	111,877	367,394	.603	.979
2100	69,235	184,999	112,060	366,294	.606	.980

[a] Ratio of the population at ages 65 and over to the population at ages 20-64.
[b] Ratio of the population at ages 65 and over and the population under age 20 to the population at ages 20-64.
[c] Estimated.
[d] Estimated, intermediate alternative.

Notes:
1. Historical data are subject to revision.
2. Components may not sum to totals because of rounding.

5. Life Expectancy Estimates

Life expectancy, or the average remaining number of years expected prior to death, is an additional way to summarize the Trustees' mortality assumptions. This report includes life expectancy at both birth and at age 65, in two different forms (period and cohort), which are useful for separate purposes.

- Period life expectancy at a selected age for a particular year incorporates the actual or expected death rates at the selected age and each older age for that year. It is a useful summary statistic for illustrating the overall level of the death rates at or above the given age experienced in a single year. Period life expectancy for a particular year provides an individual's expected average remaining lifetime at a selected age, assuming no change in death rates after that year. Table V.A4 presents historical and projected life expectancy calculated on a period basis.
- Cohort life expectancy does not incorporate death rates for a single year, but for the series of years in which the individual will actually reach each succeeding age if he or she survives. Cohort life expectancy provides the expected average remaining lifetime for an individual at a selected age in a particular year, using actual or expected future death rates for the selected age and all succeeding ages. Table V.A5 presents historical and projected life expectancy calculated on a cohort basis. Cohort life expectancy is generally greater than period life expectancy for a given year because: (1) death rates at any age generally decline over time; and (2) cohort life expectancy uses death rates for future years, while period life expectancy uses death rates only for the given year.

Life expectancy at a given age reflects death rates at that and all older ages. Period life expectancy is somewhat related to the age-sex-adjusted death rate discussed in section V.A.2. However, life expectancy places far greater weight on death rates at relatively younger ages (those at or just above the given age) than those at relatively older ages. Therefore, changes in death rates at young ages, particularly in infancy, affect life expectancy at birth to a much greater degree than changes in death rates at older ages. It is important to keep this concept in mind when considering trends in life expectancy.

Table V.A4.—Period Life Expectancy[a]

Calendar year	Historical data			
	At birth		At age 65	
	Male	Female	Male	Female
1940	61.4	65.7	11.9	13.4
1945	62.9	68.4	12.6	14.4
1950	65.6	71.1	12.8	15.1
1955	66.7	72.8	13.1	15.6
1960	66.7	73.2	12.9	15.9
1965	66.8	73.8	12.9	16.3
1970	67.1	74.9	13.1	17.1
1975	68.7	76.6	13.7	18.0
1980	69.9	77.5	14.0	18.4
1985	71.1	78.2	14.4	18.6
1990	71.8	78.9	15.0	19.0
1995	72.5	79.1	15.4	19.0
2000	74.0	79.4	15.9	19.0
2005	74.8	80.0	16.7	19.5
2010	76.1	80.9	17.5	20.2
2015	76.1	80.9	17.8	20.3
2016	76.0	81.0	17.9	20.5
2017	76.0	81.0	17.9	20.5
2018	76.1	81.1	18.0	20.5
2019	76.2	81.3	18.1	20.7
2020[b] . . .	74.1	79.8	16.9	19.7
2021[c] . . .	73.5	79.3	17.0	19.8
2022[d] . . .	75.1	80.3	17.5	20.1

Calendar year	Intermediate				Low-cost				High-cost			
	At birth		At age 65		At birth		At age 65		At birth		At age 65	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
2025	76.6	81.6	18.4	21.0	76.1	81.2	18.2	20.7	77.1	82.1	18.8	21.3
2030	77.1	82.1	18.8	21.3	76.2	81.4	18.3	20.8	78.2	83.0	19.4	21.9
2035	77.6	82.5	19.1	21.6	76.4	81.5	18.4	20.9	79.2	83.8	20.0	22.4
2040	78.1	83.0	19.4	21.9	76.6	81.7	18.5	21.0	80.2	84.6	20.6	23.0
2045	78.7	83.4	19.7	22.2	76.8	81.8	18.6	21.1	81.1	85.4	21.2	23.5
2050	79.2	83.8	20.0	22.4	77.0	82.0	18.7	21.2	82.0	86.1	21.7	24.0
2055	79.7	84.3	20.3	22.7	77.2	82.2	18.8	21.3	82.9	86.8	22.2	24.4
2060	80.2	84.7	20.6	23.0	77.3	82.3	18.9	21.4	83.7	87.5	22.7	24.8
2065	80.7	85.0	20.9	23.2	77.5	82.5	19.0	21.5	84.4	88.1	23.2	25.3
2070	81.1	85.4	21.2	23.5	77.7	82.6	19.1	21.6	85.1	88.6	23.7	25.6
2075	81.6	85.8	21.4	23.7	77.9	82.8	19.3	21.7	85.8	89.1	24.1	26.0
2080	82.0	86.1	21.7	23.9	78.1	82.9	19.4	21.8	86.4	89.6	24.5	26.4
2085	82.4	86.5	22.0	24.2	78.3	83.1	19.5	21.9	87.0	90.1	24.9	26.7
2090	82.9	86.8	22.2	24.4	78.4	83.2	19.6	22.0	87.6	90.5	25.2	27.0
2095	83.3	87.1	22.5	24.6	78.6	83.4	19.7	22.1	88.1	91.0	25.6	27.3
2100	83.6	87.4	22.7	24.8	78.8	83.5	19.8	22.2	88.6	91.3	25.9	27.6

[a] The period life expectancy at a given age for a given year is the average remaining number of years expected prior to death for a person at that exact age, born on January 1, using the mortality rates for that year over the course of his or her remaining life.
[b] Estimated using final data for ages below 65 and preliminary data for ages 65 and older.
[c] Estimated using the intermediate assumptions for ages below 65 and preliminary data for ages 65 and older.
[d] Estimated, intermediate alternative.

Table V.A5.—Cohort Life Expectancy[a]

Calendar year	Intermediate				Low-cost				High-cost			
	At birth[b]		At age 65[c]		At birth[b]		At age 65[c]		At birth[b]		At age 65[c]	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1940	70.2	76.4	12.7	14.7	70.1	76.3	12.7	14.7	70.3	76.6	12.7	14.7
1945	71.9	78.0	13.0	15.4	71.7	77.8	13.0	15.4	72.1	78.3	13.0	15.4
1950	73.0	79.4	13.1	16.2	72.7	79.0	13.1	16.2	73.4	79.9	13.1	16.2
1955	73.6	79.9	13.1	16.7	73.1	79.3	13.1	16.7	74.2	80.6	13.1	16.7
1960	74.2	80.2	13.2	17.4	73.5	79.5	13.2	17.4	75.1	81.2	13.2	17.4
1965	75.0	80.8	13.5	18.0	74.2	79.8	13.5	18.0	76.3	82.1	13.5	18.0
1970	76.2	81.6	13.8	18.5	75.1	80.5	13.8	18.5	77.8	83.2	13.8	18.5
1975	77.1	82.3	14.2	18.7	75.6	80.9	14.2	18.7	79.0	84.2	14.2	18.7
1980	77.7	83.0	14.7	18.8	76.0	81.3	14.7	18.8	80.1	85.1	14.7	18.8
1985	78.3	83.5	15.4	19.1	76.3	81.6	15.4	19.1	81.0	85.9	15.4	19.1
1990	78.9	83.9	16.0	19.3	76.6	81.8	16.0	19.3	81.9	86.6	16.0	19.3
1995	79.5	84.5	16.7	19.7	76.9	82.1	16.7	19.6	82.8	87.4	16.7	19.7
2000	80.0	84.9	17.3	20.0	77.1	82.3	17.3	19.9	83.6	88.0	17.4	20.1
2005	80.5	85.3	17.8	20.4	77.3	82.5	17.7	20.3	84.4	88.6	17.9	20.6
2010	81.0	85.7	18.2	20.8	77.6	82.7	17.9	20.5	85.2	89.1	18.5	21.2
2015	81.5	86.0	18.5	21.1	77.8	82.8	18.1	20.7	85.9	89.7	19.0	21.8
2016	81.6	86.1	18.5	21.2	77.8	82.8	18.1	20.7	86.0	89.8	19.1	21.9
2017	81.7	86.2	18.6	21.3	77.9	82.9	18.1	20.7	86.2	89.9	19.3	22.0
2018	81.8	86.3	18.6	21.3	77.9	82.9	18.1	20.8	86.3	90.0	19.4	22.1
2019	81.9	86.3	18.7	21.4	78.0	83.0	18.2	20.8	86.5	90.1	19.5	22.2
2020	82.0	86.4	18.8	21.5	78.0	83.0	18.2	20.8	86.6	90.2	19.6	22.3
2021	82.1	86.5	18.9	21.6	78.0	83.0	18.2	20.9	86.7	90.3	19.8	22.5
2022	82.2	86.5	19.0	21.7	78.1	83.0	18.3	20.9	86.9	90.4	20.0	22.7
2025	82.4	86.8	19.3	21.9	78.2	83.1	18.4	21.0	87.3	90.7	20.5	23.1
2030	82.9	87.1	19.6	22.2	78.4	83.3	18.5	21.1	87.9	91.2	21.1	23.6
2035	83.3	87.5	19.9	22.5	78.5	83.4	18.7	21.2	88.5	91.7	21.7	24.1
2040	83.7	87.8	20.2	22.7	78.7	83.6	18.8	21.3	89.1	92.1	22.2	24.6
2045	84.1	88.1	20.5	23.0	78.9	83.7	18.9	21.4	89.7	92.5	22.8	25.1
2050	84.5	88.4	20.8	23.3	79.1	83.9	19.0	21.5	90.2	92.9	23.3	25.5
2055	84.9	88.7	21.1	23.5	79.3	84.0	19.1	21.6	90.7	93.2	23.8	25.9
2060	85.3	89.0	21.4	23.8	79.4	84.2	19.2	21.7	91.1	93.6	24.2	26.3
2065	85.6	89.2	21.7	24.0	79.6	84.3	19.3	21.8	91.6	93.9	24.6	26.6
2070	86.0	89.5	22.0	24.2	79.8	84.4	19.4	21.9	92.0	94.2	25.0	27.0
2075	86.3	89.8	22.2	24.5	79.9	84.6	19.5	22.0	92.4	94.5	25.4	27.3
2080	86.6	90.0	22.5	24.7	80.1	84.7	19.6	22.1	92.8	94.8	25.8	27.6
2085	86.9	90.2	22.7	24.9	80.3	84.8	19.7	22.2	93.2	95.1	26.2	27.9
2090	87.2	90.5	23.0	25.1	80.4	85.0	19.8	22.3	93.5	95.4	26.5	28.2
2095	87.5	90.7	23.2	25.3	80.6	85.1	19.9	22.4	93.9	95.7	26.8	28.5
2100	87.8	90.9	23.4	25.5	80.7	85.2	20.0	22.5	94.2	95.9	27.2	28.7

[a] The cohort life expectancy at a given age for a given year is the average remaining number of years expected prior to death for a person at that exact age, born on January 1, using the mortality rates for the series of years in which the individual will actually reach each succeeding age if he or she survives.

[b] Cohort life expectancy at birth for those born in the calendar year is based on a combination of actual, estimated, and projected death rates for birth years 1940 through 2020. For birth years after 2020, these values depend on estimated and projected death rates.

[c] Age 65 cohort life expectancy for those attaining age 65 in calendar years 1940 through 2019 is based on a combination of actual, estimated, and projected death rates. After 2019, these values depend on estimated and projected death rates.

B. ECONOMIC ASSUMPTIONS AND METHODS

The three alternative sets of economic assumptions are intended to provide a reasonable range for estimating the future financial status of the trust funds. The intermediate assumptions reflect the Trustees' consensus expectation of moderate economic growth after completion of the recovery from the pandemic-induced recession and a period of slow growth in 2023, and their best estimates for other economic parameters. The low-cost assumptions represent a more optimistic outlook with a faster recovery to a higher level of economic output, stronger long-term economic growth, and relatively optimistic levels for other parameters. The high-cost assumptions represent a more pessimistic scenario with a recession in 2023, slower economic growth in the long term, and relatively pessimistic levels for other parameters.

Actual economic data were generally available through the third quarter of 2022 at the time the assumptions for this report were set. Those data indicate that economic activity reached a peak in the fourth quarter of 2019.[1] The recession started in the first quarter of 2020 due to the precipitous decline in economic activity in March of 2020, continuing in April of 2020, leading to the gross domestic product (GDP) in the second quarter of 2020 being almost 10 percent below the peak in the fourth quarter of 2019, expressed in constant 2012 dollars. GDP recovered rapidly, surpassing the fourth quarter 2019 peak in the first quarter of 2021. In the third quarter of 2022, GDP was about 4 percent above the previous peak.

Under the intermediate assumptions, the economy is estimated to be 1 percent above its sustainable trend level of output in the third quarter of 2022 and is then projected to grow slowly, reaching a level of almost 1 percent below the sustainable trend level at the end of 2023. Stronger growth is projected thereafter, with GDP reaching and stabilizing at the sustainable trend level in the first quarter of 2027. The sustainable trend level of GDP is assumed to be 3 percent lower at the end of 2025 and thereafter than was assumed for the intermediate assumptions in the 2022 report. Under the low-cost assumptions, the economy is projected to grow at a faster rate and return to a higher sustainable trend level of output in the first quarter of 2026. Under the high-cost assumptions, the sustainable trend level is assumed to be lower, and GDP was significantly above it in 2022; GDP is projected to fall to 2.5 percent below that lower sustainable trend level in the fourth quarter of 2023 and then to recover fully by the fourth quarter of 2027. Complete eco-

[1] On a monthly basis, economic activity peaked in February 2020, but the decline in March was sharp enough that the output in the first quarter of 2020 was substantially below the output in the fourth quarter of 2019. See www.nber.org/news/business-cycle-dating-committee-announcement-june-8-2020.

nomic cycles have little effect on the long-range estimates of financial status of the trust funds, so the assumptions do not include cycles beyond the short-range period (2023 through 2032).

The key economic assumptions underlying the three sets of projections of the future financial status of the OASI and DI Trust Funds are discussed in the remainder of this section.

1. Productivity Assumptions

Total U.S. economy productivity is defined as the ratio of real GDP to hours worked by all workers.[1] The rate of change in total-economy productivity is a major determinant of the growth of average earnings. Over the last six complete economic cycles (1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, measured peak to peak), the annual increase in total-economy productivity averaged 2.64, 1.06, 1.39, 1.84, 2.15, and 1.09 percent, respectively. For the period from 1969 to 2019, covering those last six complete economic cycles, the annual increase in total-economy productivity averaged 1.57 percent.

The assumed ultimate annual increase in total-economy productivity is 1.93, 1.63, and 1.33 percent for the low-cost, intermediate, and high-cost assumptions, respectively.[2] These rates of increase are unchanged from the 2022 report.

The average annual rate of change in total-economy productivity from 2019 (the end of the last complete economic cycle) to 2022 is estimated to be 1.52 percent. For the intermediate assumptions, the annual rate of change in productivity is assumed to be 0.18 percent for 2023, 1.11 percent for 2024, averages 1.47 percent for 2025 through 2028, and reaches its ultimate value of 1.63 percent for 2029 and thereafter. For the low-cost assumptions, the annual rate of change in productivity is 0.87 percent for 2023, averages 2.00 percent for 2024 through 2027, and reaches its ultimate value of 1.93 percent for 2028 and thereafter. For the high-cost assumptions, the assumed recession lowers the annual rate of change in productivity to -1.71 percent for 2023. The growth rate rebounds to an average of 1.49 percent for 2024 through 2027, averages 1.28 percent for 2028 through 2030, and stabilizes at its ultimate value of 1.33 percent for 2031 and there-

[1] Historical levels of real GDP are from the National Income and Product Accounts (NIPA) produced by the Bureau of Economic Analysis (BEA). Historical total hours worked are provided by the Bureau of Labor Statistics (BLS) and cover all U.S. Armed Forces and civilian employment.

[2] These assumptions for total-economy productivity are consistent with ultimate annual increases in private nonfarm business productivity of 2.36, 2.00, and 1.63 percent. Private nonfarm business productivity excludes the farm, government, nonprofit institution, and private household sectors.

after. The combined effect of data revisions, new data for 2022, and less optimistic near-term projections lowered the average productivity growth rate from 2019 to 2032 from 1.67 percent in the 2022 report to 1.40 percent for this report under the intermediate assumptions.

2. Price Inflation Assumptions

Changes in the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI) directly affect the OASDI program through the automatic cost-of-living benefit increases. Changes in the GDP price index (GDP deflator) affect the nominal levels of GDP, wages, self-employment income, average earnings, and taxable payroll. For a given real rate of growth in average earnings, a higher price inflation rate immediately results in a higher nominal rate of growth in both earnings and revenues, while the resulting added growth in nominal benefit levels occurs with a delay, causing an overall increase (improvement) in the actuarial balance. Similarly, a lower price inflation rate causes an overall decrease in the actuarial balance.

The annual increase in the CPI averaged 4.91, 8.54, 5.30, 2.73, 2.63, and 1.73 percent over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively.[1] The annual increase in the GDP deflator averaged 5.04, 7.54, 4.61, 2.08, 2.52, and 1.62 percent for the respective economic cycles. For the period from 1969 to 2019, covering the last six complete economic cycles, the annual increase in the CPI and the GDP deflator averaged 3.89 and 3.45 percent, respectively. The annual rate of change for 2020, which was affected by the recession, was 1.21 percent for the CPI and 1.35 percent for the GDP deflator. During the subsequent recovery, aggregate demand increased while supply was constrained, leading to a 2021 growth rate of 5.26 percent for the CPI and 4.49 percent for the GDP deflator and an estimated 2022 growth rate of 8.51 percent for the CPI and 7.03 percent for the GDP deflator.

The assumed ultimate annual increase in the CPI is 3.00, 2.40, and 1.80 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These values are unchanged from the 2022 report.

For the intermediate assumptions, the annual rate of change in the CPI is 4.00 percent for 2023, 2.53 percent for 2024, and reaches the ultimate

[1] BLS produces a series called the Consumer Price Index Research Series Using Current Methods (CPI-U-RS) that approximates the measured rate of inflation since 1978 had the method currently used been in effect since then. BLS does not revise the CPI values published in earlier years, for which different methods were used. These CPI published values are shown in table V.B1. The Trustees use an adjusted CPI series based on the CPI-U-RS when setting the ultimate price inflation assumption because it provides a time series that is consistent with the current method for computing the CPI.

growth rate of 2.40 percent for 2025 and thereafter. For the low-cost assumptions, the annual rate of change in the CPI is 3.90 percent for 2023, 3.02 percent for 2024, and reaches its ultimate growth rate of 3.00 percent for 2025 and thereafter. For the high-cost assumptions, the annual rate of change in the CPI is 4.56 percent for 2023, 2.92 percent for 2024, 1.86 percent for 2025, and reaches its ultimate growth rate of 1.80 percent for 2026 and thereafter.

The annual increase in the GDP deflator differs from the annual increase in the CPI because the two indices are constructed using different computational methods and coverage (the set of goods and services used in the measurement). The difference between the rate of change in the CPI and the rate of change in the GDP deflator is called the price differential in this report. For the period including 1969 through 2019, covering the last six complete economic cycles, the average annual price differential was 0.46 percentage point. For 2020, the annual price differential was -0.13 percentage point, for 2021 it was 0.77 percentage point, and for 2022 it is estimated to be 1.49 percentage points.

The fluctuations in the price differential for 2020-22 primarily reflect a decline and subsequent increase in oil prices, as well as price increases concentrated in consumer goods categories during the economic recovery. Changes in oil prices affect the CPI much more than the GDP deflator because oil comprises a much larger share of U.S. consumption than of U.S. production. Oil prices are assumed to grow at a relatively stable rate in the future. For the intermediate assumptions, the price differential is 0.11 percentage point for 2023, 0.36 percentage point for 2024, and 0.35 percentage point for 2025 and later.

The assumed ultimate price differential is 0.25, 0.35, and 0.45 percentage point for the low-cost, intermediate, and high-cost alternative, respectively. Varying the ultimate projected price differential across alternatives recognizes the historical variation in this measure. Accordingly, the assumed ultimate annual increase in the GDP deflator is 2.75 (3.00 less 0.25), 2.05 (2.40 less 0.35), and 1.35 (1.80 less 0.45) percent for the low-cost, intermediate, and high-cost alternative, respectively. The ultimate price differentials for the three alternatives are unchanged from the 2022 report.

3. Average Earnings Assumptions

The size of the taxable payroll—the main source of the OASDI program's income—for each year depends primarily on the nominal earnings in OASDI

covered employment, which is the product of covered employment[1] for the year and average covered earnings for the year. Average covered earnings also affects the future level of average benefits. In addition, the average reported annual wage in the U.S. economy determines the national average wage index (AWI). Under the automatic adjustment provisions in the law, the growth in the AWI affects the contribution and benefit base, certain parameters used in the OASDI benefit formula, and certain other program parameters.[2]

The projected growth rate in average annual covered earnings and in the AWI are derived from the projected growth rate in average U.S. earnings. Average U.S. earnings is defined as the ratio of the sum of total U.S. wages and net proprietors' income to the sum of average weekly U.S. civilian employment and Armed Forces. The growth rate in average U.S. earnings for any period is equal to the combined growth rates for total U.S. economy productivity, average hours worked per week, the ratio of earnings to total labor compensation (which includes fringe benefits), the ratio of total labor compensation to GDP, and the GDP deflator.

The average annual change in average hours worked per week was -0.20 percent over the last six complete economic cycles covering the period from 1969 to 2019. The annual change in average hours worked averaged -0.87, -0.53, -0.09, 0.11, -0.47, and -0.05 percent over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively. From 2019 to 2022, the first three years after the peak of the last complete cycle, the average annual change in average hours worked per week is estimated to be a decrease of 0.03 percent.

The assumed ultimate annual rate of change for average hours worked per week is 0.05, -0.05, and -0.15 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These values are unchanged from the 2022 report.

The average annual change in the ratio of earnings to total labor compensation was -0.14 percent from 1969 to 2019. Data from BEA indicate that the most significant component of this change was the relative increase in the cost of employer-sponsored group health insurance (ESGHI) for wage workers, followed by the increase in employer contributions to social insurance (as statutory payroll tax rates increased between 1970 and 1990), and, to a lesser extent, an increase in employer contributions to retirement plans.

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[1] Covered employment for a year is defined as the total number of persons who have any OASDI covered earnings (that is, earnings subject to the OASDI payroll tax) at any time during that year. See section V.C.2 for a more detailed discussion of covered employment.

[2] See section V.C.1 for a discussion of the AWI and the parameters indexed to it.

Assuming that the level of total employee compensation is not affected by the amount of non-wage compensation, such as ESGHI, any increase or decrease in the cost of non-wage compensation leads to a commensurate decrease or increase in wages. Projections of future ratios of earnings to total labor compensation follow this principle.

The average annual rate of change in the ratio of wages to employee compensation was -0.17 percent from 1969 to 2019. The average annual rate of change in this ratio increased sharply to 0.40 percent for the period 2019 to 2022 due to the unusual effects of the pandemic-induced recession. The average annual rate from 2022 to 2032 is assumed to be about 0.02, -0.08, and -0.13 percent for the low-cost, intermediate, and high-cost assumptions, respectively. For the last 65 years of the long-range period, from 2032 to 2097, the average rate is assumed to be about 0.00, -0.10, and -0.20 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These average rates are slightly higher (i.e., less negative) than those assumed for the 2022 report. Under the intermediate assumptions, the ratio of wages to employee compensation declines from 0.824 for 2022 to 0.767 for 2097.

Because earnings and compensation are the same for self-employed workers, the ratio of earnings to total labor compensation includes self-employment income both in the numerator and in the denominator. As a result, the rate of change in the ratio of earnings to total labor compensation (which, under the intermediate assumptions, averages -0.08 percent from 2032 to 2097) is slightly higher (i.e., less negative) than the rate of change in the ratio of wages to employee compensation.

The ratio of total labor compensation (i.e., employee compensation and net proprietors' income) to GDP varies over the economic cycle and with changes in the relative sizes of different sectors of the economy. Over the last six complete economic cycles from 1969 to 2019, this ratio has averaged 0.622. This ratio increased to 0.628 for 2020, declined to 0.613 for 2021, and is estimated to decrease to 0.605 for 2022. It is then projected to gradually rise to reach 0.628 by 2032 under the intermediate assumptions. For years after 2032, the relative sizes of different sectors of the economy are assumed to remain about constant,[1] and therefore the ratio of total labor compensation to GDP remains at about the 2032 level for each set of assumptions.

[1] The sole exception is employment in the U.S. Armed Forces, which has declined in size over the last 40 years and is assumed to remain at its 2020 level throughout the 75-year projection period.

For the intermediate assumptions, the projected average annual growth rate in average nominal U.S. earnings from 2022 to 2032 is 3.95 percent. The projected average annual growth rate from 2032 to 2097 is 3.58 percent, which reflects the assumed ultimate annual growth rates of 1.63 percent for productivity, -0.05 percent for average hours worked, 2.05 percent for the GDP deflator, and -0.08 percent for the ratio of earnings to total labor compensation. Over the same period, the projected average annual growth rate in average nominal U.S. earnings is 4.79 percent for the low-cost assumptions and 2.37 percent for the high-cost assumptions.

The average annual wage in OASDI covered employment (often referred to as the "average covered wage") is defined as the total wages and salaries paid in OASDI covered employment during the year, divided by the number of workers who worked in OASDI covered employment at any time during the year. Over long periods, the average annual growth rate in the average covered wage is expected to be very close to the average annual growth rate in average U.S. earnings. The estimated annual rate of change in the average covered wage is 4.79 percent for 2022 under the intermediate assumptions. From 2022 to 2032, the annual rate of change in the average covered wage averages 5.37, 3.99, and 2.97 percent for the low-cost, intermediate, and high-cost assumptions, respectively. The projected average annual growth rate in the average covered wage from 2032 to 2097 is 4.79, 3.56, and 2.35 percent for the low-cost, intermediate, and high-cost assumptions, respectively.

4. Assumed Real Wage Growth

For the period from 1969 to 2019, covering the last six complete economic cycles, the annual real (i.e., inflation-adjusted) growth rate in the average covered wage averaged 0.77 percent, the result of averages of 0.98, 0.03, 0.45, 1.43, 0.80, and 0.76 percent over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively.[1]

For the period 2032 to 2097, the projected average annual real wage growth rate in OASDI covered employment is 1.74, 1.14, and 0.54 percent for the low-cost, intermediate, and high-cost assumptions, respectively. The average annual real wage growth rates are slightly higher than those in the 2022 report.[2]

The real wage increased 1.52 percent for 2020, a year which included the pandemic-induced recession and the beginning of the recovery. It then

[1] In previous Trustees Reports, the real increase in the average covered wage was expressed in the form of a real wage differential—the annual percentage change in the average wage in OASDI covered employment minus the annual percentage change in the CPI.

increased 3.89 percent for 2021, during the continuing rapid recovery from the recession, and is estimated to decrease 3.43 percent for 2022 under the intermediate assumptions, primarily due to the high inflation rate. For the intermediate assumptions, the annual real wage growth rate is projected to be 0.15 percent in 2023, increase to 1.20 percent in 2024, average 1.64 percent for 2025 through 2027, average 1.57 percent for 2028 through 2031, and average 1.14 percent from 2032 to 2097. For the low-cost assumptions, the annual real wage growth rate is 0.79 percent for 2023, averages 2.77 percent for 2024 through 2026, and gradually declines to its long-term average of 1.74 percent from 2032 to 2097. For the high-cost assumptions, the real wage growth rate is -2.58 percent for 2023 and 0.70 percent for 2024. It then averages 1.67 percent for 2025 through 2027, and gradually reaches its long-term average of 0.54 percent from 2032 to 2097.

[2] In the 2022 report, the projected average real wage differential was 1.77, 1.15, and 0.53 percentage points for the low-cost, intermediate, and high-cost assumptions, respectively. The corresponding average real growth rate was 1.72, 1.12, and 0.52 percent for the low-cost, intermediate, and high-cost assumptions, respectively.

Table V.B1.—Principal Economic Assumptions

Calendar year	Annual percentage change[a] in—						
	Productivity (Total U.S. economy)	GDP price index	Average hours worked per week	Earnings as a percent of total labor compensation	Average annual wage in covered employment		Consumer price index
					Nominal	Real	
Historical data:							
5-year periods:							
1960 to 1965 . . .	3.23	1.36	0.19	-0.18	3.22	1.95	1.24
1965 to 1970 . . .	2.04	4.02	-.66	-.30	5.84	1.55	4.23
1970 to 1975 . . .	2.07	6.61	-.87	-.49	6.58	-.17	6.76
1975 to 1980 . . .	.94	7.21	-.16	-.33	8.88	-.02	8.91
1980 to 1985 . . .	1.71	5.24	.03	-.36	6.52	1.24	5.22
1985 to 1990 . . .	1.33	3.14	-.06	-.20	4.79	.93	3.83
1990 to 1995 . . .	1.30	2.45	.34	-.11	3.54	.49	3.03
1995 to 2000 . . .	2.31	1.67	.15	.28	5.31	2.81	2.43
2000 to 2005 . . .	2.63	2.32	-.79	-.38	2.69	.19	2.49
2005 to 2010 . . .	1.88	1.91	-.51	-.03	2.51	.21	2.30
2010 to 2015 . . .	.35	1.71	.45	.16	2.93	1.30	1.61
2015 to 2020 . . .	1.58	1.69	-.16	.10	2.95	1.23	1.70
Economic cycles:[b]							
1969 to 1973 . . .	2.64	5.04	-.87	-.34	5.94	.98	4.91
1973 to 1979 . . .	1.06	7.54	-.53	-.43	8.58	.03	8.54
1979 to 1990 . . .	1.39	4.61	-.09	-.29	5.78	.46	5.30
1990 to 2001 . . .	1.84	2.08	.11	.05	4.19	1.42	2.73
2001 to 2007 . . .	2.15	2.52	-.47	-.18	3.45	.80	2.63
2007 to 2019 . . .	1.09	1.62	-.05	.04	2.50	.76	1.73
2019 to 2022[c] . .	1.52	4.26	-.03	.33	5.60	.61	4.95
Single years:							
2012	.34	1.88	.13	.47	3.33	1.20	2.10
2013	.52	1.77	.33	-.33	1.23	-.14	1.37
2014	.31	1.86	.36	.27	3.60	2.07	1.50
2015	.61	.96	.41	.05	3.38	3.81	-.41
2016	.45	1.00	-.50	.10	1.29	.31	.98
2017	1.04	1.93	-.05	.14	3.47	1.32	2.13
2018	1.03	2.41	.32	-.10	3.65	1.08	2.55
2019	1.32	1.78	-.15	.19	3.62	1.92	1.66
2020	4.11	1.35	-.43	.17	2.76	1.52	1.21
2021	1.49	4.49	1.11	.48	9.36	3.89	5.26
2022[c]	-.99	7.03	-.77	.34	4.79	-3.43	8.51
Intermediate:							
2023	.18	3.89	.30	-.16	4.15	.15	4.00
2024	1.11	2.17	-.04	-.13	3.76	1.20	2.53
2025	1.40	2.05	-.04	-.04	4.06	1.62	2.40
2026	1.44	2.05	-.03	[d]	4.10	1.66	2.40
2027	1.47	2.05	-.04	[d]	4.08	1.64	2.40
2028	1.56	2.05	-.05	-.03	4.01	1.57	2.40
2029	1.63	2.05	-.05	-.05	4.03	1.60	2.40
2030	1.63	2.05	-.05	-.07	4.01	1.57	2.40
2031	1.63	2.05	-.05	-.07	3.98	1.54	2.40
2032	1.63	2.05	-.05	-.07	3.76	1.33	2.40
2032 to 2097 . . .	1.63	2.05	-.05	-.08	3.56	1.14	2.40

Table V.B1.—Principal Economic Assumptions (Cont.)

Calendar year	Annual percentage change[a] in— Productivity (Total U.S. economy)	GDP price index	Average hours worked per week	Earnings as a percent of total labor compensation	Average annual wage in covered employment: Nominal	Average annual wage in covered employment: Real	Consumer price index
Low-cost:							
2023	0.87	3.86	0.36	-0.14	4.73	0.79	3.90
2024	1.95	2.79	.07	-.11	5.82	2.71	3.02
2025	2.16	2.75	.09	-.01	6.17	3.08	3.00
2026	1.96	2.75	.06	.03	5.61	2.53	3.00
2027	1.94	2.75	.05	.04	5.34	2.27	3.00
2028	1.93	2.75	.05	.02	5.29	2.22	3.00
2029	1.93	2.75	.05	.01	5.26	2.20	3.00
2030	1.93	2.75	.05	[d]	5.25	2.19	3.00
2031	1.93	2.75	.05	.01	5.24	2.18	3.00
2032	1.93	2.75	.05	.01	5.04	1.98	3.00
2032 to 2097	1.93	2.75	.05	[d]	4.79	1.74	3.00
High-cost:							
2023	-1.71	4.16	.20	-.16	1.86	-2.58	4.56
2024	1.53	2.28	-.12	-.13	3.63	.70	2.92
2025	1.50	1.41	-.12	-.06	3.71	1.81	1.86
2026	1.41	1.35	-.14	-.04	3.44	1.61	1.80
2027	1.51	1.35	-.15	-.05	3.43	1.60	1.80
2028	1.28	1.35	-.15	-.09	2.92	1.10	1.80
2029	1.26	1.35	-.15	-.11	2.74	.92	1.80
2030	1.30	1.35	-.15	-.14	2.72	.91	1.80
2031	1.33	1.35	-.15	-.14	2.72	.90	1.80
2032	1.33	1.35	-.15	-.16	2.50	.69	1.80
2032 to 2097	1.33	1.35	-.15	-.17	2.35	.54	1.80

[a] For rows with a single year listed, the value is the annual percentage change from the prior year. For rows with a range of years listed, the value is the compound average annual percentage change.
[b] Economic cycles are shown from peak to peak, except for the last cycle, which is not yet complete.
[c] Estimated values for 2022 vary slightly by alternative and are shown for the intermediate assumptions.
[d] Greater than -0.005 and less than 0.005 percent.

5. Labor Force, Employment, and Unemployment Projections

Employment is a fundamental component of economic output (GDP), taxable payroll, and the determination of OASDI benefit eligibility and benefit levels. U.S. employment is projected in two components: the size of the labor force (those employed or seeking employment) and the unemployment rate (the proportion of those in the labor force who are not employed). Table V.B2 provides the historical and projected rates of change in employment, which follow from the rates of change in the labor force, adjusted for the varying unemployment rates from year to year.

The model used by the Office of the Chief Actuary projects the civilian labor force by age, sex, marital status, and presence of children. Projections of the labor force participation rates reflect changes in disability prevalence, educational attainment, marriage patterns, the average level of Social Security retirement benefits, the state of the economy, and life expectancy.

The annual rate of growth in the size of the labor force decreased from an average of about 2.6 percent during the 1969-73 economic cycle and 2.7 percent during the 1973-79 cycle to 1.7 percent during the 1979-90 cycle, 1.2 percent during the 1990-2001 cycle, 1.1 percent during the 2001-07 cycle, and 0.5 percent during the 2007-19 cycle. From 2019 to 2022, during the current (incomplete) economic cycle, labor force growth averaged 0.2 percent per year, which combines the fall in the labor force during the pandemic-induced recession of 2020 and the growth in the labor force in 2021-22. Going forward, labor force growth is projected to be 0.8 percent in 2023, rising to 1.2 percent in 2024, and then converging to the long-term trend of about 0.4 percent per year by 2032. The long-term growth rate in the labor force is expected to remain subdued due to a slowing of growth in the working-age population—a consequence of the baby-boom generation reaching retirement ages and succeeding lower-birth-rate cohorts reaching working ages. Under the intermediate assumptions, the labor force is projected to increase by an average of 0.7 percent per year from 2022 to 2032 and 0.4 percent per year from 2032 to 2097.

Labor force participation rates are projected with a model that uses demographic and economic assumptions specific to each alternative. More optimistic economic assumptions in the low-cost alternative are consistent with higher labor force participation rates, while demographic assumptions in the low-cost alternative (such as slower improvement in longevity) are consistent with lower labor force participation rates. These economic and demographic influences have largely offsetting effects. Therefore, the projected labor force participation rates do not vary substantially across alternatives.

Historically, labor force participation rates reflect trends in demographics and pensions. Between the mid-1960s and the mid-1980s, labor force participation rates at ages 55 and over declined for men but were fairly stable for women. During this period, the baby-boom generation reached working age and more women entered the labor force. This increasing supply of labor allowed employers to offer attractive early retirement options. Between the mid-1980s and the mid-1990s, participation rates at ages 55 and over roughly stabilized for men and increased for women. Since the mid-1990s, however, participation rates for both sexes at ages 55 and over have generally risen.

Many economic and demographic factors, including longevity, disability prevalence, the business cycle, incentives for retirement in Social Security and private pensions, education, and marriage patterns, will influence future labor force participation rates. The Office of the Chief Actuary models some of these factors explicitly. To model the effects of other factors related to increases in life expectancy, projected participation rates are adjusted upward for mid-career and older ages to reflect projected increases in life expec-

tancy. For the intermediate projections, this adjustment increases the total labor force by 3.0 percent for 2097.

For men and boys age 16 and over, the projected age-adjusted labor force participation rate[1] for 2097 is 72.8, 72.6, and 72.1 percent for the low-cost, intermediate, and high-cost assumptions, respectively. For women and girls age 16 and over, the projected age-adjusted labor force participation rate for 2097 is 62.3, 61.9, and 61.7 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These age-adjusted labor force participation rates for 2097 are higher under all three alternatives than the age-adjusted rates for 2021 of 70.3 percent for men and boys and 58.8 percent for women and girls (based on actual age-specific rates published by the Bureau of Labor Statistics), primarily due to the Trustees' projected increases in life expectancy, as well as the rise in educational attainment for women.

The total civilian unemployment rates are presented in table V.B2. For years through 2032, the table presents total civilian rates without adjustment for the changing age-sex distribution of the population. For years after 2032, the table presents age-sex-adjusted rates, using the age-sex distribution of the 2011 civilian labor force. Age-sex-adjusted rates allow for more meaningful comparisons across longer time periods.

The total civilian unemployment rate reflects the projected levels of unemployment for various age-sex groups of the population. Each group's unemployment rate gradually approaches an assumed stable value within the first ten years of the projection period for all alternatives, and thus the total age-sex-adjusted civilian unemployment rate reaches its ultimate assumed value within the first ten years of the projection period.

The assumed ultimate age-sex-adjusted unemployment rate is 3.5, 4.5, and 5.5 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These values are unchanged from the 2022 report. The Trustees assume that, as economic growth slows temporarily due to anti-inflationary measures, the unemployment rate will increase from 3.7 percent for 2022 to 4.7 percent in 2024, and then gradually decline to reach the assumed 4.5 percent for 2027 under the intermediate assumptions. Under the low-cost assumptions, the unemployment rate is projected to rise to 3.8 percent in 2023 and 2024 before declining to the ultimate unemployment rate of 3.5 percent in 2026. Under the high-cost assumptions, due to the assumed economic recession, the unemployment rate increases further to 6.3 percent

[1] The Office of the Chief Actuary adjusts the labor force participation rates to the 2011 age distribution of the civilian noninstitutional U.S. population.

in 2024, with the age-sex-adjusted rate then gradually decreasing to the ultimate unemployment rate of 5.5 percent in 2027.[1]

6. Gross Domestic Product Projections

The value of real GDP is equal to the product of three components: (1) productivity (i.e., output per hour worked), (2) average weekly total employment,[2] and (3) average hours worked per week, times 52. Consequently, the growth rate in real GDP is equal to the combined growth rates for productivity, total employment, and average hours worked. For the period from 1969 to 2019, which covers the last six complete economic cycles, the average annual growth in real GDP was 2.7 percent, combining average growth rates of 1.6 percent for productivity, 1.3 percent for total employment, and -0.2 percent for average hours worked ($1.027 = 1.016 \times 1.013 \times 0.998$). The real GDP growth rate was -2.8 percent for 2020, 5.9 percent for 2021, and is estimated to be 1.9 percent for 2022 under the intermediate assumptions.

For the intermediate assumptions, the average annual growth in real GDP is 1.9 percent from 2022 to 2032, combining the average growth rates of 1.37 percent for productivity, 0.58 percent for total employment, and -0.01 percent for average hours worked. The projected average annual growth in real GDP of 1.9 percent from 2022 to 2032 is approximately equal to the underlying sustainable trend rate, but it is slightly slower for 2023 through 2024 and slightly faster for 2025 through 2027. After 2032, the annual growth in real GDP follows the sustainable trend rate and averages 2.0 percent, which combines the projected ultimate annual growth rate of 1.63 percent for productivity, average annual growth rate of 0.40 percent for total employment, and the ultimate annual growth rate of -0.05 percent for average hours worked per week. The projected growth rate of real GDP is lower than the past average growth rate mainly because the working-age population is expected to grow more slowly than in the past.

For the low-cost assumptions, the annual growth in real GDP averages 2.9 percent from 2022 to 2032 and 2.7 percent from 2032 to 2097. For the high-cost assumptions, the annual growth in real GDP averages 1.2 percent from 2022 to 2032 and 1.2 percent from 2032 to 2097.

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[1] The assumed ultimate unemployment rates are age-sex-adjusted rates. For the intermediate assumptions, the age-sex-adjusted unemployment rate in 2027 through 2032 is 4.5, while the unadjusted rate is 4.4 for 2029 through 2032, as shown in table V.B2. For the high-cost assumptions, the age-sex-adjusted unemployment rate in 2027 through 2032 is 5.5 percent, while the unadjusted rate is 5.4 percent for 2028 through 2032.

[2] Average weekly total employment is the sum of average weekly U.S. civilian employment, which can be expressed as a product of the total civilian labor force and the complement of the unemployment rate, and U.S. Armed Forces.

7. Interest Rates

Table V.B2 presents average annual nominal and real interest rates for newly issued trust fund securities. The nominal rate is the average of the nominal interest rates for special U.S. Government obligations issuable to the trust funds in each of the 12 months of the year. Interest for these securities is compounded semiannually, or at redemption if sooner. The real interest rate is defined as the annual yield rate for investments in these securities divided by the annual rate of growth in the CPI for the first year after issuance. The real rate shown for each year reflects the actual realized (historical) or expected (future) real yield on securities issuable in the prior year.

To develop a reasonable range of assumed ultimate future real interest rates for the three alternatives, the Office of the Chief Actuary examined historical experience for the last six complete economic cycles. For the period from 1969 to 2019, the real interest rate averaged 2.4 percent per year. The real interest rate averaged 1.6, -1.0, 5.1, 4.1, 2.0, and 0.8 percent per year over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively. The assumed ultimate real interest rate is 2.8 percent, 2.3 percent, and 1.8 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These rates are unchanged from the 2022 report.

The average annual nominal interest rate was approximately 1.4 percent for securities newly issuable in 2021, implying an effective annual yield of 1.4 percent for securities held one year. The CPI rose from 2021 to 2022 by approximately 8.5 percent. The annual real interest rate for 2022 was therefore -6.6 percent ($1.014 / 1.085 = 0.935 = 1 - 0.0656$). From 2022 to 2032, projected nominal interest rates depend on changes in the economic cycle and in the CPI. When combined with the ultimate CPI assumptions of 3.0, 2.4, and 1.8 percent, the assumed ultimate real interest rates produce an ultimate nominal interest rate of 5.8 percent for the low-cost assumptions, 4.7 percent for the intermediate assumptions, and 3.6 percent for the high-cost assumptions. These nominal rates for newly issued trust fund securities reach their ultimate levels by 2032.

Table V.B2.—Additional Economic Factors

Calendar year	Average annual unemployment rate[a]	Annual percentage change[b] in—			Average annual interest rate	
		Labor force[c]	Total employment[d]	Real GDP[e]	Nominal[f]	Real[g]
Historical data:						
5-year periods:						
1960 to 1965	5.5	1.3	1.6	5.1	4.0	2.5
1965 to 1970	3.9	2.2	2.1	3.5	5.9	1.0
1970 to 1975	6.1	2.5	1.5	2.7	6.7	[h]
1975 to 1980	6.8	2.7	2.9	3.7	8.5	-.9
1980 to 1985	8.3	1.5	1.5	3.3	12.1	6.9
1985 to 1990	5.9	1.7	2.0	3.3	8.5	5.1
1990 to 1995	6.6	1.0	.9	2.6	7.0	4.3
1995 to 2000	4.6	1.5	1.8	4.3	6.2	3.9
2000 to 2005	5.4	.9	.7	2.6	4.6	2.4
2005 to 2010	6.8	.6	-.4	1.0	3.8	1.8
2010 to 2015	7.2	.4	1.3	2.1	2.0	.5
2015 to 2020	5.0	.5	-.2	1.3	2.0	.5
Economic cycles:[i]						
1969 to 1973	5.3	2.6	1.8	3.6	6.5	1.6
1973 to 1979	6.8	2.7	2.4	3.0	7.7	-1.0
1979 to 1990	7.1	1.7	1.7	3.0	10.3	5.1
1990 to 2001	5.5	1.2	1.2	3.2	6.5	4.1
2001 to 2007	5.3	1.1	1.1	2.8	4.5	2.0
2007 to 2019	6.4	.5	.6	1.7	2.4	.8
2019 to 2022[j]	5.7	.2	.1	1.6	1.8	-3.3
Single years:						
2012	8.1	.9	1.8	2.3	1.5	.3
2013	7.4	.3	1.0	1.8	1.9	.1
2014	6.2	.3	1.6	2.3	2.3	.4
2015	5.3	.8	1.7	2.7	2.0	2.7
2016	4.9	1.3	1.7	1.7	1.8	1.0
2017	4.4	.7	1.2	2.2	2.3	-.3
2018	3.9	1.1	1.6	2.9	2.9	-.2
2019	3.7	.9	1.1	2.3	2.2	1.2
2020	8.1	-1.7	-6.2	-2.8	1.0	1.0
2021	5.4	.3	3.2	5.9	1.4	-4.1
2022[j]	3.7	1.9	3.7	1.9	3.0	-6.6

Table V.B2.—Additional Economic Factors (Cont.)

Calendar year	Average annual unemployment rate[a]	Annual percentage change[b] in—			Average annual interest rate	
		Labor force[c]	Total employment[d]	Real GDP[e]	Nominal[f]	Real[g]
Intermediate:						
2023	4.3	0.8	0.2	0.7	3.5	-1.0
2024	4.7	1.2	.7	1.8	3.5	1.0
2025	4.6	1.0	1.0	2.4	3.6	1.1
2026	4.6	.8	.9	2.3	3.7	1.2
2027	4.5	.7	.8	2.2	3.9	1.3
2028	4.5	.5	.5	2.0	4.2	1.5
2029	4.4	.4	.4	2.0	4.4	1.8
2030	4.4	.4	.4	2.0	4.6	2.0
2031	4.4	.4	.4	2.0	4.6	2.2
2032	4.4	.4	.4	2.0	4.7	2.2
2035	4.5	.4	.4	2.0	4.7	2.3
2040	4.5	.3	.3	1.9	4.7	2.3
2045	4.5	.3	.3	1.9	4.7	2.3
2050	4.5	.4	.4	2.0	4.7	2.3
2055	4.5	.4	.4	2.0	4.7	2.3
2060	4.5	.4	.4	2.0	4.7	2.3
2065	4.5	.4	.4	2.0	4.7	2.3
2070	4.5	.3	.3	1.9	4.7	2.3
2075	4.5	.4	.4	1.9	4.7	2.3
2080	4.5	.4	.4	2.0	4.7	2.3
2085	4.5	.5	.5	2.1	4.7	2.3
2090	4.5	.5	.5	2.1	4.7	2.3
2095	4.5	.5	.5	2.1	4.7	2.3
2100	4.5	.4	.4	2.0	4.7	2.3
Low-cost:						
2023	3.8	1.1	1.0	2.2	4.2	-.9
2024	3.8	1.5	1.5	3.5	4.4	1.2
2025	3.6	1.4	1.6	3.9	4.8	1.4
2026	3.5	.9	1.0	3.0	5.1	1.8
2027	3.5	.8	.8	2.8	5.5	2.1
2028	3.5	.7	.7	2.7	5.5	2.5
2029	3.5	.6	.6	2.6	5.5	2.5
2030	3.5	.6	.6	2.6	5.5	2.5
2031	3.5	.6	.6	2.6	5.7	2.5
2032	3.5	.6	.6	2.5	5.8	2.7
2035	3.5	.6	.6	2.6	5.8	2.8
2040	3.5	.5	.5	2.5	5.8	2.8
2045	3.5	.6	.6	2.6	5.8	2.8
2050	3.5	.7	.7	2.7	5.8	2.8
2055	3.5	.7	.7	2.7	5.8	2.8
2060	3.5	.7	.7	2.7	5.8	2.8
2065	3.5	.6	.6	2.6	5.8	2.8
2070	3.5	.6	.6	2.6	5.8	2.8
2075	3.5	.7	.7	2.7	5.8	2.8
2080	3.5	.7	.7	2.7	5.8	2.8
2085	3.5	.8	.8	2.8	5.8	2.8
2090	3.5	.8	.8	2.8	5.8	2.8
2095	3.5	.7	.7	2.7	5.8	2.8
2100	3.5	.7	.7	2.7	5.8	2.8

Table V.B2.—Additional Economic Factors (Cont.)

Calendar year	Average annual unemployment rate[a]	Annual percentage change[b] in—			Average annual interest rate	
		Labor force[c]	Total employment[d]	Real GDP[e]	Nominal[f]	Real[g]
High-cost:						
2023	4.9	0.6	-0.7	-2.2	3.4	-1.5
2024	6.3	.8	-.6	.8	2.9	.5
2025	6.0	.8	1.1	2.5	2.8	1.0
2026	5.7	.7	1.0	2.3	3.0	1.0
2027	5.5	.5	.7	2.1	3.2	1.2
2028	5.4	.3	.4	1.5	3.2	1.4
2029	5.4	.3	.3	1.4	3.3	1.4
2030	5.4	.2	.2	1.4	3.4	1.5
2031	5.4	.2	.2	1.4	3.5	1.6
2032	5.4	.2	.2	1.4	3.6	1.7
2035	5.5	.2	.2	1.4	3.6	1.8
2040	5.5	.2	.2	1.3	3.6	1.8
2045	5.5	[h]	[h]	1.2	3.6	1.8
2050	5.5	[h]	[h]	1.2	3.6	1.8
2055	5.5	[h]	[h]	1.2	3.6	1.8
2060	5.5	[h]	[h]	1.2	3.6	1.8
2065	5.5	[h]	[h]	1.1	3.6	1.8
2070	5.5	-.1	-.1	1.1	3.6	1.8
2075	5.5	-.1	-.1	1.1	3.6	1.8
2080	5.5	-.1	-.1	1.1	3.6	1.8
2085	5.5	-.1	-.1	1.1	3.6	1.8
2090	5.5	[h]	[h]	1.1	3.6	1.8
2095	5.5	[h]	[h]	1.2	3.6	1.8
2100	5.5	[h]	[h]	1.1	3.6	1.8

[a] The Office of the Chief Actuary adjusts the civilian unemployment rates for 2033 and later to the age-sex distribution of the civilian labor force in 2011. For years through 2032, the values are the total rates without adjustment for the changing age-sex distribution.

[b] For rows with a single year listed, the value is the annual percentage change from the prior year. For rows with a range of years listed, the value is the compounded average annual percentage change.

[c] The U.S. civilian labor force.

[d] Total U.S. military and civilian employment.

[e] The value of the total output of goods and services in 2012 dollars.

[f] The average of the nominal interest rates, compounded semiannually, for special public-debt obligations issuable to the trust funds in each of the 12 months of the year.

[g] The realized or expected annual real yield for each year on securities issuable in the prior year.

[h] Greater than -0.05 and less than 0.05 percent.

[i] Economic cycles are shown from peak to peak, except for the last cycle, which is not yet complete.

[j] Estimated values for 2022 vary slightly by alternative and are shown for the intermediate assumptions.

C. PROGRAM-SPECIFIC ASSUMPTIONS AND METHODS

The Office of the Chief Actuary at the Social Security Administration uses a set of models to project future income and cost under the OASDI program. These models rely not only on the demographic and economic assumptions described in the previous sections, but also on a number of program-specific assumptions and methods. Values of many program parameters change from year to year as prescribed by formulas set out in the Social Security Act. These program parameters affect the level of payroll taxes collected and the level of benefits paid. The office uses complex models to project the numbers of future workers covered under OASDI and the levels of their covered earnings, as well as the numbers of future beneficiaries and the expected levels of their benefits. The following subsections provide descriptions of these program-specific assumptions and methods.

1. Automatically Adjusted Program Parameters

The Social Security Act requires that certain parameters affecting the determination of OASDI benefits and taxes be adjusted annually to reflect changes in particular economic measures. Formulas prescribed in the law, applied to reported statistics, change these program parameters annually. The law bases these automatic adjustments on measured changes in the national average wage index (AWI) and the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI).[1] This section shows values for program parameters adjusted using these indices from the time that these adjustments became effective through 2032. Projected values for future years depend on the economic assumptions described in the preceding section of this report.

Tables V.C1 and V.C2 present the historical and projected values of the CPI-based benefit increases, the AWI series, and the values of many of the wage-indexed program parameters. Each table shows projections under the three alternative sets of assumptions. Table V.C1 includes:

- *The annual cost-of-living benefit increase percentages.* The automatic cost-of-living adjustment provisions in the Social Security Act specify increases in OASDI monthly benefits based on increases in the CPI. Volatility in oil prices has resulted in substantial volatility in cost-of-living adjustments over the last two decades. A large cost-of-living adjustment for December 2008 was followed by no cost-of-living adjustments for December 2009 and December 2010. More recent volatility in oil

[1] The *Federal Register* publishes details of these indexation procedures annually. Also see www.ssa.gov/OACT/COLA/.

prices again affected the CPI, resulting in no cost-of-living adjustment for December 2015. Cost-of-living adjustments resumed in December 2016. All three sets of assumptions include annual cost-of-living adjustments for all future years.

- *The annual levels of and percentage increases in the AWI.* Under section 215(b)(3) of the Social Security Act, Social Security benefit computations index taxable earnings (for most workers first becoming eligible for benefits in 1979 or later) using the AWI for each year after 1950. This procedure converts a worker's past earnings to approximately average-wage-indexed equivalent values near the time of his or her benefit eligibility. Other program parameters presented in this section that are subject to the automatic-adjustment provisions also rely on the AWI.
- *The wage-indexed contribution and benefit base.* For any year, the contribution and benefit base is the maximum amount of earnings subject to the OASDI payroll tax and creditable toward benefit computation. The Social Security Act defers any increase in the contribution and benefit base if there is no cost-of-living adjustment effective for December of the preceding year. There was no increase in the contribution and benefit base for 2010, 2011, or 2016 because there was no cost-of-living adjustment for the immediate prior December in each case. Under all three sets of assumptions, the contribution and benefit base is projected to increase for all future years.
- *The wage-indexed retirement earnings test exempt amounts.* The exempt amounts are the annual amount of earnings below which beneficiaries do not have benefits withheld. A lower exempt amount applies for years prior to the year of attaining normal retirement age. A higher exempt amount applies beginning with the year in which a beneficiary attains normal retirement age. Starting in 2000, the retirement earnings test no longer applies beginning with the month of attaining normal retirement age. The Social Security Act defers any increase in these exempt amounts if there is no cost-of-living adjustment effective for December of the preceding year. There was no increase in these exempt amounts for 2010, 2011, or 2016 because there was no cost-of-living adjustment for the immediate prior December. Under all three sets of assumptions, the exempt amounts increase for all future years.

Table V.C1.—Cost-of-Living Benefit Increases, Average Wage Index, Contribution and Benefit Bases, and Retirement Earnings Test Exempt Amounts, 1975-2032

Calendar year	Cost-of-living benefit increase[a] (percent)	Average wage index (AWI)[b] Amount	Average wage index (AWI)[b] Increase (percent)	Contribution and benefit base[c]	Retirement earnings test exempt amount Under NRA[d]	Retirement earnings test exempt amount At NRA[e]
Historical data:						
1975	8.0	$8,630.92	7.5	$14,100	$2,520	$2,520
1976	6.4	9,226.48	6.9	15,300	2,760	2,760
1977	5.9	9,779.44	6.0	16,500	3,000	3,000
1978	6.5	10,556.03	7.9	17,700	3,240	4,000
1979	9.9	11,479.46	8.7	22,900	3,480	4,500
1980	14.3	12,513.46	9.0	25,900	3,720	5,000
1981	11.2	13,773.10	10.1	29,700	4,080	5,500
1982	7.4	14,531.34	5.5	32,400	4,440	6,000
1983	3.5	15,239.24	4.9	35,700	4,920	6,600
1984	3.5	16,135.07	5.9	37,800	5,160	6,960
1985	3.1	16,822.51	4.3	39,600	5,400	7,320
1986	1.3	17,321.82	3.0	42,000	5,760	7,800
1987	4.2	18,426.51	6.4	43,800	6,000	8,160
1988	4.0	19,334.04	4.9	45,000	6,120	8,400
1989	4.7	20,099.55	4.0	48,000	6,480	8,880
1990	5.4	21,027.98	4.6	51,300	6,840	9,360
1991	3.7	21,811.60	3.7	53,400	7,080	9,720
1992	3.0	22,935.42	5.2	55,500	7,440	10,200
1993	2.6	23,132.67	.9	57,600	7,680	10,560
1994	2.8	23,753.53	2.7	60,600	8,040	11,160
1995	2.6	24,705.66	4.0	61,200	8,160	11,280
1996	2.9	25,913.90	4.9	62,700	8,280	12,500
1997	2.1	27,426.00	5.8	65,400	8,640	13,500
1998	1.3	28,861.44	5.2	68,400	9,120	14,500
1999	[f]2.5	30,469.84	5.6	72,600	9,600	15,500
2000	3.5	32,154.82	5.5	76,200	10,080	17,000
2001	2.6	32,921.92	2.4	80,400	10,680	25,000
2002	1.4	33,252.09	1.0	84,900	11,280	30,000
2003	2.1	34,064.95	2.4	87,000	11,520	30,720
2004	2.7	35,648.55	4.6	87,900	11,640	31,080
2005	4.1	36,952.94	3.7	90,000	12,000	31,800
2006	3.3	38,651.41	4.6	94,200	12,480	33,240
2007	2.3	40,405.48	4.5	97,500	12,960	34,440
2008	5.8	41,334.97	2.3	102,000	13,560	36,120
2009	.0	40,711.61	-1.5	106,800	14,160	37,680
2010	.0	41,673.83	2.4	106,800	14,160	37,680
2011	3.6	42,979.61	3.1	106,800	14,160	37,680
2012	1.7	44,321.67	3.1	110,100	14,640	38,880
2013	1.5	44,888.16	1.3	113,700	15,120	40,080
2014	1.7	46,481.52	3.5	117,000	15,480	41,400
2015	.0	48,098.63	3.5	118,500	15,720	41,880
2016	.3	48,642.15	1.1	118,500	15,720	41,880
2017	2.0	50,321.89	3.5	127,200	16,920	44,880
2018	2.8	52,145.80	3.6	128,400	17,040	45,360
2019	1.6	54,099.99	3.7	132,900	17,640	46,920
2020	1.3	55,628.60	2.8	137,700	18,240	48,600
2021	5.9	60,575.07	8.9	142,800	18,960	50,520

Table V.C1.—Cost-of-Living Benefit Increases, Average Wage Index, Contribution and Benefit Bases, and Retirement Earnings Test Exempt Amounts, 1975-2032 (Cont.)

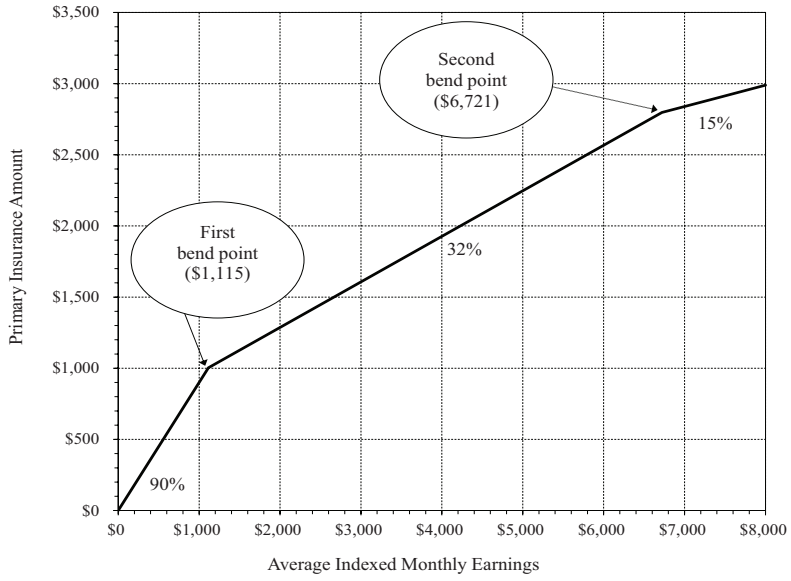
Calendar year	Cost-of-living benefit increase[a] (percent)	Average wage index (AWI)[b] Amount	Average wage index (AWI)[b] Increase (percent)	Contribution and benefit base[c]	Retirement earnings test exempt amount Under NRA[d]	Retirement earnings test exempt amount At NRA[e]
Intermediate:						
2022	[g]8.7	$63,467.98	4.8	[g]$147,000	[g]$19,560	[g]$51,960
2023	3.3	66,147.17	4.2	[g]160,200	[g]21,240	[g]56,520
2024	2.4	68,627.58	3.7	167,700	22,200	59,160
2025	2.4	71,411.99	4.1	174,900	23,160	61,680
2026	2.4	74,348.48	4.1	181,200	24,000	64,080
2027	2.4	77,393.67	4.1	188,700	25,080	66,600
2028	2.4	80,510.73	4.0	196,500	26,040	69,360
2029	2.4	83,757.03	4.0	204,600	27,120	72,240
2030	2.4	87,106.49	4.0	212,700	28,200	75,120
2031	2.4	90,574.48	4.0	221,400	29,400	78,120
2032	2.4	93,995.33	3.8	230,100	30,480	81,240
Low-cost:						
2022	[g]8.7	63,432.25	4.7	[g]147,000	[g]19,560	[g]51,960
2023	3.1	66,442.68	4.7	[g]160,200	[g]21,240	[g]56,520
2024	3.0	70,258.88	5.7	167,700	22,200	59,160
2025	3.0	74,575.71	6.1	175,500	23,280	62,040
2026	3.0	78,782.82	5.6	185,700	24,600	65,520
2027	3.0	83,005.63	5.4	197,100	26,160	69,600
2028	3.0	87,405.28	5.3	208,200	27,600	73,560
2029	3.0	92,010.68	5.3	219,300	29,040	77,400
2030	3.0	96,841.91	5.3	231,000	30,600	81,600
2031	3.0	101,915.61	5.2	243,000	32,280	85,800
2032	3.0	107,046.81	5.0	255,900	33,960	90,360
High-cost:						
2022	[g]8.7	63,460.05	4.8	[g]147,000	[g]19,560	[g]51,960
2023	4.0	64,726.55	2.0	[g]160,200	[g]21,240	[g]56,520
2024	2.6	67,055.34	3.6	167,700	22,200	59,160
2025	1.8	69,534.32	3.7	171,000	22,680	60,360
2026	1.8	71,952.76	3.5	177,300	23,520	62,520
2027	1.8	74,431.84	3.4	183,600	24,360	64,920
2028	1.8	76,626.52	2.9	190,200	25,200	67,080
2029	1.8	78,738.96	2.8	196,800	26,040	69,480
2030	1.8	80,892.11	2.7	202,500	26,880	71,520
2031	1.8	83,098.17	2.7	207,900	27,600	73,440
2032	1.8	85,191.64	2.5	213,600	28,320	75,480

[a] Effective with benefits payable for June in each year 1975-82, and for December in each year after 1982.
[b] See table VI.G6 for projected dollar amounts of the AWI for years beyond the last year of this table.
[c] Public Law 95-216 specified amounts for 1978-81. Public Law 101-239 changed the indexing procedure and caused slightly higher bases after 1989.
[d] Normal retirement age. See table V.C3 for specific values.
[e] In 1955-82, the retirement earnings test did not apply at ages 72 and over. In 1983-99, the test did not apply at ages 70 and over. Beginning in 2000, the test does not apply beginning with the month of normal retirement age attainment. In the year of normal retirement age attainment, the higher exempt amount applies to earnings prior to the month of normal retirement age attainment. Public Law 95-216 specified amounts for 1978-82. Public Law 104-121 specified amounts for 1996-2002.
[f] Originally determined as 2.4 percent. Pursuant to Public Law 106-554, effectively 2.5 percent.
[g] Actual amount, as determined under automatic-adjustment provisions.

Table V.C2 shows values for other wage-indexed parameters. The table provides historical values from 1978, when indexing of the amount of earnings required for a quarter of coverage first began, through 2023, and also shows projected values through 2032. These other wage-indexed program parameters are:

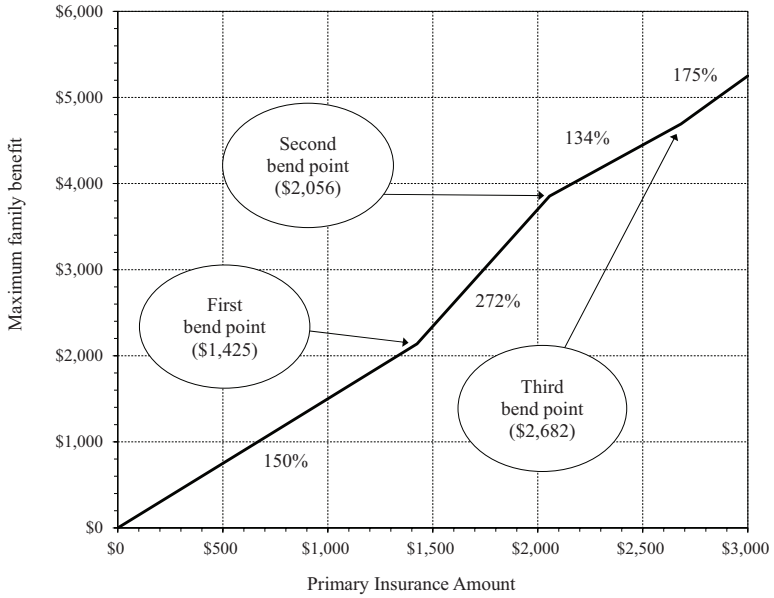
- *The bend points in the formula for computing the primary insurance amount (PIA) for workers who reach age 62, become disabled, or die in a given year.* As figure V.C1 illustrates, these two bend points define three ranges in a worker's average indexed monthly earnings (AIME). The formula for the worker's PIA multiplies a 90, 32, or 15 percent factor by the portion of the worker's AIME that falls within the three respective ranges, and then adds the resulting products together.

Figure V.C1.—Primary-Insurance-Amount Formula for Those Newly Eligible in 2023



- *The bend points in the formula for computing the maximum total amount of monthly benefits payable based on the earnings record of a retired or deceased worker (maximum family benefit).* As figure V.C2 illustrates, these three bend points define four ranges in a worker's PIA. The formula for the maximum family benefit multiplies a 150, 272, 134, or 175 percent factor by the portion of the worker's PIA that falls within the four respective ranges, and then adds the resulting products together.

Figure V.C2.—OASI Maximum-Family-Benefit Formula for Those Newly Eligible in 2023



- *The amount of earnings required in a year to earn a quarter of coverage (QC).* The number and timing of QCs earned determines an individual's insured status—the basic requirement for benefit eligibility under OASDI.
- *The old-law contribution and benefit base—the contribution and benefit base that would have been in effect without enactment of the 1977 amendments.* This old-law base is used in determining special-minimum benefits for certain workers who have many years of low earnings in covered employment. Since 1986, the calculation of OASDI benefits for certain workers who are eligible to receive pensions based on non-covered employment uses the old-law base. In addition, the Railroad Retirement program and the Employee Retirement Income Security Act of 1974 use the old-law base for certain purposes.

Table V.C2.—Values for Selected Wage-Indexed Program Parameters, Calendar Years 1978-2032

Calendar year	AIME bend points in PIA formula[a] First	AIME bend points in PIA formula[a] Second	PIA bend points in OASI maximum-family-benefit formula[b] First	PIA bend points in OASI maximum-family-benefit formula[b] Second	PIA bend points in OASI maximum-family-benefit formula[b] Third	Earnings required for a quarter of coverage	Old-law contribution and benefit base[c]
Historical data:							
1978	[d]	[d]	[d]	[d]	[d]	[e] $250	[e] $17,700
1979	[e] $180	[e] $1,085	[e] $230	[e] $332	[e] $433	260	18,900
1980	194	1,171	248	358	467	290	20,400
1981	211	1,274	270	390	508	310	22,200
1982	230	1,388	294	425	554	340	24,300
1983	254	1,528	324	468	610	370	26,700
1984	267	1,612	342	493	643	390	28,200
1985	280	1,691	358	517	675	410	29,700
1986	297	1,790	379	548	714	440	31,500
1987	310	1,866	396	571	745	460	32,700
1988	319	1,922	407	588	767	470	33,600
1989	339	2,044	433	626	816	500	35,700
1990	356	2,145	455	656	856	520	38,100
1991	370	2,230	473	682	890	540	39,600
1992	387	2,333	495	714	931	570	41,400
1993	401	2,420	513	740	966	590	42,900
1994	422	2,545	539	779	1,016	620	45,000
1995	426	2,567	544	785	1,024	630	45,300
1996	437	2,635	559	806	1,052	640	46,500
1997	455	2,741	581	839	1,094	670	48,600
1998	477	2,875	609	880	1,147	700	50,700
1999	505	3,043	645	931	1,214	740	53,700
2000	531	3,202	679	980	1,278	780	56,700
2001	561	3,381	717	1,034	1,349	830	59,700
2002	592	3,567	756	1,092	1,424	870	63,000
2003	606	3,653	774	1,118	1,458	890	64,500
2004	612	3,689	782	1,129	1,472	900	65,100
2005	627	3,779	801	1,156	1,508	920	66,900
2006	656	3,955	838	1,210	1,578	970	69,900
2007	680	4,100	869	1,255	1,636	1,000	72,600
2008	711	4,288	909	1,312	1,711	1,050	75,900
2009	744	4,483	950	1,372	1,789	1,090	79,200
2010	761	4,586	972	1,403	1,830	1,120	79,200
2011	749	4,517	957	1,382	1,803	1,120	79,200
2012	767	4,624	980	1,415	1,845	1,130	81,900
2013	791	4,768	1,011	1,459	1,903	1,160	84,300
2014	816	4,917	1,042	1,505	1,962	1,200	87,000
2015	826	4,980	1,056	1,524	1,987	1,220	88,200
2016	856	5,157	1,093	1,578	2,058	1,260	88,200
2017	885	5,336	1,131	1,633	2,130	1,300	94,500
2018	895	5,397	1,144	1,651	2,154	1,320	95,400
2019	926	5,583	1,184	1,708	2,228	1,360	98,700
2020	960	5,785	1,226	1,770	2,309	1,410	102,300
2021	996	6,002	1,272	1,837	2,395	1,470	106,200
2022	1,024	6,172	1,308	1,889	2,463	1,510	109,200
2023	1,115	6,721	1,425	2,056	2,682	1,640	118,800
Intermediate:							
2024	1,168	7,042	1,493	2,155	2,810	1,720	124,500
2025	1,218	7,339	1,556	2,246	2,929	1,790	129,900
2026	1,263	7,614	1,614	2,330	3,039	1,860	134,700
2027	1,314	7,923	1,680	2,424	3,162	1,930	140,100
2028	1,368	8,249	1,749	2,524	3,292	2,010	145,800
2029	1,425	8,587	1,820	2,627	3,427	2,100	151,800
2030	1,482	8,932	1,894	2,733	3,565	2,180	158,100
2031	1,542	9,293	1,970	2,843	3,708	2,270	164,400
2032	1,603	9,664	2,049	2,957	3,857	2,360	171,000

Table V.C2.—Values for Selected Wage-Indexed Program Parameters, Calendar Years 1978-2032 (Cont.)

Calendar year	AIME bend points in PIA formula[a]		PIA bend points in OASI maximum-family-benefit formula[b]			Earnings required for a quarter of coverage	Old-law contribution and benefit base[c]
	First	Second	First	Second	Third		
Low-cost:							
2024	$1,168	$7,038	$1,492	$2,153	$2,809	$1,720	$124,500
2025	1,223	7,372	1,563	2,256	2,942	1,800	130,500
2026	1,293	7,795	1,652	2,385	3,111	1,900	138,000
2027	1,373	8,274	1,754	2,532	3,302	2,020	146,400
2028	1,450	8,741	1,853	2,675	3,488	2,130	154,500
2029	1,528	9,209	1,952	2,818	3,675	2,250	162,900
2030	1,609	9,697	2,056	2,967	3,870	2,370	171,600
2031	1,694	10,208	2,164	3,124	4,074	2,490	180,600
2032	1,782	10,744	2,278	3,288	4,288	2,620	189,900
High-cost:							
2024	1,168	7,041	1,492	2,154	2,810	1,720	124,500
2025	1,191	7,181	1,522	2,197	2,866	1,750	126,900
2026	1,234	7,440	1,577	2,276	2,969	1,820	131,700
2027	1,280	7,715	1,635	2,361	3,079	1,880	136,500
2028	1,324	7,983	1,692	2,443	3,186	1,950	141,300
2029	1,370	8,258	1,751	2,527	3,296	2,020	146,100
2030	1,410	8,501	1,802	2,601	3,393	2,080	150,300
2031	1,449	8,736	1,852	2,673	3,486	2,130	154,500
2032	1,489	8,975	1,902	2,746	3,582	2,190	158,700

[a] The formula to compute a PIA is: (1) 90% of AIME below the first bend point, plus (2) 32% of AIME in excess of the first bend point but not in excess of the second, plus (3) 15% of AIME in excess of the second bend point. The bend points are determined based on the first year a beneficiary becomes eligible for benefits.

[b] The formula to compute an OASI family maximum is: (1) 150% of PIA below the first bend point, plus (2) 272% of PIA in excess of the first bend point but not in excess of the second, plus (3) 134% of PIA in excess of the second bend point but not in excess of the third, plus (4) 175% of PIA in excess of the third bend point. This formula also determines family maximums for disabled-worker beneficiaries first eligible after 1978 and entitled before July 1980.

[c] Contribution and benefit base that would have been in effect without enactment of the Social Security Amendments of 1977. Public Law 101-239 changed the indexing procedure and caused slightly higher bases after 1989.

[d] No provision in law for this amount in this year.

[e] Amount specified by Social Security Amendments of 1977.

In addition to the economic factors that affect the determination of OASDI benefits, there are certain legislated changes that affect current and future benefit amounts. Two such changes are the scheduled increases in the normal retirement age and in the delayed retirement credits. Table V.C3 shows the scheduled changes in these parameters and the resulting effects on benefit levels expressed as a percentage of PIA.

Table V.C3.—Legislated Changes in Normal Retirement Age and Delayed Retirement Credits for Persons Attaining Age 62 in Each Year 1986 and Later

Year of birth	Year of attainment of age 62	Normal retirement age (NRA)	Credit for each year of delayed retirement after NRA (percent)	Benefit, as a percentage of PIA, beginning at age —				
				62	65	66	67	70
1924	1986	65	3	80	100	103	106	115
1925	1987	65	3 1/2	80	100	103 1/2	107	117 1/2
1926	1988	65	3 1/2	80	100	103 1/2	107	117 1/2
1927	1989	65	4	80	100	104	108	120
1928	1990	65	4	80	100	104	108	120
1929	1991	65	4 1/2	80	100	104 1/2	109	122 1/2
1930	1992	65	4 1/2	80	100	104 1/2	109	122 1/2
1931	1993	65	5	80	100	105	110	125
1932	1994	65	5	80	100	105	110	125
1933	1995	65	5 1/2	80	100	105 1/2	111	127 1/2
1934	1996	65	5 1/2	80	100	105 1/2	111	127 1/2
1935	1997	65	6	80	100	106	112	130
1936	1998	65	6	80	100	106	112	130
1937	1999	65	6 1/2	80	100	106 1/2	113	132 1/2
1938	2000	65, 2 mo	6 1/2	79 1/6	98 8/9	105 5/12	111 11/12	131 5/12
1939	2001	65, 4 mo	7	78 1/3	97 7/9	104 2/3	111 2/3	132 2/3
1940	2002	65, 6 mo	7	77 1/2	96 2/3	103 1/2	110 1/2	131 1/2
1941	2003	65, 8 mo	7 1/2	76 2/3	95 5/9	102 1/2	110	132 1/2
1942	2004	65, 10 mo	7 1/2	75 5/6	94 4/9	101 1/4	108 3/4	131 1/4
1943-54	2005-16	66	8	75	93 1/3	100	108	132
1955	2017	66, 2 mo	8	74 1/6	92 2/9	98 8/9	106 2/3	130 2/3
1956	2018	66, 4 mo	8	73 1/3	91 1/9	97 7/9	105 1/3	129 1/3
1957	2019	66, 6 mo	8	72 1/2	90	96 2/3	104	128
1958	2020	66, 8 mo	8	71 2/3	88 8/9	95 5/9	102 2/3	126 2/3
1959	2021	66, 10 mo	8	70 5/6	87 7/9	94 4/9	101 1/3	125 1/3
1960 & later	2022 & later	67	8	70	86 2/3	93 1/3	100	124

2. Covered Employment

Projections of the total U.S. civilian labor force and unemployment rate (see table V.B2) are based on Bureau of Labor Statistics definitions from the Current Population Survey (CPS). These projections represent the average weekly number of employed and unemployed persons, age 16 and over, in the U.S. in a calendar year. Covered employment for a calendar year is defined as the total number of persons who have any OASDI covered earnings (that is, earnings subject to the OASDI payroll tax) at any time during that year. For those age 16 and over, projected covered employment is the sum of age-sex groups, each reflecting the growth projected for the group's total U.S employment and average weeks worked per year.[1] For the short-range period, the age-sex-adjusted average weeks worked declines slightly as the age-sex-adjusted unemployment rate rises to its ultimate assumed value of 4.5 percent. After 2032, the average weeks worked for each age-sex group

[1] For those under age 16, projected covered employment is the sum of age-sex components, each of which is projected as a ratio to the Social Security area population.

is assumed to remain constant. The projection method also accounts for changes in non-OASDI-covered employment and the increase in coverage of Federal civilian employment as a result of the 1983 Social Security Amendments. It also reflects changes in the number and employment status of other-than-LPR immigrants residing within the Social Security coverage area, such as undocumented immigrants and foreign workers and students with temporary visas.

The covered-worker rate is the ratio of OASDI covered workers to the Social Security area population. For men and boys age 16 and over, the projected age-adjusted covered-worker rates[1] for 2097 are 69.7, 69.8, and 69.6 percent for the low-cost, intermediate, and high-cost assumptions, respectively. For women and girls age 16 and over, the projected age-adjusted covered-worker rates for 2097 are 66.8, 66.1, and 65.7 percent for the low-cost, intermediate, and high-cost assumptions, respectively. An important factor in the variation among the projected rates for the three alternatives is the portion of the men and women in the population that is projected to be other-than-LPR immigrants. For men and boys, the intermediate projected rate for 2097 is lower than the 2021 age-adjusted rate of 71.0 percent primarily due to the projected increase in the portion of the Social Security area population that consists of other-than-LPR immigrants. For women and girls, the intermediate projected rate for 2097 is higher than the 2021 age-adjusted rate of 64.8 percent because the projected increase in the age-adjusted labor force participation rate more than offsets the projected increase in the portion of the population that will be other-than-LPR immigrants.

3. Insured Population

Eligibility for worker benefits under the OASDI program requires some threshold level of work in covered employment. A worker satisfies this requirement by his or her accumulation of quarters of coverage (QCs). Prior to 1978, a worker earned one QC for each calendar quarter in which he or she earned at least $50. In 1978, when annual earnings reporting replaced quarterly reporting, the amount required to earn a QC (up to a maximum of four per year) was set at $250. As specified in the law, the Social Security Administration has adjusted this amount each year since then according to changes in the AWI. Its value in 2023 is $1,640.

There are three types of insured status that a worker can earn under the OASDI program. The number and recency of QCs earned determine each

[1] Age-adjusted covered-worker rates are adjusted to the 2011 age distribution of the Social Security area population.

status. A worker is fully insured when his or her total number of QCs is greater than or equal to the number of years elapsed after the year of attainment of age 21 (but not less than six). After a worker has accumulated 40 QCs, he or she remains permanently fully insured. A worker is disability insured if he or she is: (1) a fully insured worker who has accumulated 20 QCs during the 40-quarter period ending with the current quarter, (2) a fully insured worker aged 24-30 who has accumulated QCs during one-half of the quarters elapsed after the quarter of attainment of age 21 and up to and including the current quarter, or (3) a fully insured worker under age 24 who has accumulated six QCs during the 12-quarter period ending with the current quarter. A worker is currently insured when he or she has accumulated six QCs during the 13-quarter period ending with the current quarter. Periods of disability reduce the number of quarters required for insured status, but not below the minimum of six QCs.

There are many types of benefits payable to workers and their family members under the OASDI program. A worker must be fully insured to be eligible for a primary retirement benefit and for his or her spouse or children to be eligible for auxiliary retirement benefits. A deceased worker must have been either currently insured or fully insured at the time of death for his or her children (and their mother or father) to be eligible for benefits. If there are no eligible surviving children, the deceased worker must have been fully insured at the time of death for his or her surviving spouse to be eligible. A worker must be disability insured to be eligible for a primary disability benefit and for his or her spouse or children to be eligible for auxiliary disability benefits.

The Office of the Chief Actuary estimates the fully insured population, as a percentage of the Social Security area population, by single year of age and sex starting in 1969. The short-range model extrapolates the historical trend in these rates from data in the Continuous Work History Sample (CWHS). The model uses information on quarters of coverage earned due to employment covered by Social Security derived from tabulations of the CWHS. The model also uses historical administrative data on beneficiaries in force and estimated historical mortality rates. The model combines this information to estimate the proportion of individuals who were alive and fully insured as of the end of each historical year. Using projected mortality rates and covered workers, the model extrapolates these rates into the future and applies them to the historical and projected population to arrive at the fully insured population by age and sex through the end of the short-range period.

The long-range fully insured model uses 30,000 simulated work histories for each sex and birth cohort, representing everyone except the other-than-LPR

immigrant population.[1] For the other-than-LPR immigrant population, the model generates substantially lower percentages attaining fully insured status. The model constructs simulated work histories using past coverage rates, earnings distributions, and amounts required for crediting QCs, and develops them in a manner that replicates historical individual variations in work patterns. The probability of covered employment in any year is assumed to be higher for those who have worked more consistently in the recent past. Model parameters are selected so that simulated fully insured percentages are consistent with the fully insured percentages estimated by the short-range model for the recent historical period.

The Office of the Chief Actuary estimates the disability insured population, as a percentage of the fully insured population, by age and sex starting in 1969. The office bases historical values on a tabulation of the disability insured population from the CWHS and estimates of the fully insured population. The short-range model projects these percentages by using the relationship between the historical percentages and covered-worker rates. The long-range model projects these percentages by using the same simulated work histories used to project the fully insured percentages. The long-range model makes additional adjustments to the model simulations in order to bring the disability insured percentages in the historical and short-range periods into close agreement with those estimated from the CWHS and the short-range model.

The office does not project the currently insured population because the number of beneficiaries who are entitled to benefits based solely on currently insured status has been very small recently and is likely to remain small in the future.

Using these insured models, the percentage of the Social Security area population aged 62 and over that is fully insured is projected to change from its estimated level of 88.5 for December 31, 2020, to 86.8, 88.6, and 90.9 for December 31, 2100, under the low-cost, intermediate, and high-cost alternatives, respectively. Over the projection period, the percentages for both men and women change significantly. The percentage for men declines, reflecting, in part, increases in the percent of the population that is classified as other-than-LPR immigrants and is thus less likely to have earnings reported and credited to them. The percentage for women increases, reflecting the past substantial growth in the employment of younger cohorts of women. Under the intermediate assumptions, for example, the percentage for men

[1] Those granted legal work authorization through the 2012 Deferred Action for Childhood Arrivals program are included in the simulations.

decreases from 94.1 to 87.7, and the percentage for women increases from 83.9 to 89.4.

4. Old-Age and Survivors Insurance Beneficiaries

The Office of the Chief Actuary projects the number of OASI beneficiaries for each type of benefit separately by the sex of the worker on whose earnings the benefits are based and by the age of the beneficiary. For the long-range period, the office also projects the number of beneficiaries by marital status for several types of benefits. The office uses two separate models in making these projections. The short-range model makes projections during the first 10 years of the projection period and the long-range model makes projections thereafter.

The short-range model develops the number of retired-worker beneficiaries by applying award rates to the aged fully insured population, excluding those already receiving retired-worker, disabled-worker, aged-widow(er), or aged-spouse benefits, and by applying termination rates to the number of retired-worker beneficiaries.

The long-range model projects the number of retired-worker beneficiaries who were not previously converted from disabled-worker beneficiary status as a percentage of the exposed population.[1] For age 62, the model projects this percentage by using a linear regression based on the historical relationship between this percentage, the employment rate[2] at age 62, and the number of months from age 62 to normal retirement age. The percentage for ages 70 and over is nearly 100 because delayed retirement credits cannot be earned after age 70. The long-range model projects the percentage for each age 63 through 69 based on historical experience with an adjustment for changes in the portion of the primary insurance amount that is payable at each age of entitlement. The model adjusts these percentages for ages 62 through 69 to reflect changes in the normal retirement age.

The long-range model calculates the number of retired-worker beneficiaries previously converted from disabled-worker beneficiary status using an extension of disabled-worker death rates by age, sex, and duration.

The Office of the Chief Actuary estimates the number of aged-spouse beneficiaries, excluding those who are also receiving a retired-worker benefit, from the population projected by age and sex. Benefits of aged-spouse beneficia-

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[1] The exposed population is the fully insured population age 62 and over, excluding persons entitled to or converted from disabled-worker benefits and fully insured persons entitled only to widow(er) benefits.

[2] The employment rate is the ratio of U.S. civilian employment to the civilian noninstitutional population.

ries depend on the earnings records of their husbands or wives, who are referred to as "earners." The short-range model projects insured aged-spouse beneficiaries in conjunction with the retired-worker beneficiaries. This model projects uninsured aged-spouse beneficiaries by applying award rates to the aged uninsured male or female population and by applying termination rates to the population already receiving such benefits.

The long-range model estimates aged-spouse beneficiaries separately for those married and divorced. The model projects the number of married aged-spouse beneficiaries, by age and sex, by applying a series of factors to the number of spouses, aged 62 and over, in the population. These factors are the probabilities that the spouse and the earner meet all of the conditions of eligibility—that is, the probabilities that: (1) the earner is 62 or over, (2) the earner is insured, (3) the earner is receiving benefits, (4) the spouse is not receiving a benefit for the care of an entitled child, (5) the spouse is either not insured or is insured but not receiving benefits, and (6) the spouse is not eligible to receive a significant government pension based on earnings from noncovered employment. To calculate the estimated number of aged-spouse beneficiaries, the model applies a projected prevalence rate to the resulting number of spouses. Due to the Bipartisan Budget Act of 2015, for those turning age 62 in 2016 and later, deemed filing now applies to all retired workers and spouses even after initial entitlement, regardless of age. Thus, spouses who are insured are no longer eligible to delay their retired-worker benefit while receiving an aged-spouse benefit.

The long-range model estimates the number of divorced aged-spouse beneficiaries, by age and sex, by applying the same factors to the number of divorced persons aged 62 and over in the population, with three differences. First, the model applies a factor to reflect the probability that the earner (former spouse) is still alive. If the former spouse is not alive, the person may be entitled to a divorced widow(er) benefit. Second, the model applies a factor to reflect the probability that the marriage to the former spouse lasted at least 10 years. Third, the model does not apply factor (3) in the previous paragraph because, effective January 1985, a divorced person is generally no longer required to wait for the former spouse to receive benefits.

The Office of the Chief Actuary bases the projected numbers of children under age 18, and students aged 18 and 19, who are eligible for benefits as children of retired-worker beneficiaries, on the projected number of children in the population. The short-range model develops the number of entitled children by applying award rates to the number of children in the population who have two living parents and by applying termination rates to the number of children already receiving benefits.

The long-range model projects separately the number of entitled children by sex of the earner parent. For each age under 18, the model multiplies the projected number of children with a parent aged 62 and over by the ratio of the number of retired workers aged 62 to 71 to the number of members of the population aged 62 to 71. For student beneficiaries, the model multiplies the number of children aged 18 and 19 in the population by the probabilities that: (1) the parent is alive, aged 62 or over, insured, and receiving a retired-worker benefit; and (2) the child is attending high school.

The Office of the Chief Actuary projects the number of disabled children, aged 18 and over, of retired-worker beneficiaries from the adult population. The short-range model applies award rates to the population and applies termination rates to the number of disabled children already receiving benefits. The long-range model projects the number of disabled children in a manner similar to that used for student children except for a factor that reflects the probability of being disabled before age 22.

The short-range model develops the number of spouses of retired workers, who are entitled to spouse benefits because they are caring for a child who is under age 16 or disabled, by applying award rates to the number of awards to children of retired workers and by applying termination rates to the number of young spouses with a child in their care who are already receiving benefits. The long-range model projects the number of young-spouse beneficiaries with a child in their care as a proportion of the number of child beneficiaries of retired workers, including projected changes in average family size.

The Office of the Chief Actuary projects the number of aged-widow(er) beneficiaries, excluding those who are also receiving a retired-worker benefit, from the population by age and sex. The short-range model projects fully insured aged-widow(er) beneficiaries in conjunction with the retired-worker beneficiaries. The model projects the number of uninsured aged-widow(er) beneficiaries by applying award rates to the aged uninsured male or female population and by applying termination rates to the population already receiving such benefits. The long-range model projects uninsured aged-widow(er) beneficiaries by marital status. The model multiplies the number of widow(er)s in the population aged 60 and over by the probabilities that: (1) the deceased earner is fully insured at death, (2) the widow(er) is not receiving a benefit for the care of an entitled child, (3) the widow(er) is not fully insured, and (4) the widow(er) benefits are not withheld because of receipt of a significant government pension based on earnings in noncovered employment. In addition, the model applies the same factors to the number of divorced persons aged 60 and over in the population and includes addi-

tional factors representing the probability that the person's former earner spouse has died and that the marriage lasted at least 10 years. The model projects the number of insured aged-widow(er) beneficiaries who are ages 60 through 71 in a manner similar to that for uninsured aged-widow(er) beneficiaries. In addition, the model assumes that some insured widow(er)s who had not applied for their retired-worker benefits will receive widow(er) benefits. The model projects insured aged-widow(er) beneficiaries over age 71 by applying termination rates to the population that started receiving such benefits prior to age 71.

The short-range model develops the number of disabled-widow(er) beneficiaries by applying award rates to the uninsured male or female population and by applying termination rates to the population already receiving a disabled-widow(er) benefit. The long-range model projects the number for each cohort by age from 50 to normal retirement age as percentages of the widowed and divorced populations, adjusted for the insured status of the deceased spouse, the prevalence of disability, and the probability that the disabled spouse is not receiving another type of benefit.

The Office of the Chief Actuary bases the projected number of children under age 18, and students aged 18 and 19, who are entitled to benefits as survivors of deceased workers, on the number of children in the population whose mothers or fathers are deceased. The short-range model develops the number of entitled children by applying award rates to the number of orphaned children and by applying termination rates to the number of children already receiving benefits.

The long-range model projects the number of surviving-child beneficiaries in a manner similar to that for student beneficiaries of retired workers, except that the model replaces the probability that the parent is aged 62 or over with the probability that the parent is deceased.

The Office of the Chief Actuary projects the number of surviving-disabled-child beneficiaries, aged 18 and over, from the adult population. The short-range model applies award rates to the population and applies termination rates to the number of surviving-disabled-child beneficiaries already receiving benefits. The long-range model projects the number of surviving-disabled-child beneficiaries in a manner similar to that for surviving-student-child beneficiaries, except for including an additional factor to reflect the probability of being disabled before age 22.

The short-range model develops the numbers of entitled surviving-mother and surviving-father beneficiaries by applying award rates to the number of awards to surviving-child beneficiaries, in cases where the children are either

under age 16 or disabled, and by applying termination rates to the number of surviving-mother and surviving-father beneficiaries already receiving benefits. The long-range model estimates the numbers of surviving-mother and surviving-father beneficiaries, assuming they are not remarried, from the number of surviving-child beneficiaries.

The Office of the Chief Actuary projects the number of surviving-parent beneficiaries based on the historical pattern of the number of such beneficiaries.

Table V.C4 shows the projected number of beneficiaries under the OASI program by type of benefit. The retired-worker beneficiary counts include those persons who receive a residual auxiliary benefit in addition to their retired-worker benefit. The office makes estimates of the number and amount of residual payments separately for spouses and widow(er)s.

Table V.C4.—OASI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1945-2100
[In thousands]

	Retired workers and auxiliaries			Survivors				
Calendar year	Worker[a]	Spouse	Child	Widow-widower	Mother-father	Child	Parent	Total
Historical data:								
1945	518	159	13	94	121	377	6	1,288
1950	1,771	508	46	314	169	653	15	3,477
1955	4,474	1,192	122	701	292	1,154	25	7,961
1960	8,061	2,269	268	1,544	401	1,577	36	14,157
1965	11,101	2,614	461	2,371	472	2,074	35	19,128
1970	13,349	2,668	546	3,227	523	2,688	29	23,030
1975	16,589	2,867	643	3,888	582	2,919	21	27,509
1980	19,564	3,018	639	4,415	563	2,610	15	30,823
1985	22,435	3,069	456	4,862	372	1,918	10	33,122
1990	24,841	3,104	421	5,098	304	1,777	6	35,551
1995	26,679	3,027	441	5,213	275	1,884	4	37,522
2000	28,505	2,798	459	4,901	203	1,878	3	38,747
2005	30,461	2,524	488	4,569	178	1,903	2	40,126
2010	34,593	2,316	580	4,285	159	1,913	2	43,847
2015	40,089	2,335	648	4,050	140	1,893	1	49,155
2016	41,233	2,370	661	4,004	133	1,893	1	50,296
2017	42,447	2,375	675	3,961	128	1,904	1	51,491
2018	43,721	2,391	690	3,908	121	1,911	1	52,743
2019	45,094	2,430	701	3,878	117	1,916	1	54,137
2020	46,330	2,323	704	3,823	115	1,936	1	55,231
2021	47,293	2,165	687	3,773	114	1,976	1	56,009
2022	48,588	2,022	682	3,728	112	2,020	1	57,152
Intermediate:								
2023	50,059	1,858	712	3,695	109	2,041	1	58,476
2025	52,853	1,750	755	3,643	105	2,056	1	61,163
2030	59,486	1,626	865	3,520	95	2,111	1	67,705
2035	63,776	1,561	972	3,289	106	2,151	1	71,855
2040	66,187	1,415	1,092	3,002	127	2,194	1	74,018
2045	67,417	1,317	1,217	2,800	133	2,225	1	75,109
2050	69,190	1,287	1,308	2,664	131	2,214	1	76,796

Table V.C4.—OASI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1945-2100 (Cont.)
[In thousands]

	Retired workers and auxiliaries			Survivors				
Calendar year	Worker[a]	Spouse	Child	Widow-widower	Mother-father	Child	Parent	Total
Intermediate (Cont.):								
2055	71,765	1,280	1,381	2,560	128	2,178	1	79,292
2060	75,341	1,262	1,464	2,473	123	2,115	1	82,778
2065	78,638	1,251	1,494	2,424	120	2,062	1	85,989
2070	81,810	1,252	1,521	2,405	118	2,041	1	89,149
2075	84,845	1,262	1,558	2,383	117	2,043	1	92,209
2080	86,757	1,264	1,570	2,335	116	2,041	1	94,084
2085	87,626	1,268	1,574	2,277	114	2,022	1	94,881
2090	88,032	1,288	1,573	2,236	111	1,992	1	95,233
2095	89,429	1,327	1,615	2,219	108	1,964	1	96,664
2100	92,017	1,378	1,669	2,221	106	1,942	1	99,333
Low-cost:								
2023	50,029	1,858	714	3,692	110	2,046	1	58,449
2025	52,739	1,750	760	3,637	106	2,074	1	61,066
2030	59,016	1,633	884	3,503	100	2,186	1	67,322
2035	62,533	1,545	1,005	3,336	105	2,349	1	70,874
2040	64,067	1,397	1,152	3,074	128	2,528	1	72,346
2045	64,500	1,284	1,302	2,891	137	2,662	1	72,778
2050	65,508	1,227	1,411	2,765	139	2,727	1	73,778
2055	67,423	1,187	1,502	2,659	140	2,753	1	75,664
2060	70,367	1,146	1,619	2,564	140	2,756	1	78,593
2065	73,048	1,115	1,676	2,502	143	2,789	1	81,273
2070	75,501	1,098	1,721	2,477	148	2,881	1	83,828
2075	77,747	1,090	1,785	2,452	155	3,005	1	86,234
2080	78,899	1,070	1,814	2,411	160	3,111	1	87,467
2085	79,123	1,050	1,832	2,375	163	3,180	1	87,724
2090	79,424	1,056	1,848	2,384	166	3,234	1	88,112
2095	81,729	1,096	1,952	2,436	169	3,296	1	90,680
2100	85,763	1,140	2,063	2,506	174	3,377	1	95,023
High-cost:								
2023	50,098	1,858	711	3,699	109	2,036	1	58,511
2025	52,999	1,750	751	3,652	104	2,038	1	61,294
2030	60,109	1,621	847	3,544	90	2,029	1	68,243
2035	65,450	1,594	930	3,224	101	1,923	1	73,223
2040	69,088	1,450	1,010	2,889	114	1,815	1	76,366
2045	71,537	1,373	1,098	2,645	116	1,744	1	78,514
2050	74,439	1,370	1,169	2,477	109	1,671	1	81,236
2055	77,950	1,394	1,224	2,352	101	1,592	1	84,613
2060	82,358	1,405	1,265	2,252	92	1,493	1	88,865
2065	86,407	1,416	1,258	2,201	83	1,398	1	92,764
2070	90,340	1,446	1,253	2,178	76	1,322	1	96,616
2075	94,108	1,485	1,250	2,158	71	1,265	1	100,338
2080	96,708	1,516	1,234	2,111	66	1,217	1	102,851
2085	98,097	1,528	1,216	2,036	61	1,167	1	104,105
2090	98,223	1,537	1,189	1,953	56	1,115	1	104,073
2095	97,792	1,545	1,170	1,875	51	1,065	1	103,498
2100	97,694	1,567	1,165	1,833	47	1,017	1	103,323

[a] Retired-worker beneficiaries include persons who also receive a residual benefit consisting of the excess of an auxiliary benefit over their retired-worker benefit.

Notes:
1. The number of beneficiaries does not include uninsured individuals who receive benefits under section 228 of the Social Security Act. Transfers from the General Fund of the Treasury reimburse the OASI Trust Fund for the cost of most of these individuals.

2. Components may not sum to totals because of rounding.

5. Disability Insurance Beneficiaries

The DI Trust Fund pays for benefits to workers who: (1) satisfy the disability insured requirements, (2) have applied for disabled-worker benefits, (3) are determined to be unable to engage in any substantial gainful activity due to a medically determinable physical or mental impairment severe enough to satisfy the requirements of the program, and (4) have not yet attained normal retirement age. Spouses and children of such disabled-worker beneficiaries may also receive DI benefits provided they satisfy certain criteria, primarily age and earnings requirements.

The Office of the Chief Actuary projects the number of disabled-worker beneficiaries in current-payment status (disability prevalence) for each future year. The projections start with the number in current-payment status as of December 2022. Projections of the number of applicants and new beneficiaries awarded benefits each year (disability incidence) and the number of beneficiaries leaving the disability rolls each year then determine the number in current-payment status in later years. Beneficiaries leave the rolls due to death and recovery (disability terminations) and due to conversion from disabled-worker to retired-worker beneficiary status at normal retirement age, after which the OASI Trust Fund pays for benefits. The remainder of this section describes the concepts of disability incidence, termination, and prevalence.

a. Disability Incidence

The disability incidence rate is the ratio of the number of applicants newly awarded disabled-worker benefits during each year to the number of individuals who meet insured requirements but are not yet receiving benefits (the disability-exposed population[1]). The Office of the Chief Actuary projects the number of newly awarded beneficiaries for each future year by multiplying assumed age-sex-specific disability incidence rates and the projected disability-exposed population by age and sex.

Figure V.C3 illustrates the projected incidence rates under the three alternatives along with historical rates. Incidence rates have varied substantially during the historical period since 1970 due to a variety of demographic and economic factors, along with changes in legislation and program administration. The solid lines in figure V.C3 show the age-sex-adjusted incidence rate consistent with the age-sex distribution of the disability-exposed population

[1] The disability-exposed population excludes those receiving benefits, while the disability insured population includes them. Section V.C.3 of this report describes the projection of the disability insured population.

for 2000. This adjustment allows a meaningful comparison of incidence rates over time by focusing on the likelihood of being awarded disabled-worker benefits, excluding the effects of a changing distribution of the population toward ages where disability is more or less likely.

The dashed lines in figure V.C3 represent the gross (unadjusted) incidence rates. The changing age-sex distribution of the exposed population over time influences these unadjusted rates. The gross incidence rate declined relative to the age-sex-adjusted rate between 1970 and 1990 as the baby-boom generation increased the size of the younger working-age population, where disability incidence is lower than in older populations. Between 1990 and 2010, the gross rate increased relative to the age-sex-adjusted rate as the baby-boom generation moved into an age range where disability incidence is higher. The projected gross incidence rate generally declines relative to the age-sex-adjusted rate as the baby-boom generation moves above the normal retirement age and the lower-birth-rate cohorts of the 1970s enter prime disability ages (50 to normal retirement age). As these smaller cohorts age beyond normal retirement age, by about 2050, the gross incidence rate returns to a higher relative level under the intermediate assumptions. Thereafter, the gross rate remains higher than the age-sex-adjusted rate, and reflects the persistently higher average age of the working-age population compared to the population in 2000, which is largely due to lower birth rates since 1965, and to the increase in the normal retirement age.

For the first 10 years of the projection period (through 2032), incidence rates reflect several factors following on the experience since the recession of 2007-09. At the beginning of the period of high unemployment that began in 2007, disability incidence rates started to rise to a level well above the general trend level, with rates reaching a peak in 2010. Between 2010 and 2012, incidence rates subsided as the economy recovered, but the decline continued after 2012, reaching levels well below those expected over the long-term. A portion of the elevation of disability incidence rates experienced during the recession of 2007-09 likely contributed to the lowering of incidence rates experienced during and subsequent to the economic recovery that followed, as many individuals applied for disability benefits earlier than they would have otherwise.

For 2022, the actual age-sex-adjusted incidence rate (2.9 per thousand) was below the level projected in last year's report (3.2 per thousand). In this year's report, incidence rates under the intermediate alternative are projected to rise more slowly early in the projection period than in last year's report, consistent with the low incidence levels experienced recently. Incidence rates are projected to rise to a temporary peak level for 2027 as some of the

reduced levels of new benefit awards in the pandemic period are realized in the next few years. After 2027, incidence rates gradually decline through the rest of the short-range period to the ultimate assumed level of incidence.

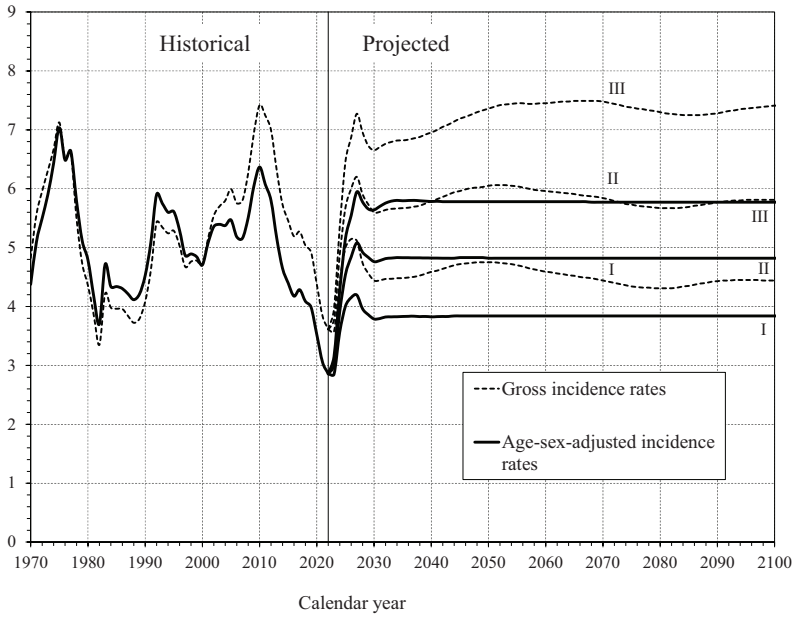
In 2032, at the end of the short-range period, age-sex-specific incidence rates are assumed to reach the ultimate rates assumed for the long-range projections. These ultimate age-sex-specific disability incidence rates were selected based on careful analysis of historical levels and patterns and expected future conditions, including the impact of scheduled increases in the normal retirement age.[1] The ultimate incidence rates represent the expected average rates of incidence for the future.

For the intermediate alternative, the Trustees assume that the ultimate age-sex-adjusted incidence rate (adjusted to the disability-exposed population for the year 2000) will be 4.8 awards per thousand exposed, which is the same as in last year's report. Figure V.C3 illustrates that the age-sex-adjusted incidence rate averaged 5.0 per thousand over the historical period 1970 through 2022, but has dropped substantially below that level since 2013. The rates seen in recent years are not consistent with an assumption of a full rise back to longer-term past historical averages. The Trustees continue to monitor experience and review the disability incidence rate assumption.

The Trustees assume that the ultimate age-sex-adjusted incidence rates for the low-cost and high-cost alternatives will be 3.8 and 5.8 awards per thousand exposed, or about 20 percent lower and higher, respectively, than the ultimate incidence rate for the intermediate alternative. These ultimate low-cost and high-cost incidence rates are similar to those in last year's report.

[1] Projected incidence rates are adjusted upward to account for additional workers who are expected to file for disability benefits (rather than retirement benefits) in response to reductions in retirement benefits as the normal retirement age rises.

Figure V.C3.—DI Disability Incidence Rates, 1970-2100
[Awards per thousand disability-exposed]



b. Disability Termination

Beneficiaries stop receiving disability benefits when they die, experience an improvement in their medically-determinable impairment such that they are deemed able to engage in substantial gainful activity, or return to substantial work. Disabled-worker beneficiaries who return to substantial work for an extended period are deemed to have recovered, and their benefits are then terminated. The termination rate is the ratio of the number of terminations for these reasons to the average number of disabled-worker beneficiaries during the year.

The Office of the Chief Actuary projects termination rates by age, sex, and reason for termination. In addition, the office projects termination rates by duration of entitlement to disabled-worker benefits in the long-range period (post-2032).

In the short-range period (through 2032), the projected age-sex-adjusted death rate (adjusted to the 2000 disabled-worker beneficiary population) under the intermediate assumptions declines from the temporarily elevated rate of 28.6 deaths per thousand beneficiaries for 2022 to about 23.8 per thousand for 2032. These rates are assumed to remain elevated through 2024

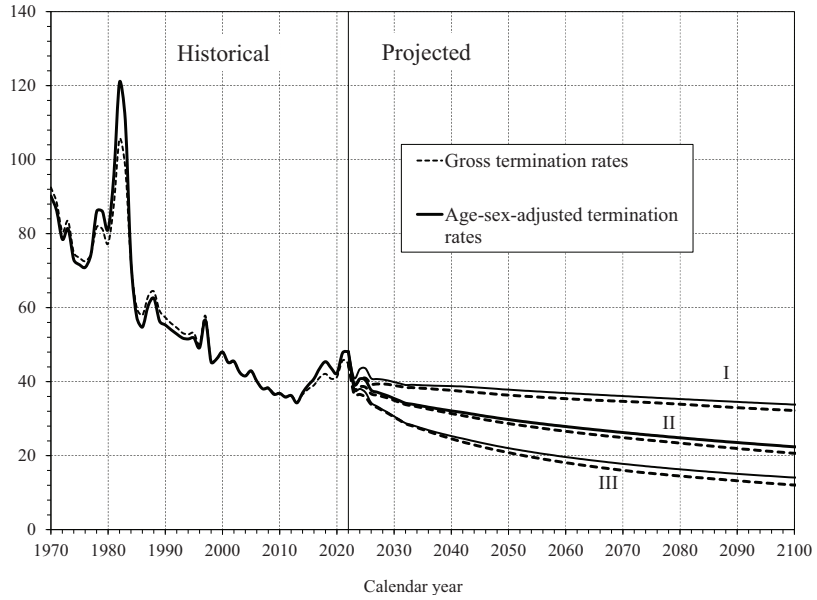
due to the COVID-19 pandemic, and then return to follow the underlying declining trend in general population mortality. The projected age-sex-adjusted recovery rate (medical improvement and return to substantial work) under the intermediate assumptions decreases from the relatively high level of 19.6 per thousand beneficiaries for 2022 to 10.4 per thousand beneficiaries for 2032. The recovery rate has been high in recent years due to an ongoing administrative effort to eliminate a backlog of medical continuing disability reviews. The recovery rate is expected to decrease as the backlog of disabled-worker reviews is assumed to be eliminated by the end of 2025. Thereafter, the rate decreases toward the expected long-term projected rate. Under the low-cost and high-cost assumptions, total age-sex-adjusted termination rates due to death and recovery are roughly 10 to 20 percent higher or lower, respectively, than under the intermediate assumptions.

For the long-range period (post-2032), the Office of the Chief Actuary projects death and recovery rates by age, sex, and duration of entitlement relative to the average level of rates experienced over the base period 2011 through 2015. The assumed ultimate age-sex-adjusted recovery rate for disabled-worker beneficiaries is 10.4 per thousand beneficiaries under the intermediate alternative.[1] The assumed ultimate age-sex-adjusted recovery rates for the low-cost and high-cost alternatives are 12.5 and 8.3 recoveries per thousand beneficiaries, respectively. Death rates by age and sex change throughout the long-range period at the same rate as death rates in the general population. The age-sex-adjusted death rate decreases from 28.6 per thousand beneficiaries in 2022 to 21.5, 12.4, and 6.1 per thousand disabled-worker beneficiaries for 2097 under the low-cost, intermediate, and high-cost assumptions, respectively.

Figure V.C4 illustrates gross and age-sex-adjusted total termination rates (including both recoveries and deaths) for disabled-worker beneficiaries for the historical period since 1970, and for the projection period through 2100. As with incidence rates, the age-sex-adjusted termination rate illustrates the real change in the tendency to terminate benefits. Changes in the age-sex distribution of the beneficiary population influence the gross termination rate. A shift in the disabled-worker beneficiary population to older ages, as occurred over the past 20 years when the baby-boom generation moved into pre-retirement ages, increases gross death termination rates relative to the age-sex-adjusted rates.

[1] The disability recovery rates for each alternative vary slightly over the last 65 years of the 75-year projection period, so the ultimate rates are presented as averages for years 2033 through 2097.

Figure V.C4.—DI Disability Termination Rates, 1970-2100
[Terminations per thousand disabled-worker beneficiaries]



c. Comparison of Incidence, Termination, and Conversion

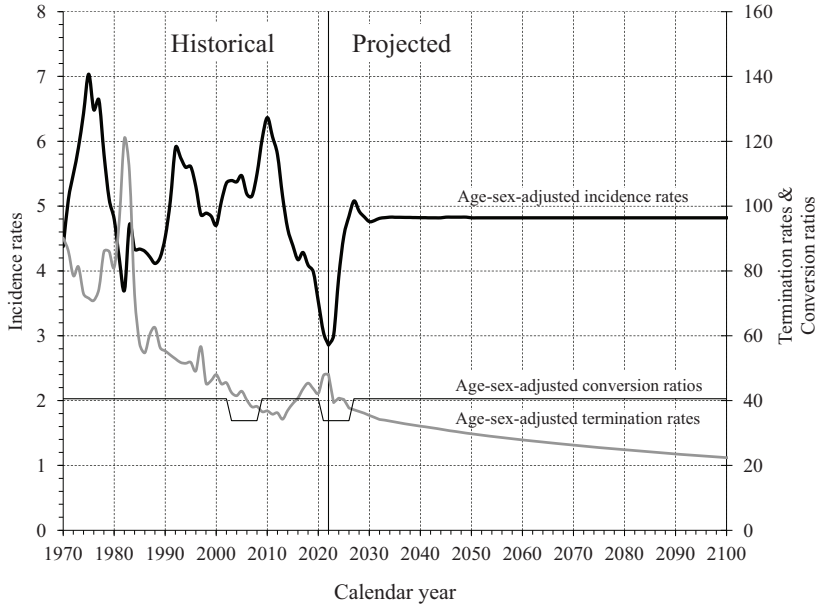
Incidence and termination rates are the foundation for projecting the number of disabled-worker beneficiaries in current-payment status. At normal retirement age, all disabled-worker beneficiaries convert to retired-worker status and leave the DI rolls.

Figure V.C5 compares the historical and projected (intermediate) levels of incidence, termination, and conversion on an age-sex-adjusted basis. Incidence rates have varied widely, and the Trustees expect the age-sex adjusted rates under the intermediate assumptions to remain near the middle of the high and low extremes experienced since 1970. Termination rates have declined and the Trustees expect them to continue to decline, largely because of declining death rates.

Conversions are a transfer of beneficiaries at normal retirement age from the DI program to the OASI program. Therefore, the disability "conversion" rate is 100 percent for disabled-worker beneficiaries reaching normal retirement age in a given year. After conversion, recovery from the disabling condition is no longer relevant for benefit eligibility. The conversion ratio is the number of conversions in a given year (that is, beneficiaries who reach normal

retirement age) divided by the average number of disabled-worker beneficiaries at all ages in that year. The ratio is constant on an age-sex-adjusted basis, except for the two periods during which normal retirement age increases under current law.

Figure V.C5.—Comparison of DI Disability Incidence Rates, Termination Rates and Conversion Ratios Under Intermediate Assumptions, 1970-2100
[Awards per thousand disability-exposed;
terminations and conversions per thousand disabled-worker beneficiaries]



d. DI Beneficiaries and Disability Prevalence Rates

The Office of the Chief Actuary makes detailed projections of disabled-worker awards, terminations, and conversions and combines these to project the number of disabled workers receiving benefits over the next 75 years. Table V.C5 presents the projected numbers of disabled-worker beneficiaries in current-payment status. The number of disabled-worker beneficiaries in current-payment status grows from 7.6 million at the end of 2022, to 10.9 million, 12.6 million, and 12.6 million at the end of 2100, under the low-cost, intermediate, and high-cost assumptions, respectively. Of course, much of this growth results from the growth and changing age distribution of the population described earlier in this chapter. Table V.C5 also presents projected numbers of auxiliary beneficiaries and disability prevalence rates on both a gross basis and an age-sex-adjusted basis.

Table V.C5.—DI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1960-2100

[Beneficiaries in thousands; prevalence rates per thousand persons insured for disability benefits]

Calendar year	Disabled-worker beneficiaries	Auxiliary beneficiaries		Total beneficiaries	Disability prevalence rates	
		Spouse	Child		Gross	Age-sex-adjusted[a]
Historical data:						
1960	455	77	155	687		
1965	988	193	558	1,739		
1970	1,493	283	889	2,665	20	18
1975	2,488	453	1,411	4,351	29	28
1980	2,856	462	1,359	4,677	28	31
1985	2,653	306	945	3,904	24	26
1990	3,007	266	989	4,261	25	28
1995	4,179	264	1,409	5,852	33	35
2000	5,036	165	1,466	6,667	36	36
2005	6,519	157	1,633	8,309	45	40
2010	8,204	161	1,820	10,185	55	44
2015	8,909	143	1,756	10,808	59	45
2016	8,809	136	1,667	10,612	58	44
2017	8,695	127	1,590	10,412	57	43
2018	8,537	119	1,507	10,164	55	41
2019	8,378	114	1,434	9,927	54	40
2020	8,151	105	1,364	9,620	52	39
2021	7,877	97	1,245	9,219	50	37
2022	7,604	92	1,146	8,842	48	34
Intermediate:						
2023	7,416	90	1,100	8,606	46	33
2025	7,518	90	1,092	8,700	47	33
2030	7,845	89	1,211	9,145	48	35
2035	8,233	90	1,357	9,681	49	37
2040	8,775	91	1,589	10,455	52	39
2045	9,518	103	1,784	11,405	55	40
2050	10,040	106	1,900	12,046	58	41
2055	10,433	108	1,966	12,507	59	42
2060	10,509	104	1,982	12,595	59	42
2065	10,658	106	1,987	12,751	59	42
2070	10,795	110	2,020	12,926	59	42
2075	10,756	110	2,086	12,952	58	43
2080	10,851	111	2,168	13,131	57	43
2085	11,106	114	2,242	13,461	57	43
2090	11,667	121	2,302	14,090	58	43
2095	12,185	125	2,350	14,660	59	43
2100	12,550	129	2,399	15,078	60	43
Low-cost:						
2023	7,379	90	1,093	8,562	46	33
2025	7,301	90	1,056	8,447	45	32
2030	6,948	88	1,077	8,112	42	31
2035	6,826	74	1,164	8,064	40	30
2040	6,998	70	1,359	8,427	41	30
2045	7,447	75	1,528	9,050	42	31
2050	7,779	75	1,622	9,476	43	31
2055	8,054	75	1,677	9,805	43	32
2060	8,119	71	1,699	9,889	43	32
2065	8,259	73	1,727	10,058	42	32
2070	8,415	75	1,795	10,285	41	32
2075	8,481	75	1,899	10,455	40	32
2080	8,705	76	2,014	10,795	40	32
2085	9,134	78	2,114	11,326	40	32
2090	9,860	86	2,200	12,146	41	32
2095	10,450	90	2,279	12,819	42	32
2100	10,870	91	2,368	13,329	42	32

Table V.C5.—DI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1960-2100 (Cont.)

[Beneficiaries in thousands; prevalence rates per thousand persons insured for disability benefits]

Calendar year	Disabled-worker beneficiaries	Auxiliary beneficiaries		Total beneficiaries	Disability prevalence rates	
		Spouse	Child		Gross	Age-sex-adjusted[a]
High-cost:						
2023	7,452	90	1,105	8,647	47	33
2025	7,750	91	1,129	8,969	48	34
2030	8,706	90	1,312	10,107	54	40
2035	9,627	107	1,491	11,225	59	44
2040	10,556	114	1,689	12,358	63	47
2045	11,614	135	1,861	13,609	69	49
2050	12,332	142	1,972	14,446	74	51
2055	12,839	146	2,033	15,018	78	52
2060	12,894	141	2,027	15,062	79	53
2065	13,001	143	1,986	15,130	80	53
2070	13,028	148	1,947	15,123	81	53
2075	12,740	146	1,927	14,813	81	53
2080	12,492	145	1,934	14,571	80	54
2085	12,249	143	1,948	14,340	79	54
2090	12,230	144	1,954	14,327	80	54
2095	12,421	147	1,945	14,513	81	54
2100	12,556	150	1,927	14,632	82	54

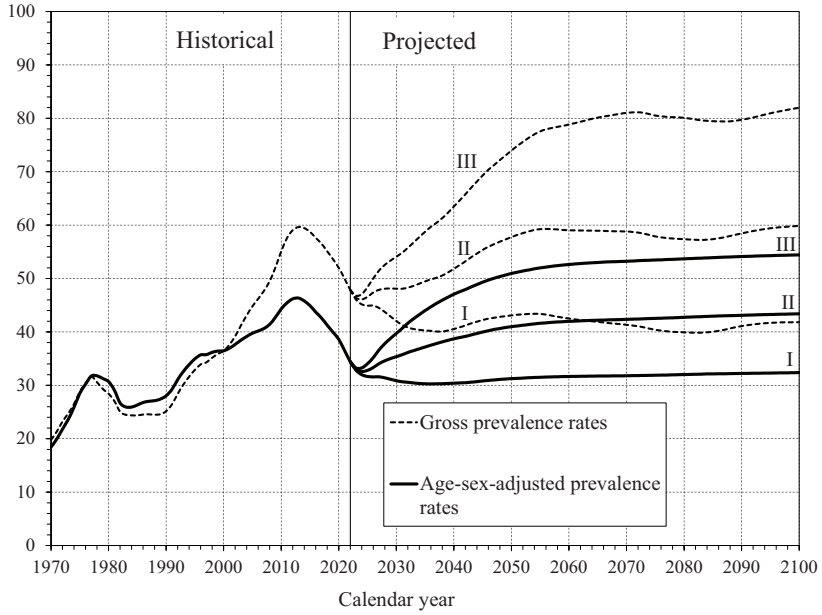
[a] Adjusted to the age-sex distribution of the disability insured population for the year 2000.

Note: Components may not sum to totals because of rounding.

The disability prevalence rate is the ratio of the number of disabled-worker beneficiaries in current-payment status to the number of persons insured for disability benefits. Figure V.C6 illustrates the historical and projected disability prevalence rates on both a gross basis and on an age-sex-adjusted basis (adjusted to the age-sex distribution of the disability insured population for the year 2000).

Changes in prevalence rates are a direct result of changes in incidence rates and termination rates. Figure V.C5 depicts patterns for incidence and termination rates, which are helpful for understanding the trend in prevalence rates. Annual incidence and termination rates are not directly comparable or combinable because their denominators differ.

Figure V.C6.—DI Disability Prevalence Rates, 1970-2100
[Rate per thousand persons insured for disability benefits]



Age-sex-adjusted prevalence rates have increased primarily because: (1) termination rates, in particular death termination rates, have declined; (2) incidence rates at younger ages have increased relative to rates at older ages (new beneficiaries at younger ages have more potential years on the disability rolls); (3) incidence rates have increased substantially for women to parity with men; and (4) the maturation of the DI program (disabled-worker benefits became available to those over age 50 at the start of the program in 1957 and to younger workers in 1960, and disability insured status requirements were eased for those under age 31 in 1968). Gross prevalence rates have increased more than age-sex-adjusted prevalence rates since the baby-boom generation began to reach ages 45 through normal retirement age, a time of life when disability incidence rates are relatively high. The Office of the Chief Actuary projects both gross and age-sex adjusted prevalence rates to grow at a slower pace based on assumed stabilization in these four factors: (1) the age distribution of the general population, (2) the age distribution of the disability insured population, (3) incidence rates by age and sex, and (4) DI program age and insured requirements. As these factors gradually stabilize, the declining death termination rate continues to have a small influence toward higher disability prevalence rates.

As mentioned above in the discussion of incidence and termination rates, the age-sex-adjusted prevalence rate isolates the changing trend in the underlying likelihood of receiving benefits for the insured population, without reflecting changes in the age and sex distribution of the population. As with incidence rates, gross disability prevalence rates declined relative to the age-sex-adjusted rate when the baby-boom generation reached working age between 1970 and 1990; this trend reflects the lower disability prevalence rates associated with younger ages. Conversely, the gross rate of disability prevalence has increased relative to the age-sex-adjusted rate after 1990 due to the aging of the baby-boom generation into ages with higher disability prevalence rates.

Under the intermediate assumptions, the projected age-sex-adjusted disability prevalence rate grows from 34.4 per thousand disability insured workers at the end of 2022 to 43.4 per thousand at the end of 2100. The projected age-sex-adjusted disability prevalence rate at the end of 2100 is 32.4 per thousand under the low-cost assumptions and 54.4 per thousand under the high-cost assumptions.

Table V.C5 presents projections of the numbers of auxiliary beneficiaries paid from the DI Trust Fund. As indicated at the beginning of this subsection, auxiliary beneficiaries are qualifying spouses and children of disabled-worker beneficiaries. A spouse must either be at least age 62 or have an eligible child beneficiary in his or her care who is either under age 16 or disabled prior to age 22. A child must be: (1) under age 18, (2) age 18 or 19 and still a student in high school, or (3) age 18 or older and disabled prior to age 22.

The projection of the number of auxiliary beneficiaries relies on the projected number of disabled-worker beneficiaries. In the short-range period (2023 through 2032), the Office of the Chief Actuary projects incidence and termination rates for each category of auxiliary beneficiary. After 2032, the office projects child beneficiaries at ages 18 and under in relation to the projected number of children in the population using the probability that either of their parents is a disabled-worker beneficiary. The office projects the remaining categories of children and spouses in a similar manner.

6. Covered and Taxable Earnings, Taxable Payroll, and Payroll Tax Contributions

Covered earnings include both covered wages and covered self-employment net earnings. The Office of the Chief Actuary projects covered wages for component sectors of the economy (i.e., private, State and local government, Federal civilian, and military) based on the projected overall growth of sec-

toral and total wages in the U.S. economy. The projections of covered wages also reflect changes in covered employment due to a relative increase in non-covered undocumented immigrants and to the mandatory coverage of new hires in the Federal civilian sector. The office projects covered self-employment net earnings based on the growth in net proprietors' income in the U.S. economy.

Taxable earnings are the portion of covered earnings subject to the Social Security payroll tax. Taxable wages for an employee are total covered wages from all wage employment up to the contribution and benefit base. Taxable wages for an employer are the sum of all covered wages paid to each employee up to the base. Employees with multiple jobs whose total wages exceed the base are eligible for a refund of excess employee taxes withheld; employers are not eligible for a refund on this basis. For self-employed workers with no taxable wages, taxable earnings are the amount of covered self-employment net earnings up to the base. For self-employed workers with taxable wages less than the base, covered self-employment net earnings are taxable up to the difference between the base and their taxable wages. For projection purposes, the Office of the Chief Actuary computes taxable earnings based on a proportion of covered earnings that is at or below the base.

The OASDI taxable payroll (see table VI.G6) for a year is computed as the amount of earnings which, when multiplied by the combined OASDI employee-employer payroll tax rate for that year, yields the total amount of payroll taxes due from wages paid and self-employment net earnings for the year. Taxable payroll is used as the denominator for income rates, cost rates, and actuarial balances. Taxable payroll is derived by adjusting total taxable earnings to account for categories of earnings that are taxed at rates other than the combined employee-employer rate and to take into account amounts credited as wages that were not included in normally reported wages. For 1951 and later, taxable earnings are reduced by one-half of the amount of wages paid to employees with multiple jobs that exceed the contribution and benefit base. For 1983 through 2001, deemed wage credits for military service after 1956 are added to taxable earnings. The self-employment tax rates for 1951 through 1983 were less than the combined employee-employer rates; therefore, the self-employment component of taxable payroll for those years is reduced by multiplying the ratio of the self-employment rate to the combined employee-employer rate times the taxable self-employment net earnings. Finally, for 1966 through 1979, employers were exempt from paying their share of payroll tax on their employees' tips and, for 1980 through 1987, employers paid tax on only part of their employees' tips. For those

years, the taxable payroll is reduced by half of the amount of tips for which the employer owed no payroll tax.

The ratio of taxable payroll to covered earnings (the taxable ratio) declined from 88.6 percent for 1984 to 82.6 percent for 2000, mostly due to much larger increases in wage levels for very high earners than for all other earners. From 2000 to 2010, the taxable ratio varied with the business cycle, rising during economic downturns and declining during recoveries. Specifically, the taxable ratio rose to 85.7 percent for 2002, declined to 82.4 percent for 2007, rose to 85.2 percent for 2009, and averaged 83.0 percent for the period 2010 to 2019.

The ratio declined to 82.2 percent for 2020 from the previous year's 83.1 percent. Unlike previous economic downturns, the pandemic-induced recession led to a much greater decrease in wages for earners at the low end of the earnings distribution than for those at the high end. This resulted in a relatively higher proportion of total wages being above the contribution and benefit base than has typically been the case in other economic downturns. The ratio declined further to 81.0 percent for 2021, mainly due to increases in bonuses paid to high earners and the exercising of stock options.

The taxable ratio for 2022 is estimated to increase to 82.3 percent for all three alternatives. The ratio for the intermediate assumptions increases to 83.1 for 2023 and 83.2 for 2024. For the low-cost and high-cost alternatives, the ratio for 2023 increases to 83.1 and 83.5, respectively. Subsequently, for all three alternatives, the ratio gradually decreases to the levels assumed for the end of the short-range period.

For this report, the Trustees assume a level for the taxable ratio at the end of the short-range period (2032) of 84.0 percent for the low-cost assumptions, 82.5 percent for the intermediate assumptions, and 81.0 percent for the high-cost assumptions.[1] These are the same assumptions that the Trustees used for the end of the short-range period (2031) for the 2022 report.

The Office of the Chief Actuary projects payroll tax contributions using the patterns of tax collection required by Federal laws and regulations. The office determines payroll tax liabilities by multiplying the scheduled tax rates for each year by the amount of taxable wages and self-employment net earnings for that year. The office then splits these liabilities into amounts by collection period. For wages, Federal law requires that employers withhold

[1] The taxable ratio drifts down slightly after 2032, to 84.0, 82.3, and 80.7 percent for 2097 for the low-cost, intermediate, and high-cost assumptions, respectively, as self-employment income (which has a lower percent taxable than wages) becomes an increasing share of total earnings.

OASDI and HI payroll taxes and Federal individual income taxes from employees' pay. As an employer's accumulation of such taxes (including the employer share of payroll taxes) meets certain thresholds, which the Department of the Treasury determines, the employer must deposit these taxes with the U.S. Treasury by a specific day, depending on the amount of money involved.[1] For projection purposes, the office splits the payroll tax contributions related to wages into amounts paid in the same quarter as incurred and in the following quarter. Self-employed workers must make estimated tax payments on their earnings four times during the year and make up any underestimate on their individual income tax returns. The projection splits the self-employed tax liabilities by collection quarter to reflect this pattern.

The projected tax contributions also reflect the method used to ensure that money transferred to the trust funds is adjusted, over time, to equal the actual liability owed. Because payers generally make tax payments without identifying the separate OASDI contribution amounts, Treasury makes daily transfers of money from the General Fund to the trust funds on an initial estimated basis. The Social Security Administration periodically certifies the amounts of wages and self-employment net earnings on which tax contributions are owed for each year, at which time Treasury determines adjustments to appropriations to reconcile tax liabilities with deposits in the trust funds. This process also includes periodic transfers from the trust funds to the General Fund for contributions on wages in excess of the contribution and benefit base.

Table V.C6 shows the payroll tax contribution rates applicable under current law in each calendar year and the allocation of these rates between the OASI and DI Trust Funds.[2] It also shows the contribution and benefit base for each year through 2023.

[1] Generally, the higher the amount of liability, the sooner the taxes must be paid. For smaller employers, payment is due by the middle of the month following when the liability was incurred. Medium-size employers have three banking days in which to make their deposits. Larger employers must make payment on the next business day after paying their employees.

[2] Table VI.G1 shows the payroll tax contribution rates for the Hospital Insurance (HI) program.

Table V.C6.—Contribution and Benefit Base and Payroll Tax Contribution Rates

Calendar years	Contribution and benefit base	Payroll tax contribution rates (percent)					
		Employees and employers, combined[a]			Self-employed[b]		
		OASDI	OASI	DI	OASDI	OASI	DI
1937-49	$3,000	2.00	2.00	—	—	—	—
1950	3,000	3.00	3.00	—	—	—	—
1951-53	3,600	3.00	3.00	—	2.2500	2.2500	—
1954	3,600	4.00	4.00	—	3.0000	3.0000	—
1955-56	4,200	4.00	4.00	—	3.0000	3.0000	—
1957-58	4,200	4.50	4.00	0.50	3.3750	3.0000	0.3750
1959	4,800	5.00	4.50	.50	3.7500	3.3750	.3750
1960-61	4,800	6.00	5.50	.50	4.5000	4.1250	.3750
1962	4,800	6.25	5.75	.50	4.7000	4.3250	.3750
1963-65	4,800	7.25	6.75	.50	5.4000	5.0250	.3750
1966	6,600	7.70	7.00	.70	5.8000	5.2750	.5250
1967	6,600	7.80	7.10	.70	5.9000	5.3750	.5250
1968	7,800	7.60	6.65	.95	5.8000	5.0875	.7125
1969	7,800	8.40	7.45	.95	6.3000	5.5875	.7125
1970	7,800	8.40	7.30	1.10	6.3000	5.4750	.8250
1971	7,800	9.20	8.10	1.10	6.9000	6.0750	.8250
1972	9,000	9.20	8.10	1.10	6.9000	6.0750	.8250
1973	10,800	9.70	8.60	1.10	7.0000	6.2050	.7950
1974	13,200	9.90	8.75	1.15	7.0000	6.1850	.8150
1975	14,100	9.90	8.75	1.15	7.0000	6.1850	.8150
1976	15,300	9.90	8.75	1.15	7.0000	6.1850	.8150
1977	16,500	9.90	8.75	1.15	7.0000	6.1850	.8150
1978	17,700	10.10	8.55	1.55	7.1000	6.0100	1.0900
1979	22,900	10.16	8.66	1.50	7.0500	6.0100	1.0400
1980	25,900	10.16	9.04	1.12	7.0500	6.2725	.7775
1981	29,700	10.70	9.40	1.30	8.0000	7.0250	.9750
1982	32,400	10.80	9.15	1.65	8.0500	6.8125	1.2375
1983	35,700	10.80	9.55	1.25	8.0500	7.1125	.9375
1984[c]	37,800	11.40	10.40	1.00	11.4000	10.4000	1.0000
1985[c]	39,600	11.40	10.40	1.00	11.4000	10.4000	1.0000
1986[c]	42,000	11.40	10.40	1.00	11.4000	10.4000	1.0000
1987[c]	43,800	11.40	10.40	1.00	11.4000	10.4000	1.0000
1988[c]	45,000	12.12	11.06	1.06	12.1200	11.0600	1.0600
1989[c]	48,000	12.12	11.06	1.06	12.1200	11.0600	1.0600
1990	51,300	12.40	11.20	1.20	12.4000	11.2000	1.2000
1991	53,400	12.40	11.20	1.20	12.4000	11.2000	1.2000
1992	55,500	12.40	11.20	1.20	12.4000	11.2000	1.2000
1993	57,600	12.40	11.20	1.20	12.4000	11.2000	1.2000
1994	60,600	12.40	10.52	1.88	12.4000	10.5200	1.8800
1995	61,200	12.40	10.52	1.88	12.4000	10.5200	1.8800
1996	62,700	12.40	10.52	1.88	12.4000	10.5200	1.8800
1997	65,400	12.40	10.70	1.70	12.4000	10.7000	1.7000
1998	68,400	12.40	10.70	1.70	12.4000	10.7000	1.7000
1999	72,600	12.40	10.70	1.70	12.4000	10.7000	1.7000
2000	76,200	12.40	10.60	1.80	12.4000	10.6000	1.8000
2001	80,400	12.40	10.60	1.80	12.4000	10.6000	1.8000
2002	84,900	12.40	10.60	1.80	12.4000	10.6000	1.8000
2003	87,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2004	87,900	12.40	10.60	1.80	12.4000	10.6000	1.8000
2005	90,000	12.40	10.60	1.80	12.4000	10.6000	1.8000

Table V.C6.—Contribution and Benefit Base and Payroll Tax Contribution Rates (Cont.)

Calendar years	Contribution and benefit base	Payroll tax contribution rates (percent)					
		Employees and employers, combined[a]			Self-employed[b]		
		OASDI	OASI	DI	OASDI	OASI	DI
2006	$94,200	12.40	10.60	1.80	12.4000	10.6000	1.8000
2007	97,500	12.40	10.60	1.80	12.4000	10.6000	1.8000
2008	102,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2009	106,800	12.40	10.60	1.80	12.4000	10.6000	1.8000
2010[d]	106,800	12.40	10.60	1.80	12.4000	10.6000	1.8000
2011[d]	106,800	10.40	8.89	1.51	10.4000	8.8900	1.5100
2012[d]	110,100	10.40	8.89	1.51	10.4000	8.8900	1.5100
2013	113,700	12.40	10.60	1.80	12.4000	10.6000	1.8000
2014	117,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2015	118,500	12.40	10.60	1.80	12.4000	10.6000	1.8000
2016	118,500	12.40	10.03	2.37	12.4000	10.0300	2.3700
2017	127,200	12.40	10.03	2.37	12.4000	10.0300	2.3700
2018	128,400	12.40	10.03	2.37	12.4000	10.0300	2.3700
2019	132,900	12.40	10.60	1.80	12.4000	10.6000	1.8000
2020	137,700	12.40	10.60	1.80	12.4000	10.6000	1.8000
2021	142,800	12.40	10.60	1.80	12.4000	10.6000	1.8000
2022	147,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2023	160,200	12.40	10.60	1.80	12.4000	10.6000	1.8000
2024 and later	[e]	12.40	10.60	1.80	12.4000	10.6000	1.8000

[a] Except as noted below, the combined employee/employer rate is divided equally between employees and employers.
[b] Beginning in 1990, self-employed persons receive a deduction, for purposes of computing their net earnings, equal to half of the combined OASDI and HI contributions that would be payable without regard to the contribution and benefit base. The OASDI contribution rate then applies to net earnings after this deduction, but subject to the OASDI base.
[c] In 1984 only, employees received an immediate credit of 0.3 percent of taxable wages against their OASDI payroll tax contributions. The self-employed received similar credits of 2.7 percent, 2.3 percent, and 2.0 percent against their combined OASDI and Hospital Insurance (HI) contributions on net earnings from self-employment in 1984, 1985, and 1986-89, respectively. The General Fund of the Treasury reimbursed the trust funds for these credits.
[d] Public Law 111-147 exempted most employers from paying the employer share of OASDI payroll tax on wages paid during the period March 19, 2010 through December 31, 2010 to certain qualified individuals hired after February 3, 2010. Public Law 111-312 reduced the OASDI payroll tax rate for 2011 by 2 percentage points for employees and for self-employed workers. Public Law 112-96 extended the 2011 rate reduction through 2012. These laws require that the General Fund of the Treasury reimburse the OASI and DI Trust Funds for these temporary reductions in 2010 through 2012 payroll tax revenue, in order to "replicate to the extent possible" revenue that would have been received if the combined employee/employer payroll tax rates had remained at 12.4 percent for OASDI (10.6 percent for OASI and 1.8 percent for DI).
[e] Subject to automatic adjustment based on increases in average wages.

7. Income From Taxation of Benefits

Under current law, the OASI and DI Trust Funds are credited with income tax revenue from the taxation of up to the first 50 percent of taxpayers' OASI and DI benefit payments. (The HI Trust Fund receives the remainder of the income tax revenue from the taxation of up to 85 percent of taxpayers' OASI and DI benefit payments.) Benefits are partially subject to federal income tax for beneficiaries with income (defined for this purpose as adjusted gross income excluding Social Security benefits, plus half of their Social Security benefits and all of their non-taxable interest income) in excess of specified

threshold amounts. The threshold amounts are $25,000 for single filers, $32,000 for joint filers, and $0 for those married individuals filing separately.

For the short-range period, the Office of the Chief Actuary estimates the income to the OASI and DI Trust Funds from taxation of benefits by applying the following two factors (projected by the Office of Tax Analysis, Department of the Treasury) to total OASI and DI scheduled benefits: (1) the percentage of taxpayers' scheduled benefits (limited to 50 percent) that is taxable and (2) the average marginal tax rate applicable to those benefits. Up to 85 percent of benefits may be subject to federal income tax, with any tax on more than 50 percent of a taxpayer's benefits credited to the Medicare Hospital Insurance Trust Fund.

For the long-range period, the office estimates the income to the trust funds from taxation of benefits by applying projected ratios of taxation of OASI and DI benefits to total OASI and DI scheduled benefits. These tax ratios rely on estimates from the Office of Tax Analysis in the Department of the Treasury. The Office of the Chief Actuary's estimates reflect the following assumptions: (1) The income thresholds used for benefit taxation are specified in the Internal Revenue Code to be constant in the future, and have never been changed, while income and benefit levels continue to rise. Accordingly, projected ratios of income from taxation of benefits to the amount of benefits increase gradually. (2) A permanent level shift upward in the ratios is projected for 2026 and beyond due to the expiration of the personal income tax provisions in Public Law 115-97, the Tax Cuts and Jobs Act of 2017. (3) Because indexation of income tax brackets is not specified in the Social Security Act, and because periodic changes have been made in the past to avoid indefinite compression of the income tax brackets relative to income levels (bracket creep), the Trustees assume that such periodic changes will occur in the future. As a result, after the tenth year of the projection period, income tax brackets are assumed to rise with average wages, rather than with the C-CPI-U as specified under current law. Thus, the income tax brackets are projected to roughly maintain their levels relative to the income distribution.

8. Average Benefits

Projections of average benefits for each benefit type reflect recent historical averages, projected average primary insurance amounts (PIAs), and projected ratios of average benefits to average PIAs. Calculations of average PIAs are based on projected distributions of beneficiaries by duration from year of initial entitlement, average PIAs at initial entitlement, and increases in PIAs after initial entitlement. Projected increases in average PIAs after ini-

tial entitlement depend on automatic benefit increases, recomputations to reflect additional covered earnings, and differences in mortality by level of lifetime earnings. Calculations of future average PIAs at initial entitlement are based on projected earnings histories, which in turn reflect a combination of the actual earnings histories associated with a sample of 2019 initial entitlements and more recent actual earnings levels by age and sex for covered workers.

For retired-worker, aged-spouse, and aged-widow(er) benefits, the percentage of the PIA that is payable depends on the age at initial entitlement to benefits. Projected ratios of average benefits to average PIAs for these types of benefits are based on projections of age distributions at initial entitlement.

9. Scheduled Benefits

For each type of benefit, scheduled benefits are the product of the number of beneficiaries and the corresponding average monthly benefit. The short-range model calculates scheduled benefits on a quarterly basis. The long-range model calculates all scheduled benefits on an annual basis, using the number of beneficiaries at the beginning and end of the year. Adjustments to these annual scheduled benefits include retroactive payments to newly awarded beneficiaries and other amounts not reflected in the regular monthly scheduled benefits.

Scheduled lump-sum death benefits are estimated as the product of: (1) the number of lump-sum death payments projected on the basis of the assumed death rates, the projected fully insured population, and the estimated percentage of the fully insured population that will qualify for lump-sum death payments; and (2) the amount of the lump-sum death payment, which is $255 (unindexed since 1973).

10. Illustrative Scheduled Benefit Amounts

Table V.C7 shows, under the intermediate assumptions, future scheduled benefit amounts payable upon retirement at the normal retirement age and at age 65, for various hypothetical workers attaining age 65 in 2023 and subsequent years. The illustrative benefit amounts in table V.C7 are presented in CPI-indexed 2023 dollars—that is, adjusted to 2023 levels by the CPI indexing series shown in table VI.G6. Table V.C7 also shows each benefit amount as a percentage of the average of each hypothetical worker's highest 35 years

of Social Security covered earnings, indexed by national average wage growth to the year prior to initial entitlement to retired worker benefits.[1]

The normal retirement age was 65 for individuals who reached age 62 before 2000. It increased to age 66 during the period 2000 through 2005, at a rate of 2 months per year as workers attained age 62. Under current law, the normal retirement age increases to age 67 during the period 2017 through 2022, also by 2 months per year as workers attain age 62. The illustrative benefit amounts shown in table V.C7 for retirees at age 65 are lower than the amounts shown for retirees at normal retirement age because monthly benefits taken before normal retirement age are reduced to reflect the expected additional years benefits will be collected. For example, those who start collecting benefits at age 65 in 2027 and survive to age 67 will receive benefits for two more years than if they had instead waited to start collecting benefits at normal retirement age in 2029.

Table V.C7 shows five different pre-retirement earnings patterns. Four of these patterns assume the earnings history of workers with scaled-earnings patterns[2] and reflect very low, low, medium, and high career-average levels of pre-retirement earnings starting at age 21. The fifth pattern assumes the earnings history of a steady maximum earner starting at age 22. The four scaled-earnings patterns derive from earnings experienced by insured workers during calendar years 2000 through 2019. These earnings levels differ by age. The career-average level of earnings for each scaled case targets a percent of the AWI.

For the scaled medium earner, the career-average earnings level is about equal to the AWI (estimated to be $66,147 for 2023). For the scaled very low, low, and high earners, the career-average earnings level, wage-indexed to the year before starting benefits, is about 25 percent, 45 percent, and 160 percent of the AWI, respectively (estimated to be $16,537, $29,766, and $105,835, respectively, for 2023). The steady maximum earner has earnings at or above the contribution and benefit base ($160,200 for 2023) for each year starting at age 22 through the year prior to retirement.

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[1] Actuarial Note 2023.9 has additional detail on illustrative benefits for hypothetical workers. See www.ssa.gov/OACT/NOTES/ran9/.

[2] Actuarial Note 2023.3 has more details on scaled-earnings patterns. See www.ssa.gov/OACT/NOTES/ran3/.

Table V.C7.—Annual Scheduled Benefit Amounts[a] for Retired Workers With Various Pre-Retirement Earnings Patterns Based on Intermediate Assumptions, Calendar Years 2023-2100

	Retirement at normal retirement age			Retirement at age 65		
Year attain age 65[b]	Age at retirement	CPI-indexed 2023 dollars[c]	Percent of 35-year average earnings	Age at retirement	CPI-indexed 2023 dollars[c]	Percent of 35-year average earnings
Scaled very low earnings:[d]						
2023	66:8	$13,041	78.9	65:0	$11,311	71.3
2025	67:0	12,790	75.8	65:0	11,063	67.7
2030	67:0	13,581	74.3	65:0	11,758	66.4
2035	67:0	14,707	75.6	65:0	12,730	67.1
2040	67:0	15,703	76.0	65:0	13,601	67.4
2045	67:0	16,686	76.3	65:0	14,454	67.6
2050	67:0	17,676	76.5	65:0	15,306	67.7
2055	67:0	18,675	76.5	65:0	16,169	67.7
2060	67:0	19,730	76.5	65:0	17,088	67.7
2065	67:0	20,852	76.4	65:0	18,060	67.7
2070	67:0	22,067	76.4	65:0	19,109	67.7
2075	67:0	23,356	76.4	65:0	20,226	67.7
2080	67:0	24,713	76.4	65:0	21,401	67.7
2085	67:0	26,150	76.4	65:0	22,646	67.7
2090	67:0	27,668	76.4	65:0	23,959	67.7
2095	67:0	29,262	76.5	65:0	25,341	67.7
2100	67:0	30,942	76.4	65:0	26,795	67.7
Scaled low earnings:[e]						
2023	66:8	17,082	57.4	65:0	14,824	51.9
2025	67:0	16,787	55.2	65:0	14,499	49.3
2030	67:0	17,791	54.1	65:0	15,390	48.3
2035	67:0	19,265	55.0	65:0	16,677	48.8
2040	67:0	20,570	55.3	65:0	17,806	49.0
2045	67:0	21,858	55.5	65:0	18,922	49.2
2050	67:0	23,139	55.7	65:0	20,035	49.3
2055	67:0	24,455	55.7	65:0	21,173	49.3
2060	67:0	25,835	55.6	65:0	22,366	49.3
2065	67:0	27,307	55.6	65:0	23,639	49.2
2070	67:0	28,896	55.6	65:0	25,014	49.2
2075	67:0	30,583	55.6	65:0	26,475	49.2
2080	67:0	32,362	55.6	65:0	28,017	49.2
2085	67:0	34,244	55.6	65:0	29,645	49.2
2090	67:0	36,229	55.6	65:0	31,363	49.2
2095	67:0	38,318	55.6	65:0	33,173	49.2
2100	67:0	40,515	55.6	65:0	35,075	49.2
Scaled medium earnings:[f]						
2023	66:8	28,204	42.6	65:0	24,463	38.5
2025	67:0	27,753	41.1	65:0	23,947	36.6
2030	67:0	29,374	40.2	65:0	25,399	35.8
2035	67:0	31,793	40.9	65:0	27,501	36.2
2040	67:0	33,939	41.1	65:0	29,361	36.4
2045	67:0	36,064	41.2	65:0	31,209	36.5
2050	67:0	38,183	41.3	65:0	33,043	36.6
2055	67:0	40,342	41.3	65:0	34,914	36.6
2060	67:0	42,626	41.3	65:0	36,887	36.6
2065	67:0	45,054	41.3	65:0	38,989	36.5
2070	67:0	47,676	41.2	65:0	41,259	36.5
2075	67:0	50,459	41.3	65:0	43,664	36.5
2080	67:0	53,390	41.3	65:0	46,205	36.5
2085	67:0	56,496	41.3	65:0	48,890	36.5
2090	67:0	59,770	41.3	65:0	51,726	36.5
2095	67:0	63,215	41.3	65:0	54,708	36.5
2100	67:0	66,843	41.3	65:0	57,845	36.5

Table V.C7.—Annual Scheduled Benefit Amounts[a] for Retired Workers With Various Pre-Retirement Earnings Patterns Based on Intermediate Assumptions, Calendar Years 2023-2100 (Cont.)

	Retirement at normal retirement age			Retirement at age 65		
Year attain age 65[b]	Age at retirement	CPI-indexed 2023 dollars[c]	Percent of 35-year average earnings	Age at retirement	CPI-indexed 2023 dollars[c]	Percent of 35-year average earnings
Scaled high earnings:[g]						
2023	66:8	$37,269	35.2	65:0	$32,345	31.9
2025	67:0	36,579	33.9	65:0	31,621	30.2
2030	67:0	38,822	33.2	65:0	33,598	29.6
2035	67:0	42,037	33.8	65:0	36,391	30.0
2040	67:0	44,882	33.9	65:0	38,861	30.1
2045	67:0	47,693	34.1	65:0	41,301	30.2
2050	67:0	50,503	34.2	65:0	43,734	30.2
2055	67:0	53,360	34.2	65:0	46,209	30.2
2060	67:0	56,375	34.1	65:0	48,821	30.2
2065	67:0	59,587	34.1	65:0	51,598	30.2
2070	67:0	63,052	34.1	65:0	54,601	30.2
2075	67:0	66,732	34.1	65:0	57,785	30.2
2080	67:0	70,612	34.1	65:0	61,146	30.2
2085	67:0	74,718	34.1	65:0	64,702	30.2
2090	67:0	79,048	34.1	65:0	68,452	30.2
2095	67:0	83,607	34.1	65:0	72,400	30.2
2100	67:0	88,402	34.1	65:0	76,553	30.2
Steady maximum earnings:[h]						
2023	66:8	45,587	28.0	65:0	39,456	25.3
2025	67:0	45,010	27.0	65:0	38,640	24.0
2030	67:0	47,766	26.4	65:0	41,085	23.5
2035	67:0	51,747	26.8	65:0	44,540	23.7
2040	67:0	55,205	27.0	65:0	47,536	23.8
2045	67:0	58,704	27.1	65:0	50,551	23.9
2050	67:0	62,112	27.2	65:0	53,489	23.9
2055	67:0	65,531	27.2	65:0	56,430	24.0
2060	67:0	69,185	27.2	65:0	59,578	24.0
2065	67:0	73,106	27.2	65:0	62,957	24.0
2070	67:0	77,373	27.2	65:0	66,643	23.9
2075	67:0	81,897	27.2	65:0	70,541	23.9
2080	67:0	86,659	27.2	65:0	74,644	23.9
2085	67:0	91,701	27.2	65:0	78,988	23.9
2090	67:0	97,014	27.2	65:0	83,564	24.0
2095	67:0	102,606	27.2	65:0	88,383	24.0
2100	67:0	108,487	27.2	65:0	93,448	24.0

[a] Annual amounts are the total for the 12-month period starting with the month of retirement.
[b] Attains age 65 on January 1 of the year.
[c] CPI-indexed dollar adjustment uses the adjusted CPI indexing series shown in table VI.G6.
[d] Career average earnings at about 25 percent of the national Average Wage Index (AWI).
[e] Career average earnings at about 45 percent of the AWI.
[f] Career average earnings at about 100 percent of the AWI.
[g] Career average earnings at about 160 percent of the AWI.
[h] Earnings for each year at or above the contribution and benefit base.

11. Administrative Expenses

The projection of administrative expenses through the short-range period is based on historical experience and the projected growth in average wages. The Office of Budget of the Social Security Administration provides estimates for the first several years of the projection. For years after the short-range period, projected administrative expenses reflect increases in the number of beneficiaries in current-payment status, and increases in the average wage. However, the increases in average wage are partially offset by assumed administrative productivity gains.

12. Railroad Retirement Financial Interchange

Railroad workers are covered under a separate multi-tiered benefit plan, with a first tier of coverage similar to OASDI coverage. An annual financial interchange between the Railroad Retirement fund and the OASI and DI Trust Funds is made to resolve the difference between: (1) the amount of OASDI benefits that would be paid to railroad workers and their families if railroad employment had been covered under the OASDI program, plus administrative expenses associated with these benefits; and (2) the amount of OASDI payroll tax and income tax that would be received with allowances for interest from railroad workers.

The Office of the Chief Actuary's projection of future amounts for the financial interchange with the Railroad Retirement fund reflects trends similar to those used in estimating the cost of OASDI benefits. The annual short-range net cost for the OASI and DI Trust Funds is about $6 to $7 billion and the long-range summarized net cost for the OASI and DI Trust Funds is 0.05 percent of taxable payroll.

VI. APPENDICES

A. HISTORY OF OASI AND DI TRUST FUND OPERATIONS

The Federal Old-Age and Survivors Insurance (OASI) Trust Fund was established on January 1, 1940 as a separate account in the United States Treasury. The Federal Disability Insurance (DI) Trust Fund, another separate account in the United States Treasury, was established on August 1, 1956. These funds conduct the financial operations of the OASI and DI programs. The Board of Trustees is responsible for overseeing the financial operations of these funds. The following paragraphs describe the various components of trust fund income and cost. Following this description, tables VI.A1 and VI.A2 present the historical operations of the separate trust funds since their inception, and table VI.A3 presents the operations of the hypothetical combined trust funds[1] during the period when they have co-existed.

The primary income of these two funds comes from appropriations under permanent authority on the basis of payroll tax contributions. Federal law requires that all employees who work in OASDI covered employment, and their employers, make payroll tax contributions on their wages up to a specified annual maximum amount (the contribution and benefit base). Employees and their employers must also make payroll tax contributions on monthly cash tips if such tips are at least $20. Self-employed persons must make payroll tax contributions on their covered net earnings from self-employment subject to the annual contribution and benefit base. The Federal Government pays amounts equivalent to the combined employer and employee contributions that would be paid on deemed wage credits attributable to military service performed between 1957 and 2001, if such wage credits were covered wages. Treasury initially deposits payroll tax contributions to the trust funds each day on an estimated basis. Subsequently, Treasury makes adjustments based on the certified amount of wages and self-employment earnings in the records of the Social Security Administration.

Income also includes various reimbursements from the General Fund of the Treasury, such as: (1) the cost of noncontributory wage credits for military service before 1957, and periodic adjustments to previous determinations of this cost; (2) the cost in 1971 through 1982 of deemed wage credits for military service performed after 1956; (3) the cost of benefits to certain uninsured persons who attained age 72 before 1968; (4) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984 through 1989 by Public Law 98-21; (5) the cost in 2009 through 2017 of excluding certain self-employment earnings from SECA taxes under Public

[1] The OASI and DI Trust Funds are distinct legal entities which operate independently. To illustrate the actuarial status of the program as a whole, the fund operations are often combined on a hypothetical basis.

Law 110-246; and (6) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. This also includes a portion of proceeds of repayments of loans authorized by Public Law 116-136.

Beginning in 1984, Federal law subjected up to 50 percent of an individual's or couple's OASDI benefits to Federal income taxation under certain circumstances. Effective for taxable years beginning after 1993, the law increased the maximum percentage from 50 percent to 85 percent. Treasury credits the proceeds from this taxation of up to 50 percent of benefits to the OASI and DI Trust Funds in advance, on an estimated basis, at the beginning of each calendar quarter, with no reimbursement to the General Fund for interest costs attributable to the advance transfers.[1] Treasury makes subsequent adjustments based on the actual amounts shown on annual income tax records. Each of the OASI and DI Trust Funds receives the income taxes paid on the benefits from that trust fund.[2]

Another source of income to the trust funds is interest received on investments held by the trust funds. On a daily basis, Treasury invests trust fund income in interest-bearing obligations of the U.S. Government. These investments include the special public-debt obligations described in the next paragraph. The Social Security Act also authorizes the trust funds to hold obligations guaranteed as to both principal and interest by the United States. The act therefore permits the trust funds to hold certain Federally sponsored agency obligations and marketable obligations.[3] The trust funds may acquire any of these obligations on original issue at the issue price or by purchase of outstanding obligations at their market price.

The Social Security Act authorizes the issuance of special public-debt obligations for purchase exclusively by the trust funds. The act provides that the interest rate for special obligations newly issued in any month is the average market yield, as of the last business day of the prior month, on all of the outstanding marketable U.S. obligations that are due or callable more than 4 years in the future. This rate is rounded to the nearest one-eighth of one percent. Beginning January 1999, in calculating the average market yield rate for this purpose, the Treasury incorporates the yield to the call date when a callable bond's market price is above par.

Although the Social Security Act does not authorize the purchase or sale of special issue securities in the open market, Treasury redeems special issue

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[1] The HI Trust Fund receives the additional tax revenue resulting from the increase to 85 percent.

[2] A special provision applies to benefits paid to nonresident aliens. Effective for taxable years beginning after 1994, Public Law 103-465 subjects benefits to a flat-rate tax, usually 25.5 percent, before they are paid. Therefore, this tax remains in the trust funds. From 1984 to 1994, the flat-rate tax was usually 15 percent.

[3] The Social Security Act requires the trust funds to acquire special-issue obligations unless the Managing Trustee determines that the purchase of marketable obligations is in the public interest. The purchase of marketable obligations has been quite limited and has not occurred since 1980.

securities prior to maturity at par value when needed to meet current operating expenses. As a result, changes in market yield rates after issuance of special issue securities do not cause fluctuations in the value of these securities. As is true for marketable Treasury securities held by the public, the full faith and credit of the U.S. Government backs all of the investments held by the trust funds.

Annual cost for the OASI and DI Trust Funds primarily consists of: (1) OASDI benefit payments[1], net of any reimbursements from the General Fund of the Treasury for unnegotiated benefit checks; and (2) expenses incurred by the Social Security Administration and the Department of the Treasury in administering the OASDI program and the provisions of the Internal Revenue Code relating to the collection of contributions. Such administrative expenses include, among other items, the cost of (1) payroll; (2) construction, rental, lease, or purchase of office buildings and related facilities for the Social Security Administration; and (3) information technology systems. The Social Security Act prohibits payments from the OASI and DI Trust Funds for any purpose not related to the payment of benefits or administrative costs for the OASDI program.

Annual cost also includes: (1) the costs of vocational rehabilitation services furnished to disabled persons receiving cash benefits because of their disabilities, where such services contributed to their successful rehabilitation; and (2) net costs of the provisions of the Railroad Retirement Act that provide for a system of coordination and financial interchange between the Railroad Retirement program and the Social Security program. Under the financial interchange provisions, the Railroad Retirement program's Social Security Equivalent Benefit Account and the trust funds interchange amounts on an annual basis so that each trust fund is in the same position it would have been had railroad employment always been covered under Social Security.

The statements of the operations of the trust funds in this report do not include the net worth of facilities and other fixed capital assets because the value of fixed capital assets is not available in the form of a financial asset redeemable for the payment of benefits or administrative costs. As a result of this unavailability, the actuarial status of the trust funds does not take these assets into account.

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[1] Periodically, benefit payments which were scheduled to be paid on January 3 were actually paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. The most recent such accelerated payment affected benefits scheduled to be paid on January 3, 2021. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year without regard to the accelerated payments described above.

Table VI.A1.— Operations of the OASI Trust Fund, Calendar Years 1937-2022
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[af]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
1937[g]	$0.8	$0.8	—	—	[h]	[h]	[h]	—	—	$0.8	$0.8	—
1938[g]	.4	.4	—	—	[h]	[h]	[h]	—	—	.4	1.1	7,660
1939[g]	.6	.6	—	—	[h]	[h]	[h]	—	—	.6	1.7	8,086
1940	.4	.3	—	—	[h]	$0.1	[h]	[h]	—	.3	2.0	2,781
1941	.8	.8	—	—	$0.1	.1	$0.1	[h]	—	.7	2.8	1,782
1942	1.1	1.0	—	—	.1	.2	.1	[h]	—	.9	3.7	1,737
1943	1.3	1.2	—	—	.1	.2	.2	[h]	—	1.1	4.8	1,891
1944	1.4	1.3	—	—	.1	.2	.2	[h]	—	1.2	6.0	2,025
1945	1.4	1.3	—	—	.1	.3	.3	[h]	—	1.1	7.1	1,975
1946	1.4	1.3	—	—	.2	.4	.4	[h]	—	1.0	8.1	1,704
1947	1.7	1.6	[h]	—	.2	.5	.5	[h]	—	1.2	9.4	1,592
1948	2.0	1.7	[h]	—	.3	.6	.6	$0.1	—	1.4	10.7	1,542
1949	1.8	1.7	[h]	—	.1	.7	.7	.1	—	1.1	11.8	1,487
1950	2.9	2.7	[h]	—	.3	1.0	1.0	.1	—	1.9	13.7	1,156
1951	3.8	3.4	[h]	—	.4	2.0	1.9	.1	—	1.8	15.5	698
1952	4.2	3.8	—	—	.4	2.3	2.2	.1	—	1.9	17.4	681
1953	4.4	3.9	—	—	.4	3.1	3.0	.1	—	1.3	18.7	564
1954	5.6	5.2	—	—	.4	3.7	3.7	.1	[h]	1.9	20.6	500
1955	6.2	5.7	—	—	.5	5.1	5.0	.1	[h]	1.1	21.7	405
1956	6.7	6.2	—	—	.5	5.8	5.7	.1	[h]	.9	22.5	371
1957	7.4	6.8	—	—	.6	7.5	7.3	.2	[h]	-.1	22.4	300
1958	8.1	7.6	—	—	.6	8.6	8.3	.2	$0.1	-.5	21.9	259
1959	8.6	8.1	—	—	.5	10.3	9.8	.2	.3	-1.7	20.1	212
1960	11.4	10.9	—	—	.5	11.2	10.7	.2	.3	.2	20.3	180
1961	11.8	11.3	—	—	.5	12.4	11.9	.2	.3	-.6	19.7	163
1962	12.6	12.1	—	—	.5	14.0	13.4	.3	.4	-1.4	18.3	141
1963	15.1	14.5	—	—	.5	14.9	14.2	.3	.4	.1	18.5	123
1964	16.3	15.7	—	—	.6	15.6	14.9	.3	.4	.6	19.1	118
1965	16.6	16.0	—	—	.6	17.5	16.7	.3	.4	-.9	18.2	109
1966	21.3	20.6	$0.1	—	.6	19.0	18.3	.3	.4	2.3	20.6	96
1967	24.0	23.1	.1	—	.8	20.4	19.5	.4	.5	3.7	24.2	101
1968	25.0	23.7	.4	—	.9	23.6	22.6	.5	.4	1.5	25.7	103
1969	29.6	27.9	.4	—	1.2	25.2	24.2	.5	.5	4.4	30.1	102
1970	32.2	30.3	.4	—	1.5	29.8	28.8	.5	.6	2.4	32.5	101
1971	35.9	33.7	.5	—	1.7	34.5	33.4	.5	.6	1.3	33.8	94
1972	40.1	37.8	.5	—	1.8	38.5	37.1	.7	.7	1.5	35.3	88
1973	48.3	46.0	.4	—	1.9	47.2	45.7	.6	.8	1.2	36.5	75
1974	54.7	52.1	.4	—	2.2	53.4	51.6	.9	.9	1.3	37.8	68
1975	59.6	56.8	.4	—	2.4	60.4	58.5	.9	1.0	-.8	37.0	63
1976	66.3	63.4	.6	—	2.3	67.9	65.7	1.0	1.2	-1.6	35.4	54
1977	72.4	69.6	.6	—	2.2	75.3	73.1	1.0	1.2	-2.9	32.5	47
1978	78.1	75.5	.6	—	2.0	83.1	80.4	1.1	1.6	-5.0	27.5	39
1979	90.3	87.9	.6	—	1.8	93.1	90.6	1.1	1.4	-2.9	24.7	30
1980	105.8	103.5	.5	—	1.8	107.7	105.1	1.2	1.4	-1.8	22.8	23
1981	125.4	122.6	.7	—	2.1	126.7	123.8	1.3	1.6	-1.3	21.5	18
1982	125.2	123.7	.7	—	.8	142.1	138.8	1.5	1.8	[i].6	22.1	15
1983	150.6	138.3	5.5	—	6.7	153.0	149.2	1.5	2.3	-2.4	19.7	14
1984	169.3	159.5	4.7	$2.8	2.3	161.9	157.8	1.6	2.4	7.4	27.1	[j]20
1985	184.2	175.1	4.0	3.2	1.9	171.2	167.2	1.6	2.3	[i]8.7	35.8	[j]24
1986	197.4	189.1	1.8	3.4	3.1	181.0	176.8	1.6	2.6	[i]3.2	39.1	[j]28
1987	210.7	201.1	1.7	3.3	4.7	187.7	183.6	1.5	2.6	23.1	62.1	[j]30
1988	240.8	227.7	2.1	3.4	7.6	200.0	195.5	1.8	2.8	40.7	102.9	[j]41
1989	264.7	248.1	2.1	2.4	12.0	212.5	208.0	1.7	2.8	52.2	155.1	[j]59

Table VI.A1.— Operations of the OASI Trust Fund, Calendar Years 1937-2022 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[af]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
1990 . .	$286.7	$266.1	-$0.7	$4.8	$16.4	$227.5	$223.0	$1.6	$3.0	$59.1	$214.2	[j]78
1991 . .	299.3	272.5	.1	5.9	20.8	245.6	240.5	1.8	3.4	53.7	267.8	87
1992 . .	311.2	281.1	-.1	5.9	24.3	259.9	254.9	1.8	3.1	51.3	319.1	103
1993 . .	323.3	290.9	[h]	5.3	27.0	273.1	267.8	2.0	3.4	50.2	369.3	117
1994 . .	328.3	293.3	[h]	5.0	29.9	284.1	279.1	1.6	3.4	44.1	413.5	130
1995 . .	342.8	304.7	-.2	5.5	32.8	297.8	291.6	2.1	4.1	45.0	458.5	139
1996 . .	363.7	321.6	[h]	6.5	35.7	308.2	302.9	1.8	3.6	55.5	514.0	149
1997 . .	397.2	349.9	[h]	7.4	39.8	322.1	316.3	2.1	3.7	75.1	589.1	160
1998 . .	424.8	371.2	[h]	9.1	44.5	332.3	326.8	1.9	3.7	92.5	681.6	177
1999 . .	457.0	396.4	[h]	10.9	49.8	339.9	334.4	1.8	3.7	117.2	798.8	201
2000 . .	490.5	421.4	[h]	11.6	57.5	358.3	352.7	2.1	3.5	132.2	931.0	223
2001 . .	518.1	441.5	[h]	11.9	64.7	377.5	372.3	2.0	3.3	140.6	1,071.5	247
2002 . .	539.7	455.2	.4	12.9	71.2	393.7	388.1	2.1	3.5	146.0	1,217.5	272
2003 . .	543.8	456.1	[h]	12.5	75.2	406.0	399.8	2.6	3.6	137.8	1,355.3	300
2004 . .	566.3	472.8	[h]	14.6	79.0	421.0	415.0	2.4	3.6	145.3	1,500.6	322
2005 . .	604.3	506.9	-.3	13.8	84.0	441.9	435.4	3.0	3.6	162.4	1,663.0	340
2006 . .	642.2	534.8	[h]	15.6	91.8	461.0	454.5	3.0	3.5	181.3	1,844.3	361
2007 . .	675.0	560.9	[h]	17.2	97.0	495.7	489.1	3.1	3.6	179.3	2,023.6	372
2008 . .	695.5	574.6	[h]	15.6	105.3	516.2	509.3	3.2	3.6	179.3	2,202.9	392
2009 . .	698.2	570.4	[h]	19.9	107.9	564.3	557.2	3.4	3.7	133.9	2,336.8	390
2010 . .	677.1	544.8	2.0	22.1	108.2	584.9	577.4	3.5	3.9	92.2	2,429.0	400
2011 . .	698.8	482.4	87.8	22.2	106.5	603.8	596.2	3.5	4.1	95.0	2,524.1	402
2012 . .	731.1	503.9	97.7	26.7	102.8	645.5	637.9	3.4	4.1	85.6	2,609.7	391
2013 . .	743.8	620.8	4.2	20.7	98.1	679.5	672.1	3.4	3.9	64.3	2,674.0	384
2014 . .	769.4	646.2	.4	28.0	94.8	714.2	706.8	3.1	4.3	55.2	2,729.2	374
2015 . .	801.6	679.5	.3	30.6	91.2	750.5	742.9	3.4	4.3	51.0	2,780.3	364
2016 . .	797.5	678.8	.1	31.6	87.0	776.4	768.6	3.5	4.3	21.1	2,801.3	358
2017 . .	825.6	706.5	[h]	35.9	83.2	806.7	798.7	3.7	4.3	19.0	2,820.3	347
2018 . .	831.0	715.9	[h]	34.5	80.7	853.5	844.9	3.8	4.8	-22.4	2,797.9	330
2019 . .	917.9	805.1	[h]	34.9	77.9	911.4	902.8	3.7	4.9	6.5	2,804.3	307

Table VI.A1.— Operations of the OASI Trust Fund, Calendar Years 1937-2022 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[af]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
2020 . .	$968.3	$856.0	[h]	$39.0	$73.3	$961.0	$952.4	$3.7	$4.8	$7.4	$2,811.7	292
2021 . .	942.9	838.2	[h]	37.2	67.5	1,001.9	993.1	4.0	4.8	-59.1	2,752.6	281
2022 . .	1,056.7	945.9	0.2	47.1	63.5	1,097.5	1,088.1	4.0	5.3	-40.7	2,711.9	251

[a] Beginning in 1979, benefit payments scheduled to be paid on January 3 of a given year were paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. For comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year without regard to the accelerated payments described above.

[b] Represents asset reserves at the beginning of a year as a percentage of cost during the year. The table shows no ratio for 1937 because no reserves existed at the beginning of the year.

[c] Includes adjustments for prior calendar years.

[d] Includes net reimbursements from the General Fund of the Treasury to the OASI Trust Fund for: (1) the cost of noncontributory wage credits for military service before 1957; (2) the cost in 1971-82 of deemed wage credits for military service performed after 1956; (3) the cost of benefits to certain uninsured persons who attained age 72 before 1968; (4) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (5) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (6) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. Also includes transfers of a portion of proceeds from repayments of loans authorized under Public Law 116-136.

[e] Net interest includes net profits or losses on marketable investments. Beginning in 1967, the trust fund pays administrative expenses on an estimated basis, with a final adjustment including interest made in the following fiscal year. Net interest includes the amounts of these interest adjustments. The 1970 report describes the accounting for administrative expenses for years prior to 1967. Beginning in October 1973, figures include relatively small amounts of gifts to the fund. Net interest for 1983-86 reflects payments for interest on amounts owed under the interfund borrowing provisions. During 1983-90, net interest reflects interest reimbursements paid from the trust fund to the General Fund on advance tax transfers.

[f] Beginning in 1966, includes payments for vocational rehabilitation services furnished to disabled persons receiving benefits because of their disabilities. Beginning in 1983, net benefit amounts include reimbursements paid from the General Fund to the trust fund for unnegotiated benefit checks. Excluding the portion attributable to vocational rehabilitation services and unnegotiated benefit checks, amounts are the same as benefits scheduled under law at that time for all historical years.

[g] Operations prior to 1940 are for the Old-Age Reserve Account established by the original Social Security Act. The 1939 Amendments transferred the asset reserves of the Account to the OASI Trust Fund effective January 1, 1940.

[h] Between -$50 million and $50 million.

[i] Reflects interfund borrowing of $17.5 billion by the OASI Trust Fund from the DI and HI Trust Funds in 1982 and the subsequent repayment of those loans in 1985 ($4.4 billion) and 1986 ($13.2 billion).

[j] Reserves used for the trust fund ratio calculation include January advance tax transfers.

Note: Components may not sum to totals because of rounding.

Table VI.A2.— Operations of the DI Trust Fund, Calendar Years 1957-2022
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[a f]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
1957 . .	$0.7	$0.7	—	—	[g]	$0.1	$0.1	[g]	—	$0.6	$0.6	—
1958 . .	1.0	1.0	—	—	[g]	.3	.2	[g]	—	.7	1.4	249
1959 . .	.9	.9	—	—	[g]	.5	.5	[g]	[g]	.4	1.8	284
1960 . .	1.1	1.0	—	—	$0.1	.6	.6	[g]	[g]	.5	2.3	304
1961 . .	1.1	1.0	—	—	.1	1.0	.9	$0.1	[g]	.1	2.4	239
1962 . .	1.1	1.0	—	—	.1	1.2	1.1	.1	[g]	-.1	2.4	206
1963 . .	1.2	1.1	—	—	.1	1.3	1.2	.1	[g]	-.1	2.2	183
1964 . .	1.2	1.2	—	—	.1	1.4	1.3	.1	[g]	-.2	2.0	159
1965 . .	1.2	1.2	—	—	.1	1.7	1.6	.1	[g]	-.4	1.6	121
1966 . .	2.1	2.0	[g]	—	.1	1.9	1.8	.1	[g]	.1	1.7	82
1967 . .	2.4	2.3	[g]	—	.1	2.1	1.9	.1	[g]	.3	2.0	83
1968 . .	3.5	3.3	[g]	—	.1	2.5	2.3	.1	[g]	1.0	3.0	83
1969 . .	3.8	3.6	[g]	—	.2	2.7	2.6	.1	[g]	1.1	4.1	111
1970 . .	4.8	4.5	[g]	—	.3	3.3	3.1	.2	[g]	1.5	5.6	126
1971 . .	5.0	4.6	$0.1	—	.4	4.0	3.8	.2	[g]	1.0	6.6	140
1972 . .	5.6	5.1	.1	—	.4	4.8	4.5	.2	[g]	.8	7.5	140
1973 . .	6.4	5.9	.1	—	.5	6.0	5.8	.2	[g]	.5	7.9	125
1974 . .	7.4	6.8	.1	—	.5	7.2	7.0	.2	[g]	.2	8.1	110
1975 . .	8.0	7.4	.1	—	.5	8.8	8.5	.3	[g]	-.8	7.4	92
1976 . .	8.8	8.2	.1	—	.4	10.4	10.1	.3	[g]	-1.6	5.7	71
1977 . .	9.6	9.1	.1	—	.3	11.9	11.5	.4	[g]	-2.4	3.4	48
1978 . .	13.8	13.4	.1	—	.3	13.0	12.6	.3	[g]	.9	4.2	26
1979 . .	15.6	15.1	.1	—	.4	14.2	13.8	.4	[g]	1.4	5.6	30
1980 . .	13.9	13.3	.1	—	.5	15.9	15.5	.4	[g]	-2.0	3.6	35
1981 . .	17.1	16.7	.2	—	.2	17.7	17.2	.4	[g]	-.6	3.0	21
1982 . .	22.7	22.0	.2	—	.5	18.0	17.4	.6	[g]	[h] -.4	2.7	17
1983 . .	20.7	18.0	1.1	—	1.6	18.2	17.5	.6	[g]	2.5	5.2	15
1984 . .	17.3	15.5	.4	$0.2	1.2	18.5	17.9	.6	[g]	-1.2	4.0	[i]35
1985 . .	19.3	17.0	1.2	.2	.9	19.5	18.8	.6	[g]	[h]2.4	6.3	[i]27
1986 . .	19.4	18.2	.2	.2	.8	20.5	19.9	.6	$0.1	[h]1.5	7.8	[i]38
1987 . .	20.3	19.5	.2	[g]	.6	21.4	20.5	.8	.1	-1.1	6.7	[i]44
1988 . .	22.7	21.8	.2	.1	.6	22.5	21.7	.7	.1	.2	6.9	[i]38
1989 . .	24.8	23.8	.2	.1	.7	23.8	22.9	.8	.1	1.0	7.9	[i]38
1990 . .	28.8	28.4	-.6	.1	.9	25.6	24.8	.7	.1	3.2	11.1	[i]40
1991 . .	30.4	29.1	[g]	.2	1.1	28.6	27.7	.8	.1	1.8	12.9	39
1992 . .	31.4	30.1	[g]	.2	1.1	32.0	31.1	.8	.1	-.6	12.3	40
1993 . .	32.3	31.2	[g]	.3	.8	35.7	34.6	1.0	.1	-3.4	9.0	35
1994 . .	52.8	51.4	[g]	.3	1.2	38.9	37.7	1.0	.1	14.0	22.9	23
1995 . .	56.7	54.4	-.2	.3	2.2	42.1	40.9	1.1	.1	14.6	37.6	55
1996 . .	60.7	57.3	[g]	.4	3.0	45.4	44.2	1.2	[g]	15.4	52.9	83
1997 . .	60.5	56.0	[g]	.5	4.0	47.0	45.7	1.3	.1	13.5	66.4	113
1998 . .	64.4	59.0	[g]	.6	4.8	49.9	48.2	1.6	.2	14.4	80.8	133
1999 . .	69.5	63.2	[g]	.7	5.7	53.0	51.4	1.5	.1	16.5	97.3	152
2000 . .	77.9	71.1	-.8	.7	6.9	56.8	55.0	1.6	.2	21.1	118.5	171
2001 . .	83.9	74.9	[g]	.8	8.2	61.4	59.6	1.7	[g]	22.5	141.0	193
2002 . .	87.4	77.3	[g]	.9	9.2	67.9	65.7	2.0	.2	19.5	160.5	208
2003 . .	88.1	77.4	[g]	.9	9.7	73.1	70.9	2.0	.2	15.0	175.4	219
2004 . .	91.4	80.3	[g]	1.1	10.0	80.6	78.2	2.2	.2	10.8	186.2	218
2005 . .	97.4	86.1	[g]	1.1	10.3	88.0	85.4	2.3	.3	9.4	195.6	212
2006 . .	102.6	90.8	[g]	1.2	10.6	94.5	91.7	2.3	.4	8.2	203.8	207
2007 . .	109.9	95.2	[g]	1.4	13.2	98.8	95.9	2.5	.4	11.1	214.9	206
2008 . .	109.8	97.6	[g]	1.3	11.0	109.0	106.0	2.5	.4	.9	215.8	197
2009 . .	109.3	96.9	[g]	2.0	10.5	121.5	118.3	2.7	.4	-12.2	203.5	178

Table VI.A2.— Operations of the DI Trust Fund, Calendar Years 1957-2022 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[a f]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
2010 . .	$104.0	$92.5	$0.4	$1.9	$9.3	$127.7	$124.2	$3.0	$0.5	-$23.6	$179.9	159
2011 . .	106.3	81.9	14.9	1.6	7.9	132.3	128.9	2.9	.5	-26.1	153.9	136
2012 . .	109.1	85.6	16.5	.6	6.4	140.3	136.9	2.9	.5	-31.2	122.7	110
2013 . .	111.2	105.4	.7	.4	4.7	143.4	140.1	2.8	.6	-32.2	90.4	86
2014 . .	114.9	109.7	.1	1.7	3.4	145.1	141.7	2.9	.4	-30.2	60.2	62
2015 . .	118.6	115.4	g	1.1	2.1	146.6	143.4	2.8	.4	-28.0	32.3	41
2016 . .	160.0	157.4	g	1.2	1.4	145.9	142.8	2.8	.4	14.1	46.3	22
2017 . .	171.0	167.1	g	2.0	1.9	145.8	142.8	2.8	.2	25.1	71.5	32
2018 . .	172.3	169.2	g	.5	2.6	146.8	143.7	2.9	.2	25.6	97.1	49
2019 . .	143.9	139.4	g	1.6	2.9	147.9	145.1	2.7	.1	-4.0	93.1	66
2020 . .	149.7	145.3	g	1.7	2.8	146.3	143.6	2.6	.1	3.5	96.6	64
2021 . .	145.5	142.4	g	.5	2.6	142.6	140.1	2.5	.1	2.8	99.4	68
2022 . .	165.1	160.7	g	1.6	2.8	146.5	143.6	2.7	.2	18.6	118.0	68

[a] Beginning in 1979, benefit payments scheduled to be paid on January 3 of a given year were paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. For comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year without regard to the accelerated payments described above.
[b] Represents asset reserves at the beginning of a year as a percentage of cost during the year. The table shows no ratio for 1957 because no reserves existed at the beginning of the year.
[c] Includes adjustments for prior calendar years.
[d] Includes net reimbursements from the General Fund of the Treasury to the DI Trust Fund for: (1) the cost of noncontributory wage credits for military service before 1957; (2) the cost in 1971-82 of deemed wage credits for military service performed after 1956; (3) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (4) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (5) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.
[e] Net interest includes net profits or losses on marketable investments. Beginning in 1967, the trust fund pays administrative expenses on an estimated basis, with a final adjustment including interest made in the following fiscal year. Net interest includes the amounts of these interest adjustments. The 1970 report describes the accounting for administrative expenses for years prior to 1967. Beginning in July 1974, figures include relatively small amounts of gifts to the fund. Net interest for 1983-86 reflects payments for interest on amounts owed under the interfund borrowing provisions. During 1983-90, net interest reflects interest reimbursements paid from the trust fund to the General Fund on advance tax transfers.
[f] Beginning in 1966, includes payments for vocational rehabilitation services furnished to disabled persons receiving benefits because of their disabilities. Beginning in 1983, net benefit amounts include reimbursements paid from the General Fund to the trust fund for unnegotiated benefit checks. Excluding the portion attributable to vocational rehabilitation services and unnegotiated benefit checks, amounts are the same as benefits scheduled under law at that time for all historical years.
[g] Between -$50 million and $50 million.
[h] Reflects interfund borrowing by the OASI Trust Fund from the DI Trust Fund in 1982 of $5.1 billion and the subsequent repayment of that loan in 1985 ($2.5 billion) and 1986 ($2.5 billion).
[i] Reserves used for the trust fund ratio calculation include January advance tax transfers.

Note: Components may not sum to totals because of rounding.

Table VI.A3.— Operations of the Combined OASI and DI Trust Funds, Calendar Years 1957-2022

[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[a f]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
1957 . . .	$8.1	$7.5	—	—	$0.6	$7.6	$7.4	$0.2	[g]	$0.5	$23.0	298
1958	9.1	8.5	—	—	.6	8.9	8.6	.2	$0.1	.2	23.2	259
1959 . . .	9.5	8.9	—	—	.6	10.8	10.3	.2	.3	-1.3	22.0	215
1960 . . .	12.4	11.9	—	—	.6	11.8	11.2	.2	.3	.6	22.6	186
1961 . . .	12.9	12.3	—	—	.6	13.4	12.7	.3	.3	-.5	22.2	169
1962 . . .	13.7	13.1	—	—	.6	15.2	14.5	.3	.4	-1.5	20.7	146
1963 . . .	16.2	15.6	—	—	.6	16.2	15.4	.3	.4	[g]	20.7	128
1964 . . .	17.5	16.8	—	—	.6	17.0	16.2	.4	.4	.5	21.2	122
1965 . . .	17.9	17.2	—	—	.7	19.2	18.3	.4	.5	-1.3	19.8	110
1966 . . .	23.4	22.6	$0.1	—	.7	20.9	20.1	.4	.5	2.5	22.3	95
1967 . . .	26.4	25.4	.1	—	.9	22.5	21.4	.5	.5	3.9	26.3	99
1968 . . .	28.5	27.0	.4	—	1.0	26.0	25.0	.6	.5	2.5	28.7	101
1969 . . .	33.3	31.5	.5	—	1.3	27.9	26.8	.6	.5	5.5	34.2	103
1970 . . .	37.0	34.7	.5	—	1.8	33.1	31.9	.6	.6	3.9	38.1	103
1971 . . .	40.9	38.3	.5	—	2.0	38.5	37.2	.7	.6	2.4	40.4	99
1972 . . .	45.6	42.9	.5	—	2.2	43.3	41.6	.9	.7	2.3	42.8	93
1973 . . .	54.8	51.9	.5	—	2.4	53.1	51.5	.8	.8	1.6	44.4	80
1974 . . .	62.1	58.9	.5	—	2.7	60.6	58.6	1.1	.9	1.5	45.9	73
1975 . . .	67.6	64.3	.5	—	2.9	69.2	67.0	1.2	1.0	-1.5	44.3	66
1976 . . .	75.0	71.6	.7	—	2.7	78.2	75.8	1.2	1.2	-3.2	41.1	57
1977 . . .	82.0	78.7	.7	—	2.5	87.3	84.7	1.4	1.2	-5.3	35.9	47
1978 . . .	91.9	88.9	.8	—	2.3	96.0	93.0	1.4	1.6	-4.1	31.7	37
1979 . . .	105.9	103.0	.7	—	2.2	107.3	104.4	1.5	1.5	-1.5	30.3	30
1980 . . .	119.7	116.7	.7	—	2.3	123.5	120.6	1.5	1.4	-3.8	26.5	25
1981 . . .	142.4	139.4	.8	—	2.2	144.4	141.0	1.7	1.6	-1.9	24.5	18
1982 . . .	147.9	145.7	.9	—	1.4	160.1	156.2	2.1	1.8	[h] .2	24.8	15
1983 . . .	171.3	156.3	6.7	—	8.3	171.2	166.7	2.2	2.3	.1	24.9	14
1984 . . .	186.6	175.0	5.2	$3.0	3.4	180.4	175.7	2.3	2.4	6.2	31.1	[i]21
1985 . . .	203.5	192.1	5.2	3.4	2.7	190.6	186.1	2.2	2.4	[h]11.1	42.2	[i]24
1986 . . .	216.8	207.4	1.9	3.7	3.9	201.5	196.7	2.2	2.7	[h] 4.7	46.9	[i]29
1987 . . .	231.0	220.6	1.9	3.2	5.3	209.1	204.1	2.4	2.6	21.9	68.8	[i]31
1988 . . .	263.5	249.5	2.3	3.4	8.2	222.5	217.1	2.5	2.9	41.0	109.8	[i]41
1989 . . .	289.4	271.9	2.3	2.5	12.7	236.2	230.9	2.4	2.9	53.2	163.0	[i]57
1990 . . .	315.4	294.5	-1.3	5.0	17.2	253.1	247.8	2.3	3.0	62.3	225.3	[i]75
1991 . . .	329.7	301.6	.1	6.1	21.9	274.2	268.2	2.6	3.5	55.5	280.7	82
1992 . . .	342.6	311.3	-.1	6.1	25.4	291.9	286.0	2.7	3.2	50.7	331.5	96
1993 . . .	355.6	322.0	.1	5.6	27.9	308.8	302.4	3.0	3.4	46.8	378.3	107
1994 . . .	381.1	344.7	[g]	5.3	31.1	323.0	316.8	2.7	3.5	58.1	436.4	117
1995 . . .	399.5	359.1	-.4	5.8	35.0	339.8	332.6	3.1	4.1	59.7	496.1	128
1996 . . .	424.5	378.9	[g]	6.8	38.7	353.6	347.0	3.0	3.6	70.9	567.0	140
1997 . . .	457.7	406.0	[g]	7.9	43.8	369.1	362.0	3.4	3.7	88.6	655.5	154
1998 . . .	489.2	430.2	[g]	9.7	49.3	382.3	375.0	3.5	3.8	106.9	762.5	171
1999 . . .	526.6	459.6	[g]	11.6	55.5	392.9	385.8	3.3	3.8	133.7	896.1	194
2000 . . .	568.4	492.5	-.8	12.3	64.5	415.1	407.6	3.8	3.7	153.3	1,049.4	216
2001 . . .	602.0	516.4	[g]	12.7	72.9	438.9	431.9	3.7	3.3	163.1	1,212.5	239
2002 . . .	627.1	532.5	.4	13.8	80.4	461.7	453.8	4.2	3.6	165.4	1,378.0	263
2003 . . .	631.9	533.5	[g]	13.4	84.9	479.1	470.8	4.6	3.7	152.8	1,530.8	288
2004 . . .	657.7	553.0	[g]	15.7	89.0	501.6	493.3	4.5	3.8	156.1	1,686.8	305
2005 . . .	701.8	592.9	-.3	14.9	94.3	529.9	520.7	5.3	3.9	171.8	1,858.7	318
2006 . . .	744.9	625.6	[g]	16.9	102.4	555.4	546.2	5.3	3.8	189.5	2,048.1	335
2007 . . .	784.9	656.1	[g]	18.6	110.2	594.5	584.9	5.5	4.0	190.4	2,238.5	345
2008 . . .	805.3	672.1	[g]	16.9	116.3	625.1	615.3	5.7	4.0	180.2	2,418.7	358
2009 . . .	807.5	667.3	[g]	21.9	118.3	685.8	675.5	6.2	4.1	121.7	2,540.3	353

Table VI.A3.— Operations of the Combined OASI and DI Trust Funds, Calendar Years 1957-2022 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c]	Net interest[e]	Total[a]	Benefit payments[a f]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
2010 . .	$781.1	$637.3	$2.4	$23.9	$117.5	$712.5	$701.6	$6.5	$4.4	$68.6	$2,609.0	357
2011 . .	805.1	564.2	102.7	23.8	114.4	736.1	725.1	6.4	4.6	69.0	2,677.9	354
2012 . .	840.2	589.5	114.3	27.3	109.1	785.8	774.8	6.3	4.7	54.4	2,732.3	341
2013 . .	855.0	726.2	4.9	21.1	102.8	822.9	812.3	6.2	4.5	32.1	2,764.4	332
2014 . .	884.3	756.0	.5	29.6	98.2	859.2	848.5	6.1	4.7	25.0	2,789.5	322
2015 . .	920.2	794.9	.3	31.6	93.3	897.1	886.3	6.2	4.7	23.0	2,812.5	311
2016 . .	957.5	836.2	.1	32.8	88.4	922.3	911.4	6.2	4.7	35.2	2,847.7	305
2017 . .	996.6	873.6	[g]	37.9	85.1	952.5	941.5	6.5	4.5	44.1	2,891.8	299
2018 . .	1,003.4	885.1	[g]	35.0	83.3	1,000.2	988.6	6.7	4.9	3.1	2,894.9	289
2019 . .	1,061.8	944.5	[g]	36.5	80.8	1,059.3	1,047.9	6.4	4.9	2.5	2,897.4	273
2020 . .	1,118.1	1,001.3	[g]	40.7	76.1	1,107.2	1,095.9	6.3	5.0	10.9	2,908.3	262
2021 . .	1,088.3	980.6	[g]	37.6	70.1	1,144.6	1,133.2	6.5	4.9	-56.3	2,852.0	254
2022 . .	1,221.8	1,106.6	.2	48.6	66.4	1,243.9	1,231.7	6.7	5.5	-22.1	2,829.9	229

[a] Beginning in 1979, benefit payments scheduled to be paid on January 3 of a given year were paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. For comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year without regard to the accelerated payments described above.

[b] Represents asset reserves at the beginning of a year as a percentage of cost during the year.

[c] Includes adjustments for prior calendar years.

[d] Includes net reimbursements from the General Fund of the Treasury to the OASI and DI Trust Funds for: (1) the cost of noncontributory wage credits for military service before 1957; (2) the cost in 1971-82 of deemed wage credits for military service performed after 1956; (3) the cost of benefits to certain uninsured persons who attained age 72 before 1968; (4) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (5) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (6) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. Also includes transfers of a portion of proceeds from repayments of loans authorized under Public Law 116-136.

[e] Net interest includes net profits or losses on marketable investments. Beginning in 1967, the trust funds pay administrative expenses on an estimated basis, with a final adjustment including interest made in the following fiscal year. Net interest includes the amounts of these interest adjustments. The 1970 report describes the accounting for administrative expenses for years prior to 1967. Beginning in October 1973, figures include relatively small amounts of gifts to the funds. Net interest for 1983-86 reflects payments for interest on amounts owed under the interfund borrowing provisions. During 1983-90, net interest reflects interest reimbursements paid from the trust funds to the General Fund on advance tax transfers.

[f] Beginning in 1966, includes payments for vocational rehabilitation services furnished to disabled persons receiving benefits because of their disabilities. Beginning in 1983, net benefit amounts include reimbursements paid from the General Fund to the trust funds for unnegotiated benefit checks. Excluding the portion attributable to vocational rehabilitation services and unnegotiated benefit checks, amounts are the same as benefits scheduled under law at that time for all historical years.

[g] Between -$50 million and $50 million.

[h] Reflects interfund borrowing by the OASI Trust Fund from the HI Trust Fund in 1982 of $12.4 billion and the subsequent repayment of that loan in 1985 ($1.8 billion) and 1986 ($10.6 billion).

[i] Reserves used for the trust fund ratio calculation include January advance tax transfers.

Note: Components may not sum to totals because of rounding.

Tables VI.A4 and VI.A5 show the total asset reserves of the OASI Trust Fund and the DI Trust Fund, respectively, at the end of calendar years 2021 and 2022. The tables show the invested asset reserves by interest rate and year of maturity. Bonds issued to the trust funds in 2022 had an interest rate of 3.000 percent, compared with an interest rate of 1.500 percent for bonds issued in 2021.

Table VI.A4.—OASI Trust Fund Asset Reserves, End of Calendar Years 2021 and 2022
[In thousands]

	December 31, 2021	December 31, 2022
Obligations sold only to the trust funds (special issue securities):		
Certificates of indebtedness:		
1.500 percent, 2022	$53,944,023	—
3.875 percent, 2023	—	$44,376,263
4.000 percent, 2023	—	72,467,687
4.250 percent, 2023	—	71,154,194
Bonds:		
0.750 percent, 2023	14,931,408	—
0.750 percent, 2024-25	29,862,816	29,862,816
0.750 percent, 2026-33	119,451,256	119,451,256
1.375 percent, 2023	6,693,020	—
1.375 percent, 2024-25	13,386,040	13,386,040
1.375 percent, 2026	6,693,019	6,693,019
1.375 percent, 2027	173,240,401	173,240,401
1.500 percent, 2023	12,696,179	—
1.500 percent, 2024-25	25,392,358	25,392,358
1.500 percent, 2026-32	88,873,260	88,873,260
1.500 percent, 2033	12,696,179	12,696,179
1.750 percent, 2023	4,908,185	—
1.750 percent, 2024-25	9,816,370	9,816,370
1.750 percent, 2026-27	9,816,372	9,816,372
1.750 percent, 2028	178,148,587	178,148,587
1.875 percent, 2023	2,320,956	—
1.875 percent, 2024-27	9,283,824	9,283,824
1.875 percent, 2028-30	6,962,865	6,962,865
1.875 percent, 2031	188,111,583	188,111,583
2.000 percent, 2023	3,655,628	—
2.000 percent, 2024-25	7,311,256	7,311,256
2.000 percent, 2026-29	14,622,516	14,622,516
2.000 percent, 2030	185,790,628	185,790,628
2.250 percent, 2023	5,582,927	—
2.250 percent, 2024-25	11,165,854	11,165,854
2.250 percent, 2026-27	11,165,852	11,165,852
2.250 percent, 2028	5,582,927	5,582,927
2.250 percent, 2029	183,731,514	183,731,514
2.250 percent, 2030-31	3,193,030	3,193,030
2.250 percent, 2032	189,708,097	189,708,097
2.250 percent, 2033	12,818,538	12,818,538
2.250 percent, 2034	177,899,339	177,899,339
2.500 percent, 2023	5,971,787	—
2.500 percent, 2024-25	11,943,574	11,943,574
2.500 percent, 2026	166,547,382	166,547,382
2.875 percent, 2023	7,264,432	—
2.875 percent, 2024	7,264,432	7,264,432
2.875 percent, 2025	160,575,595	160,575,595
2.875 percent, 2032	1	1
2.875 percent, 2033	176,889,560	176,889,560
3.000 percent, 2024-28	—	86,332,165
3.000 percent, 2029-32	—	69,065,728
3.000 percent, 2033	—	17,266,433
3.250 percent, 2023	10,628,270	—
3.250 percent, 2024	153,311,163	153,311,163
4.000 percent, 2023	142,682,893	—
5.000 percent, 2022	130,152,459	—
Total investments	2,752,688,355	2,711,918,658
Undisbursed balances[a]	-52,566	-19,502
Total asset reserves	2,752,635,789	2,711,899,156

[a] A negative amount for a given year represents a situation where actual program cost exceeded the amount of invested securities of the OASI Trust Fund that were redeemed to cover such cost. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Amounts of special issue securities are at par value. The trust fund purchases and redeems special issue securities at par value. The table groups equal amounts that mature in two or more years at a given interest rate.

Table VI.A5.—DI Trust Fund Asset Reserves, End of Calendar Years 2021 and 2022
[In thousands]

	December 31, 2021	December 31, 2022
Obligations sold only to the trust funds (special issue securities):		
Certificates of indebtedness:		
1.500 percent, 2022	$7,651,929	—
1.625 percent, 2022	352,540	—
3.875 percent, 2023	—	$9,749,638
4.250 percent, 2023	—	10,542,313
Bonds:		
0.750 percent, 2024-26	1,438,419	1,438,419
0.750 percent, 2027-29	1,438,422	1,438,422
0.750 percent, 2030-34	2,397,365	2,397,365
0.750 percent, 2035	5,348,270	5,348,270
1.500 percent, 2024-29	845,268	845,268
1.500 percent, 2030-35	845,274	845,274
1.500 percent, 2036	5,489,148	5,489,148
2.250 percent, 2024-25	2,489,358	2,489,358
2.250 percent, 2026	1,244,680	1,244,680
2.250 percent, 2027-32	7,468,074	7,468,074
2.250 percent, 2033-34	9,737,594	9,737,594
2.875 percent, 2024-25	7,248,238	7,248,238
2.875 percent, 2026-32	25,368,826	25,368,826
3.000 percent, 2024-29	—	8,953,524
3.000 percent, 2030-35	—	8,953,518
3.000 percent, 2036	—	1,492,254
3.000 percent, 2037	—	6,981,402
4.000 percent, 2023	14,675,554	—
5.000 percent, 2022	5,398,822	—
Total investments	99,437,781	118,031,585
Undisbursed balances[a]	-43,640	-43,856
Total asset reserves	99,394,141	117,987,729

[a] A negative amount for a given year represents a situation where actual program cost exceeded the amount of invested securities of the DI Trust Fund that were redeemed to cover such cost. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Amounts of special issue securities are at par value. The trust fund purchases and redeems special issue securities at par value. The table groups equal amounts that mature in two or more years at a given interest rate.

B. HISTORY OF ACTUARIAL STATUS ESTIMATES

This appendix chronicles the history of the long-range OASDI actuarial balance and the year of combined OASI and DI Trust Fund reserve depletion since 1982 under the intermediate assumptions. The actuarial balance is the principal summary measure of actuarial status for the long-range period as a whole. The year of trust fund reserve depletion is also critical, as it indicates the year by which legislative action would be needed in order to maintain timely payment of scheduled benefits.

The 1983 report was the last report for which the actuarial balance was positive for the OASDI program. The two basic components of actuarial balance are the summarized income rate and the summarized cost rate, both of which are expressed as percentages of taxable payroll over the period. Section IV.B.4 defines the summarized income rate, summarized cost rate, and actuarial balance in detail. For any given period, the actuarial balance includes the difference between the present value of non-interest income for the period and the present value of the cost for the period, each divided by the present value of taxable payroll for all years in the period. The computation of the actuarial balance also includes:

- In the reports for 1988 and later, the amount of the trust fund asset reserves on hand at the beginning of the valuation period; and
- In the reports for 1991 and later, the present value of a target trust fund asset reserve equal to 100 percent of the annual cost to be reached and maintained at the end of the valuation period.

Reports of 1973-87 used the average-cost method, a simpler method which approximates the results of the present-value approach for computing the actuarial balance. Under the average-cost method, the sum of the annual cost rates over the 75-year projection period was divided by the total number of years, 75, to obtain the average cost rate per year. A similar computation produced the average income rate. The actuarial balance was the difference between the average income rate and the average cost rate.

When the 1973 report introduced the average-cost method, the financing of the program was more nearly on a pay-as-you-go basis over the long-range. Also, the long-range demographic and economic assumptions in that report produced an annual rate of growth in total taxable payroll which was about the same as the annual rate at which the trust funds earned interest. In either circumstance (i.e., pay-as-you-go financing, where the annual income rate is the same as the annual cost rate, or an annual rate of growth in total taxable payroll equal to the annual interest rate), the average-cost method produces

the same result as the present-value method. However, by 1988, neither of these circumstances still existed.

After the 1977 and 1983 Social Security Amendments, projections indicated substantial increases in the trust fund reserves continuing well into the 21st century. These laws changed the program's financing from essentially pay-as-you-go to partial advance funding through the 75-year period. Also, for the reports from 1973 through 1987, long-range fertility rates and average real wage growth assumptions were gradually reduced, resulting in an annual rate of growth in taxable payroll that was significantly lower than the assumed interest rate by 1987. As a result of the difference between this rate of growth and the assumed interest rate, the results of the average-cost method and the present-value method began to diverge in the reports for 1973 through 1987, and by 1988 they were quite different. While the average-cost method reflected most of the effects of assumed interest rates, it no longer reflected all interest effects. The present-value method, by contrast, accurately reflects the implications of assumed interest rates. As a result, the 1988 report reintroduced the present-value method of calculating the actuarial balance.

A positive actuarial balance indicates that estimated income (plus starting reserves, beginning with the 1988 report) is more than sufficient to meet estimated trust fund obligations (plus the ending target fund, beginning with the 1991 report) for the period as a whole. Even with a positive actuarial balance, it is possible for reserves to become temporarily depleted within the long-range period. An actuarial balance of zero indicates that the estimated income (plus starting reserves, beginning with the 1988 report) exactly matches estimated trust fund obligations (plus the ending target fund, beginning with the 1991 report) for the period as a whole. A negative actuarial balance indicates that estimated income (plus starting reserves, beginning with the 1988 report) is insufficient to meet estimated trust fund obligations (plus the ending target fund, beginning with the 1991 report) for the entire period.

Table VI.B1 contains the long-range OASDI actuarial balances, summarized income rates, and summarized cost rates for the 1982 report through the current report. The reports presented these values on the basis of the intermediate assumptions, which recent reports refer to as alternative II and reports from 1982 to 1990 referred to as alternative II-B.

Table VI.B1.—Long-Range OASDI Actuarial Balances and Trust Fund Reserve Depletion Dates as Shown in the Trustees Reports for 1982-2023 under Intermediate Assumptions[a]

[As a percentage of taxable payroll]

Year of report	Summarized income rate	Summarized cost rate	Actuarial balance[b]	Change from previous year[c]	Year of combined trust fund reserve depletion
1982	12.27	14.09	-1.82	[d]	1983
1983	12.87	12.84	+.02	+1.84	[e]
1984	12.90	12.95	-.06	-.08	[e]
1985	12.94	13.35	-.41	-.35	2049
1986	12.96	13.40	-.44	-.03	2051
1987	12.89	13.51	-.62	-.18	2051
1988	12.94	13.52	-.58	+.04	2048
1989	13.02	13.72	-.70	-.13	2046
1990	13.04	13.95	-.91	-.21	2043
1991	13.11	14.19	-1.08	-.17	2041
1992	13.16	14.63	-1.46	-.38	2036
1993	13.21	14.67	-1.46	[d]	2036
1994	13.24	15.37	-2.13	-.66	2029
1995	13.27	15.44	-2.17	-.04	2030
1996	13.33	15.52	-2.19	-.02	2029
1997	13.37	15.60	-2.23	-.03	2029
1998	13.45	15.64	-2.19	+.04	2032
1999	13.49	15.56	-2.07	+.12	2034
2000	13.51	15.40	-1.89	+.17	2037
2001	13.58	15.44	-1.86	+.03	2038
2002	13.72	15.59	-1.87	-.01	2041
2003	13.78	15.70	-1.92	-.04	2042
2004	13.84	15.73	-1.89	+.03	2042
2005	13.87	15.79	-1.92	-.04	2041
2006	13.88	15.90	-2.02	-.09	2040
2007	13.92	15.87	-1.95	+.06	2041
2008	13.94	15.63	-1.70	+.26	2041
2009	14.02	16.02	-2.00	-.30	2037
2010	14.01	15.93	-1.92	+.08	2037
2011	14.02	16.25	-2.22	-.30	2036
2012	14.02	16.69	-2.67	-.44	2033
2013	13.88	16.60	-2.72	-.05	2033
2014	13.89	16.77	-2.88	-.16	2033
2015	13.86	16.55	-2.68	+.20	2034
2016	13.84	16.50	-2.66	+.02	2034
2017	13.84	16.67	-2.83	-.17	2034
2018	13.84	16.69	-2.84	-.02	2034
2019	13.81	16.60	-2.78	+.06	2035
2020	13.85	17.06	-3.21	-.43	2035
2021	13.78	17.31	-3.54	-.32	2034
2022	13.78	17.20	-3.42	+.12	2035
2023	13.78	17.38	-3.61	-.19	2034

[a] The 1982-90 reports referred to the intermediate assumptions as alternative II-B; the 1991 and later reports refer to the intermediate assumptions as alternative II.

[b] The definition and method of calculating the actuarial balance were changed in 1988 and 1991. See text for details.

[c] A detailed year-by-year breakdown of the reasons for the changes in the actuarial balance since the 1983 Trustees Report may be found in Actuarial Note 2023.8 at www.ssa.gov/OACT/NOTES/ran8/.

[d] Between -0.005 and 0.005 percent of taxable payroll.

[e] Not projected to become depleted during the 75-year projection period.

Note: Components may not sum to totals because of rounding.

For several of the years included in the table, significant legislative changes or definitional changes affected the actuarial balance. The Social Security Amendments of 1983 account for the largest single change shown in the table: the actuarial balance of -1.82 for the 1982 report improved to +0.02 for the 1983 report. In 1985, the actuarial balance changed largely because of an adjustment made to the method for estimating the age distribution of immigrants.

Rebenchmarking of the National Income and Product Accounts and changes in demographic assumptions contributed to the change in the actuarial balance for 1987. Various changes in assumptions and methods for the 1988 report had roughly offsetting effects on the actuarial balance. In 1989 and 1990, changes in economic assumptions accounted for most of the changes in the actuarial balance.

In 1991, the effect of legislation, changes in economic assumptions, and the introduction of the cost of reaching and maintaining an ending target trust fund level combined to produce the change in the actuarial balance. In 1992, changes in disability assumptions and the method for projecting average benefit levels accounted for most of the change in the actuarial balance. In 1993, numerous small changes in assumptions and methods had offsetting effects on the actuarial balance. In 1994, changes in the real wage assumptions, disability rates, and the earnings sample used for projecting average benefit levels accounted for most of the change in the actuarial balance. In 1995, numerous small changes had largely offsetting effects on the actuarial balance, including a substantial reallocation of the payroll tax rate, which reduced the OASI actuarial balance, but increased the DI actuarial balance.

In 1996, a change in the method of projecting dually-entitled beneficiaries produced a large increase in the actuarial balance, which almost totally offset decreases produced by changes in the valuation period and in the demographic and economic assumptions. Various changes in assumptions and methods for the 1997 report had roughly offsetting effects on the actuarial balance. In 1998, increases caused by changes in the economic assumptions, although partially offset by decreases produced by changes in the valuation period and in the demographic assumptions, accounted for most of the changes in the actuarial balance. In 1999, increases caused by changes in the economic assumptions (related to improvements in the CPI by the Bureau of Labor Statistics) accounted for most of the changes in the actuarial balance. For the 2000 report, changes in economic assumptions and methodology caused increases in the actuarial balance, although reductions in the balance caused by the change in valuation period and changes in demographic assumptions partially offset these increases.

For the 2001 report, increases caused by changes in the demographic starting values, although partially offset by a decrease produced by the change in the valuation period, accounted for most of the changes in the actuarial balance. For the 2002 report, changes in the valuation period and the demographic assumptions—both decreases in the actuarial balance—were offset by changes in the economic assumptions, while an increase due to disability assumptions was slightly more than offset by a decrease due to changes in the projection methods and data. For the 2003 report, an increase due to the change in program assumptions was more than offset by decreases due to the change in valuation period and changes in demographic assumptions. In the 2004 report, increases due to changing the method of projecting benefit levels for higher earners more than offset decreases in the actuarial balance arising from the change in the valuation period and the net effect of other changes in programmatic data and methods. For the 2005 report, an increase due to changing the method of projecting future average benefit levels was more than offset by decreases due to changes in the valuation period, updated starting values for the economic assumptions, and other methodological changes.

In 2006, decreases in the actuarial balance due to the change in the valuation period, a reduction in the ultimate annual real interest rate, and improvements in calculating mortality for disabled workers, were greater in aggregate than increases in the actuarial balance due to changes in demographic starting values and the ultimate total fertility rate, as well as other programmatic data and method changes. For the 2007 report, increases in the actuarial balance arising from revised disability incidence rate assumptions, improvements in average benefit level projections, and changes in near-term economic projections, more than offset decreases in the balance due to the valuation period change and updated historical mortality data. For the 2008 report, the large increase in the actuarial balance was primarily due to changes in immigration projection methods and assumptions. These changes more than offset the decreases in the actuarial balance due to the change in the valuation period and the lower starting and ultimate mortality rates. In 2009, changes in starting values and near-term economic assumptions due to the economic recession, faster ultimate rates of decline in death rates for ages 65-84, and the change in the valuation period accounted for most of the large decrease in the actuarial balance. Legislative changes, in particular the estimated effects of the Patient Protection and Affordable Care Act and the Health Care and Education Reconciliation Act of 2010, were the main reason for the increase in the actuarial balance for the 2010 report. The change in the valuation period partially offset this increase; there were also changes in

several assumptions, methods, and recent data which had largely offsetting effects.

For the 2011 report, changes in mortality projections, due to new starting values and revised methods, were the most significant of several factors contributing to the increase in the deficit. In 2012, changes in economic assumptions and starting values accounted for about half of the decrease in actuarial balance. Other factors worsening the actuarial balance were the change in valuation period, changes to starting demographic values, changes to ultimate disability incidence assumptions, and methodology changes and data updates. For the 2013 report, the change in valuation period accounted for the entire net change in the actuarial balance. The effects of substantially lower death rates for 2009 than previously projected and the American Taxpayer Relief Act of 2012 (which lowered the Federal marginal income tax rates) were offset by updates of program-specific data and methodology improvements. In 2014, changes in economic data and assumptions accounted for the majority of the net change in the actuarial balance. Other factors worsening the actuarial balance were the change in the valuation period and various methodology improvements and data updates. For the 2015 report, methodological improvements and updates of programmatic data accounted for the majority of the net increase in the actuarial balance. Also increasing the actuarial balance were a lower assumed ultimate average wage differential and changes in near-term economic assumptions. These increases were offset somewhat by the change in the valuation period and updates to historical and near-term projected birth rates.

For the 2016 report, the actuarial balance increased primarily due to the effects of the Bipartisan Budget Act of 2015 and improvements made to immigration methods. The most notable immigration change was a revision to the method for projecting emigration of the never-authorized population to reflect lower rates of emigration for those who have resided here longer. These increases in the actuarial balance were largely offset by the effects of changes in ultimate economic assumptions, including a lower real interest rate and a lower annual increase in the rate of price inflation. In 2017, the change in the valuation period and various methodology improvements accounted for most of the net reduction in the actuarial balance. Other economic factors also contributed to worsening the actuarial balance, including a lower real wage differential assumption and an assumed weaker recovery from the recent recession. These reductions were offset somewhat by lower estimated disability incidence rates over the short-range period. For the 2018 report, incorporating the effects of lower-than-expected birth rates, lower near-term fertility assumptions, and the change in the valuation period

decreased the actuarial balance. Offsetting these factors to a large degree were the effects of higher-than-expected death rates and several methods improvements, most notably an update to the sample used to project average benefit levels for newly-entitled worker beneficiaries. For the 2019 report, the actuarial balance increased primarily due to higher-than-expected death rates and lower near-term and ultimate disability incidence rate assumptions. Partially offsetting these factors were the effects of a lower ultimate real interest rate assumption and the change in the valuation period. For the 2020 report, the actuarial balance decreased primarily due to the following factors. First, the repeal of the Affordable Care Act's excise tax on employer-sponsored group health insurance premiums reduced projected earnings as a share of employee compensation, having a significant negative financial effect on the trust funds. In addition, lower assumed values for the ultimate total fertility rate, the ultimate rate of price inflation, and the ultimate real interest rate, as compared to the rates assumed for the 2019 report, decreased the actuarial balance.

In 2021, the actuarial balance decreased due to the change in the valuation period and three main additional factors. First, economic assumptions were updated to reflect experience during and following the COVID-19 pandemic. In particular, the levels of productivity and potential GDP were assumed to be roughly 1 percent lower beginning with the second quarter of 2020. Second, the data and methodology used for projecting average benefit levels were updated and improved. Third, data and estimates provided by the Office of Tax Analysis at the Department of the Treasury indicated lower near-term and ultimate levels of taxation of benefits.

For the 2022 report, the actuarial balance increased primarily due to a decrease in the assumed ultimate disability incidence rate, incorporating recent economic data, and changes in near-term economic assumptions. In particular, employment, earnings, and GDP following the 2020 recession recovered much faster than had been assumed in the 2021 report. These disability and economic factors were partially offset by the change in the valuation period and updates for recent demographic data.

Section IV.B.6 describes changes affecting the actuarial balance shown for the 2023 report.

C. FISCAL YEAR HISTORICAL AND PROJECTED TRUST FUND OPERATIONS THROUGH 2032

Tables VI.C1, VI.C2, and VI.C3 contain details of the fiscal year 2022 operations of the OASI, DI, and the combined OASI and DI Trust Funds, respectively. The fiscal year for the U.S. Government is the 12-month period ending September 30. Fiscal year 2022 is the most recent fiscal year for which complete information is available. The descriptions of the values in these tables are similar to the corresponding descriptions and values in the calendar year operations tables in section III.A. Please see that section for a description of the various items of income and cost.

Table VI.C1.—Operations of the OASI Trust Fund, Fiscal Year 2022
[In millions]

Total asset reserves, September 30, 2021		$2,755,799
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$933,445	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund	-4,403	
Net payroll tax contributions[a]		929,042
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L.s 111-312, 112-78, and 112-96[a]	[b]	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		[b]
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	259	
All other, not subject to withholding	46,711	
Total income from taxation of benefits		46,970
Investment income and interest adjustments:		
Interest on investments	65,081	
Interest adjustments[c]	[b]	
Total investment income and interest adjustments		65,081
Gifts		[b]
Total income		1,041,093
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[d]	1,063,929	
Reimbursement from the General Fund for unnegotiated checks	-52	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	19	
Net benefit payments[d]		1,063,896
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		5,316
Administrative expenses:		
Costs incurred by:		
Social Security Administration	3,452	
Department of the Treasury	603	
Offsetting miscellaneous receipts	-1	
Miscellaneous reimbursements from the General Fund [e]	-5	
Net administrative expenses		4,050
Total cost		1,073,262
Net increase in asset reserves		-32,169
Total invested assets	2,723,601	
Undisbursed balances[f]	29	
Total asset reserves, September 30, 2022		2,723,629

[a] Includes adjustments for prior years.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI program.
[f] A positive balance represents a situation where the invested securities of the OASI Trust Fund that were redeemed to make cash payments exceeded actual program cash payments. In this situation, this excess amount will be used to partially offset future redemption of additional invested securities.

Note: Components may not sum to totals because of rounding.

Table VI.C2.—Operations of the DI Trust Fund, Fiscal Year 2022
[In millions]

Total asset reserves, September 30, 2021		$98,063
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$158,563	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund	-746	
Net payroll tax contributions[a]		157,816
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L.s 111-312, 112-78, and 112-96[a]	[b]	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		[b]
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	4	
All other, not subject to withholding[a]	1,529	
Total income from taxation of benefits[a]		1,533
Investment income and interest adjustments:		
Interest on investments	2,657	
Interest adjustments[c]	2	
Total investment income and interest adjustments		2,658
Gifts		[b]
Total income		162,007
Cost:		
Benefit payments:		
Monthly benefits[d]	142,386	
Reimbursement from the General Fund for unnegotiated checks	-28	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	101	
Net benefit payments[d]		142,459
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		156
Administrative expenses:		
Costs incurred by:		
Social Security Administration	2,655	
Department of the Treasury	105	
Demonstration projects	7	
Miscellaneous reimbursements from the General Fund[e]	-2	
Net administrative expenses		2,764
Total cost		145,379
Net increase in asset reserves		16,628
Total invested assets	114,679	
Undisbursed balances[f]	12	
Total asset reserves, September 30, 2022		114,691

[a] Includes adjustments for prior years.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the DI program.
[f] A positive balance represents a situation where the invested securities of the DI Trust Fund that were redeemed to make cash payments exceeded actual program cash payments. In this situation, this excess amount will be used to partially offset future redemption of additional invested securities.

Note: Components may not sum to totals because of rounding.

Table VI.C3.—Operations of the Combined OASI and DI Trust Funds, Fiscal Year 2022
[In millions]

Total asset reserves, September 30, 2021		$2,853,862
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$1,092,007	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund	-5,149	
Net payroll tax contributions[a]		1,086,858
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L.s 111-312, 112-78, and 112-96[a]	[b]	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		[b]
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	262	
All other, not subject to withholding[a]	48,240	
Total income from taxation of benefits[a]		48,502
Investment income and interest adjustments:		
Interest on investments	67,738	
Interest adjustments[c]	2	
Total investment income and interest adjustments		67,740
Gifts		[b]
Total income		1,203,100
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[d]	1,206,315	
Reimbursement from the General Fund for unnegotiated checks	-80	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	120	
Net benefit payments[d]		1,206,355
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		5,471
Administrative expenses:		
Costs incurred by:		
Social Security Administration	6,108	
Department of the Treasury	708	
Offsetting miscellaneous receipts	-1	
Demonstration projects	7	
Miscellaneous reimbursements from the General Fund[e]	-7	
Net administrative expenses		6,814
Total cost		1,218,641
Net increase in asset reserves		-15,541
Total invested assets	2,838,279	
Undisbursed balances[f]	41	
Total asset reserves, September 30, 2022		2,838,320

[a] Includes adjustments for prior years.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust funds and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust funds.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI and DI programs.
[f] A positive balance represents a situation where the invested securities of the combined OASI and DI Trust Funds that were redeemed to make cash payments exceeded actual program cash payments. In this situation, this excess amount will be used to partially offset future redemption of additional invested securities.

Note: Components may not sum to totals because of rounding.

Tables VI.C4, VI.C5, and VI.C6 show estimates of the operations and status of the OASI, DI, and the hypothetical combined OASI and DI Trust Funds, respectively, during fiscal years 2018 through 2032.

Table VI.C4.—Operations of the OASI Trust Fund, Fiscal Years 2018-2032[a]
[Dollar amounts in billions]

Fiscal year	Income					Cost				Asset Reserves		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
Historical data:												
2018	$822.4	$706.1	[f]	$34.7	$81.6	$841.5	$833.0	$3.7	$4.8	-$19.0	$2,801.1	335
2019	900.1	785.6	[f]	34.9	79.6	896.8	888.1	3.9	4.9	3.2	2,804.3	312
2020	955.6	841.7	[f]	37.9	76.0	948.7	940.2	3.7	4.8	6.9	2,811.2	296
2021	936.0	831.1	[f]	34.3	70.5	991.4	982.7	3.9	4.8	-55.4	2,755.8	284
2022	1,041.1	929.0	[f]	47.0	65.1	1,073.3	1,063.9	4.0	5.3	-32.2	2,723.6	257
Intermediate:												
2023	1,149.1	1,035.3	$0.2	50.4	63.2	1,200.4	1,190.9	4.1	5.4	-51.3	2,672.3	227
2024	1,153.0	1,037.1	[f]	55.6	60.3	1,301.7	1,291.4	4.3	6.1	-148.7	2,523.6	205
2025	1,211.1	1,093.7	[f]	59.2	58.2	1,383.1	1,372.6	4.3	6.1	-171.9	2,351.7	182
2026	1,272.9	1,147.6	[f]	70.9	54.4	1,465.2	1,454.4	4.5	6.3	-192.3	2,159.4	161
2027	1,327.3	1,195.5	.2	79.1	52.5	1,549.6	1,538.5	4.6	6.4	-222.3	1,937.1	139
2028	1,390.0	1,255.5	[f]	85.4	49.2	1,638.9	1,627.6	4.8	6.5	-248.9	1,688.3	118
2029	1,440.3	1,304.4	[f]	92.1	43.9	1,731.2	1,719.7	5.0	6.6	-290.9	1,397.4	98
2030	1,495.3	1,358.4	[f]	99.6	37.3	1,825.7	1,813.9	5.1	6.7	-330.4	1,067.0	77
2031	1,549.2	1,412.6	[f]	107.6	29.0	1,921.2	1,909.2	5.3	6.8	-372.0	695.0	56
2032	1,599.3	1,464.8	[f]	116.2	18.3	2,017.6	2,005.2	5.4	6.9	-418.2	276.7	34
Low-cost:												
2023	1,152.1	1,038.1	.2	50.4	63.4	1,199.9	1,190.4	4.1	5.4	-47.8	2,675.8	227
2024	1,191.2	1,072.0	[f]	55.4	63.8	1,298.0	1,287.7	4.3	6.0	-106.8	2,569.0	206
2025	1,276.5	1,153.7	[f]	59.2	63.6	1,382.8	1,372.4	4.3	6.1	-106.3	2,462.7	186
2026	1,370.2	1,234.0	[f]	71.2	65.0	1,471.3	1,460.5	4.6	6.2	-101.1	2,361.6	167
2027	1,454.3	1,305.5	.2	79.8	68.8	1,562.8	1,551.7	4.8	6.3	-108.6	2,253.1	151
2028	1,551.9	1,393.6	[f]	86.5	71.9	1,660.2	1,648.7	5.1	6.4	-108.3	2,144.8	136
2029	1,639.0	1,471.7	[f]	93.7	73.6	1,761.8	1,749.9	5.3	6.6	-122.8	2,022.0	122
2030	1,733.8	1,556.9	[f]	101.8	75.1	1,866.8	1,854.5	5.5	6.7	-133.0	1,889.0	108
2031	1,831.6	1,644.7	[f]	110.6	76.4	1,974.5	1,961.9	5.8	6.8	-142.9	1,746.1	96
2032	1,928.3	1,732.0	[f]	120.1	76.2	2,084.8	2,071.8	6.0	7.0	-156.5	1,589.6	84
High-cost:												
2023	1,140.3	1,027.0	.2	50.5	62.6	1,200.9	1,191.3	4.1	5.4	-60.6	2,663.1	227
2024	1,107.0	990.9	[f]	55.9	60.2	1,310.3	1,299.9	4.3	6.1	-203.3	2,459.8	203
2025	1,159.6	1,046.1	[f]	59.9	53.6	1,398.4	1,387.8	4.3	6.3	-238.7	2,221.1	176
2026	1,207.3	1,088.0	[f]	71.5	47.7	1,477.7	1,466.8	4.4	6.5	-270.5	1,950.6	150
2027	1,246.5	1,124.0	.2	79.4	42.9	1,556.2	1,545.1	4.6	6.5	-309.6	1,641.0	125
2028	1,286.9	1,165.5	[f]	85.4	36.1	1,639.2	1,627.9	4.7	6.6	-352.2	1,288.7	100
2029	1,312.1	1,193.0	[f]	91.7	27.4	1,724.2	1,712.8	4.7	6.7	-412.1	876.6	75
2030	1,341.0	1,223.7	[f]	98.8	18.6	1,810.4	1,798.8	4.8	6.8	-469.4	407.3	48
2031	[g]	1,252.9	[f]	106.2	[g]	1,896.6	1,884.9	4.9	6.8	[g]	[g]	21
2032	[g]	1,278.7	[f]	114.2	[g]	1,982.8	1,970.9	5.0	6.9	[g]	[g]	[g]

[a] The OASI Trust Fund reserves become depleted in fiscal year 2031 under the high-cost assumptions. For any period during which reserves would be depleted, scheduled benefits could not be paid in full on a timely basis, income from taxing benefits would be less than would apply to scheduled benefits, and interest on trust fund reserves would be negligible.
[b] Represents asset reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year.
[c] Includes adjustments for prior years.
[d] Includes reimbursements from the General Fund of the Treasury to the OASI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (and (2) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. Also includes transfers of a portion of proceeds from repayments of loans authorized under Public Law 116-136.
[e] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in law.
[f] Between -$50 million and $50 million.
[g] When the fund reserves are depleted, values under current law would reflect permissible expenditures only, which would be less than the full cost of paying scheduled benefits shown in this table.

Note: Components may not sum to totals because of rounding.

Table VI.C5.—Operations of the DI Trust Fund, Fiscal Years 2018-2032
[Dollar amounts in billions]

Fiscal year	Income					Cost				Asset Reserves		Trust fund ratio at start of year[a]
	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b,d]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
Historical data:												
2018..	$170.3	$167.0	[e]	$1.0	$2.2	$146.6	$143.6	$2.8	$0.2	$23.7	$93.1	47
2019..	151.0	146.8	[e]	1.2	2.9	147.7	144.9	2.8	.1	3.3	96.4	63
2020..	147.4	142.9	[e]	1.7	2.8	146.7	144.1	2.5	.1	.7	97.1	66
2021..	144.4	141.2	[e]	.5	2.7	143.4	140.7	2.5	.1	1.0	98.1	68
2022..	162.0	157.8	[e]	1.5	2.7	145.4	142.5	2.8	.2	16.6	114.7	67
Intermediate:												
2023..	180.1	175.8	[e]	1.1	3.2	151.0	148.0	2.9	[e]	29.1	143.8	76
2024..	182.0	176.1	[e]	1.7	4.2	158.5	155.5	3.0	[e]	23.5	167.3	91
2025..	192.7	185.7	[e]	1.8	5.1	168.4	165.3	3.1	[e]	24.3	191.5	99
2026..	203.1	194.9	[e]	2.2	6.0	178.5	175.3	3.2	[e]	24.6	216.1	107
2027..	212.5	203.0	[e]	2.4	7.1	187.1	183.7	3.4	[e]	25.4	241.5	115
2028..	224.1	213.2	[e]	2.6	8.3	193.5	189.9	3.6	[e]	30.6	272.1	125
2029..	234.0	221.5	[e]	2.7	9.8	199.2	195.5	3.7	[e]	34.8	306.9	137
2030..	245.2	230.7	[e]	2.9	11.6	205.2	201.2	3.9	[e]	40.0	346.9	150
2031..	256.7	239.9	[e]	3.1	13.7	212.2	208.1	4.1	.1	44.5	391.3	163
2032..	268.1	248.7	[e]	3.3	16.0	220.3	216.0	4.3	.1	47.8	439.1	178
Low-cost:												
2023..	180.6	176.3	[e]	1.1	3.3	150.1	147.2	2.9	[e]	30.5	145.2	76
2024..	188.5	182.0	[e]	1.7	4.8	155.5	152.4	3.0	[e]	33.0	178.2	93
2025..	204.2	195.9	[e]	1.8	6.5	163.0	160.0	3.1	[e]	41.1	219.3	109
2026..	220.5	209.6	[e]	2.1	8.8	170.9	167.7	3.3	[e]	49.6	268.9	128
2027..	235.8	221.7	[e]	2.3	11.8	177.0	173.6	3.5	[e]	58.7	327.7	152
2028..	254.6	236.6	[e]	2.4	15.6	180.7	177.0	3.7	[e]	74.0	401.6	181
2029..	272.5	249.9	[e]	2.5	20.1	184.1	180.2	3.9	[e]	88.4	490.1	218
2030..	292.5	264.4	[e]	2.7	25.5	188.1	184.0	4.1	[e]	104.4	594.5	261
2031..	313.9	279.3	[e]	2.8	31.8	193.3	188.9	4.3	[e]	120.6	715.0	308
2032..	336.4	294.1	[e]	3.0	39.3	199.8	195.2	4.5	[e]	136.6	851.7	358
High-cost:												
2023..	178.7	174.4	[e]	1.1	3.2	151.8	148.9	2.9	[e]	26.8	141.5	76
2024..	174.0	168.3	[e]	1.7	4.0	162.3	159.3	3.0	[e]	11.6	153.2	87
2025..	183.8	177.6	[e]	1.9	4.2	176.0	172.9	3.1	[e]	7.8	161.0	87
2026..	191.5	184.8	[e]	2.3	4.4	188.5	185.2	3.2	[e]	3.0	164.0	85
2027..	198.0	190.9	[e]	2.6	4.5	199.2	195.8	3.4	[e]	-1.2	162.8	82
2028..	205.2	197.9	[e]	2.8	4.5	207.6	204.1	3.5	[e]	-2.4	160.4	78
2029..	210.0	202.6	[e]	3.0	4.4	214.7	211.1	3.6	[e]	-4.8	155.6	75
2030..	215.3	207.8	[e]	3.2	4.3	222.1	218.3	3.8	.1	-6.8	148.8	70
2031..	220.3	212.7	[e]	3.4	4.2	230.7	226.7	3.9	.1	-10.4	138.4	64
2032..	224.6	217.1	[e]	3.6	3.9	240.2	236.1	4.0	.1	-15.6	122.8	58

[a] Represents asset reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year.
[b] Includes adjustments for prior years.
[c] Includes reimbursements from the General Fund of the Treasury to the DI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; and (2) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.
[d] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in law.
[e] Between -$50 million and $50 million.

Note: Components may not sum to totals because of rounding.

Table VI.C6.—Operations of the Combined OASI and DI Trust Funds, Fiscal Years 2018-2032[a]

[Dollar amounts in billions]

Fiscal year	Income					Cost				Asset Reserves		Trust fund ratio at start of year[b]
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	
Historical data:												
2018	$992.7	$873.2	[f]	$35.7	$83.8	$988.0	$976.7	$6.4	$4.9	$4.7	$2,894.2	292
2019	1,051.1	932.4	[f]	36.1	82.5	1,044.5	1,033.0	6.6	4.9	6.5	2,900.7	277
2020	1,103.0	984.6	[f]	39.6	78.8	1,095.4	1,084.3	6.2	5.0	7.5	2,908.2	265
2021	1,080.4	972.3	[f]	34.8	73.3	1,134.8	1,123.4	6.4	4.9	-54.4	2,853.9	256
2022	1,203.1	1,086.9	[f]	48.5	67.7	1,218.6	1,206.4	6.8	5.5	-15.5	2,838.3	234
Intermediate:												
2023	1,329.2	1,211.1	$0.2	51.5	66.4	1,351.4	1,338.9	7.0	5.4	-22.2	2,816.2	210
2024	1,335.0	1,213.3	[f]	57.3	64.4	1,460.2	1,446.9	7.3	6.1	-125.3	2,690.9	193
2025	1,403.8	1,279.5	[f]	61.1	63.3	1,551.5	1,537.9	7.4	6.2	-147.7	2,543.2	173
2026	1,476.1	1,342.5	[f]	73.1	60.4	1,643.8	1,629.7	7.7	6.3	-167.7	2,375.5	155
2027	1,539.8	1,398.5	.2	81.6	59.6	1,736.7	1,722.3	8.0	6.4	-196.9	2,178.7	137
2028	1,614.1	1,468.7	[f]	88.0	57.5	1,832.4	1,817.5	8.4	6.5	-218.3	1,960.4	119
2029	1,674.4	1,525.9	[f]	94.8	53.7	1,930.5	1,915.1	8.7	6.6	-256.1	1,704.3	102
2030	1,740.5	1,589.1	[f]	102.5	48.9	2,030.9	2,015.1	9.0	6.8	-290.4	1,413.9	84
2031	1,805.9	1,652.5	[f]	110.7	42.7	2,133.4	2,117.2	9.4	6.9	-327.6	1,086.3	66
2032	1,867.4	1,713.6	[f]	119.6	34.3	2,237.9	2,221.2	9.7	7.0	-370.5	715.8	49
Low-cost:												
2023	1,332.8	1,214.4	.2	51.5	66.7	1,350.1	1,337.6	7.0	5.4	-17.3	2,821.0	210
2024	1,379.7	1,254.1	[f]	57.1	68.6	1,453.5	1,440.1	7.3	6.1	-73.8	2,747.2	194
2025	1,480.7	1,349.6	[f]	61.0	70.1	1,545.8	1,532.4	7.4	6.1	-65.2	2,682.1	178
2026	1,590.7	1,443.6	[f]	73.3	73.8	1,642.3	1,628.2	7.8	6.2	-51.5	2,630.5	163
2027	1,690.1	1,527.2	.2	82.1	80.6	1,739.9	1,725.3	8.3	6.3	-49.8	2,580.7	151
2028	1,806.6	1,630.2	[f]	88.9	87.5	1,840.9	1,825.8	8.7	6.4	-34.3	2,546.4	140
2029	1,911.5	1,721.6	[f]	96.2	93.7	1,945.8	1,930.1	9.2	6.6	-34.3	2,512.0	131
2030	2,026.3	1,821.3	[f]	104.5	100.6	2,054.9	2,038.5	9.6	6.7	-28.6	2,483.5	122
2031	2,145.5	1,924.0	[f]	113.4	108.1	2,167.8	2,150.8	10.1	6.8	-22.3	2,461.2	115
2032	2,264.7	2,026.1	[f]	123.1	115.5	2,284.6	2,267.0	10.6	7.0	-19.9	2,441.3	108
High-cost:												
2023	1,319.0	1,201.4	.2	51.5	65.8	1,352.7	1,340.2	7.0	5.4	-33.7	2,804.6	210
2024	1,281.0	1,159.2	[f]	57.7	64.2	1,472.6	1,459.2	7.3	6.1	-191.6	2,613.0	190
2025	1,343.4	1,223.7	[f]	61.8	57.9	1,574.4	1,560.7	7.4	6.3	-230.9	2,382.0	166
2026	1,398.8	1,272.8	[f]	73.8	52.1	1,666.2	1,652.1	7.7	6.5	-267.4	2,114.6	143
2027	1,444.5	1,314.8	.2	82.1	47.4	1,755.3	1,740.9	7.9	6.5	-310.8	1,803.8	120
2028	1,492.1	1,363.4	[f]	88.2	40.6	1,846.8	1,832.0	8.2	6.6	-354.7	1,449.1	98
2029	1,522.1	1,395.6	[f]	94.7	31.8	1,939.0	1,923.9	8.4	6.7	-416.9	1,032.2	75
2030	1,556.3	1,431.5	[f]	101.9	22.9	2,032.5	2,017.1	8.6	6.8	-476.2	556.0	51
2031	1,585.9	1,465.6	[f]	109.6	10.7	2,127.3	2,111.6	8.8	6.9	-541.4	14.6	26
2032	[g]	1,495.8	[f]	117.9	[g]	2,223.0	2,207.0	9.0	7.0	[g]	[g]	1

[a] The OASDI Trust Fund reserves become depleted in fiscal year 2032 under the high-cost assumptions. For any period during which reserves would be depleted, scheduled benefits could not be paid in full on a timely basis, income from taxing benefits would be less than would apply to scheduled benefits, and interest on trust fund reserves would be negligible.

[b] Represents asset reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year.

[c] Includes adjustments for prior years.

[d] Includes reimbursements from the General Fund of the Treasury to the OASI and DI Trust Funds for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; and (2) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96. Also includes transfers of a portion of proceeds from repayments of loans authorized under Public Law 116-136.

[e] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in law.

[f] Between -$50 million and $50 million.

[g] When the fund reserves are depleted, values under current law would reflect permissible expenditures only, which would be less than the full cost of paying scheduled benefits shown in this table.

Note: Components may not sum to totals because of rounding.

D. LONG-RANGE SENSITIVITY ANALYSIS

This appendix presents estimates that illustrate the sensitivity of the long-range actuarial status of the OASDI program to changes in selected individual assumptions. The estimates based on the three alternative sets of assumptions, which were presented earlier in this report, illustrate the effects of varying all of the principal assumptions simultaneously, in order to portray a significantly more optimistic or pessimistic future. For each sensitivity analysis presented in this appendix, the intermediate alternative II projection is the reference point, and one assumption is varied within that alternative. The variation used for each individual assumption is the same as the level used for that assumption in the low-cost alternative I and high-cost alternative III projections.

Each table in this section shows the effects of changing a particular assumption on the OASDI summarized income rates, summarized cost rates, and actuarial balances for 25-year, 50-year, and 75-year valuation periods. Each table also shows the effects on the annual balance for 2097 and on the year of combined trust fund reserve depletion. Following each table is a discussion of the estimated changes in cost rates. The change in each of the actuarial balances is approximately equal to the change in the corresponding cost rate, but in the opposite direction. This appendix does not discuss income rates following each table because income rates vary only slightly with changes in assumptions that affect revenue from taxation of benefits.

1. Total Fertility Rate

Table VI.D1 shows selected measures of OASDI actuarial status on the basis of alternative II with three different assumptions for the future paths of total fertility rates. Under the Trustees' assumptions, the average annual total fertility rate for the period 2033 through 2097 is 1.69, 1.99, and 2.19 children per woman under alternatives III, II, and I, respectively. The ultimate total fertility rate (1.70 under the alternative III assumptions, 2.00 under the alternative II assumptions, and 2.20 under the alternative I assumptions) is reached on a cohort basis over the lifetime of girls attaining age 14 in 2021 and later, so that the ultimate fertility rate on an annual (or period) basis is reached in 2056.

Table VI.D1.—Sensitivity of OASDI Measures to Fertility Assumptions
[As a percentage of taxable payroll]

Valuation period	Average total fertility rate[a] [b] 1.69	1.99	2.19
Summarized income rate:			
25-year: 2023-47	14.34	14.34	14.34
50-year: 2023-72	13.93	13.90	13.88
75-year: 2023-97	13.85	13.78	13.73
Summarized cost rate:			
25-year: 2023-47	16.83	16.85	16.85
50-year: 2023-72	17.47	17.14	16.92
75-year: 2023-97	18.17	17.38	16.87
Actuarial balance:			
25-year: 2023-47	-2.49	-2.50	-2.51
50-year: 2023-72	-3.54	-3.24	-3.04
75-year: 2023-97	-4.32	-3.61	-3.14
Annual balance for 2097	-6.69	-4.35	-3.07
Year of combined trust fund reserve depletion	2034	2034	2034

[a] The total fertility rate for any year is the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, the selected year, and if she were to survive the entire childbearing period. The average total fertility rate shown is for the period 2033 through 2097.
[b] The total fertility rates used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate for the three fertility assumptions varies by only about 0.02 percent of taxable payroll. In contrast, the 75-year cost rate varies over a wide range, decreasing from 18.17 percent to 16.87 percent, as the average total fertility rate for the period 2033 through 2097 increases from 1.69 for alternative III to 2.19 for alternative I. Similarly, while the 25-year actuarial balance varies by only 0.02 percent of taxable payroll, the 75-year actuarial balance varies over a much wider range, from -4.32 percent to -3.14 percent.

During the 25-year period, the very slight increases in the working-age population and tax income resulting from higher fertility (than that experienced in an alternative scenario) are more than offset by the effects of decreases in female labor force participation and increases in the number of child beneficiaries. Therefore, program cost as a percent of taxable payroll increases slightly with higher fertility. For the 75-year long-range period, however, changes in fertility have a relatively greater effect on the working-age population than on the beneficiary population. As a result, an increase in fertility significantly reduces the cost rate. Each increase of 0.1 in the average total fertility rate increases (improves) the long-range actuarial balance by about 0.24 percent of taxable payroll.

2. Death Rates

Table VI.D2 shows selected measures of OASDI actuarial status on the basis of alternative II with three different assumptions about future reductions in death rates for the period from 2032 to 2097. These assumptions are described in section V.A.2. Under the Trustees' assumptions, the age-sex-adjusted death rates[1] decline at average annual rates of 0.28 percent, 0.74 percent, and 1.24 percent for alternatives I, II, and III, respectively.

Table VI.D2.—Sensitivity of OASDI Measures to Death-Rate Assumptions
[As a percentage of taxable payroll]

Valuation period	Average annual death-rate reduction[a b]		
	0.28 percent	0.74 percent	1.24 percent
Summarized income rate:			
25-year: 2023-47	14.34	14.34	14.34
50-year: 2023-72	13.88	13.90	13.92
75-year: 2023-97	13.74	13.78	13.82
Summarized cost rate:			
25-year: 2023-47	16.65	16.85	17.10
50-year: 2023-72	16.66	17.14	17.72
75-year: 2023-97	16.65	17.38	18.21
Actuarial balance:			
25-year: 2023-47	-2.31	-2.50	-2.75
50-year: 2023-72	-2.78	-3.24	-3.79
75-year: 2023-97	-2.91	-3.61	-4.39
Annual balance for 2097	-2.88	-4.35	-5.82
Year of combined trust fund reserve depletion	2034	2034	2034

[a] The average annual death-rate reduction is the average annual geometric rate of decline in the age-sex-adjusted death rate for the period from 2032 to 2097.
[b] The death-rate reductions used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

The variation in cost for the 25-year period is less pronounced than the variation for the 75-year period because decreases in death rates have cumulative effects. The 25-year cost rate increases from 16.65 percent (for an average annual death-rate reduction of 0.28 percent from 2032 to 2097) to 17.10 percent (for an average annual death-rate reduction of 1.24 percent from 2032 to 2097). The 75-year cost rate increases from 16.65 percent to 18.21 percent. The actuarial balance decreases from -2.31 percent to -2.75 percent for the 25-year period, and from -2.91 percent to -4.39 percent for the 75-year period.

Lower death rates raise both the income (through increased taxable payroll) and the cost of the OASDI program. The relative increase in cost, however,

[1] Based on the enumerated total population as of April 1, 2010, if that population were to experience the death rates by age and sex for the selected year.

exceeds the relative increase in taxable payroll. For any given year, reductions in the death rates for people who are age 62 and over (ages at which death rates are the highest) increase the number of retired-worker beneficiaries (and, therefore, the amount of retirement benefits paid) without adding significantly to the number of covered workers (and, therefore, to the taxable payroll). Reductions in death rates for people at age 50 to retirement eligibility age result in significant increases to the taxable payroll. However, those increases are not large enough to offset the sum of the additional retirement benefits mentioned above and the disability benefits paid to additional beneficiaries at these pre-retirement ages, which are ages of high disability incidence. At ages under 50, death rates are so low that even substantial reductions in death rates do not result in significant increases in the numbers of covered workers or beneficiaries. Consequently, if death rates decline by about the same relative amount for all ages, the cost increases faster than the rate of growth in payroll, which results in higher cost rates and lower actuarial balances. Each additional 0.1-percentage-point increase in the average annual rate of decline in the death rate decreases (worsens) the long-range actuarial balance by about 0.15 percent of taxable payroll.

3. Immigration

Table VI.D3 shows selected measures of OASDI actuarial status under alternative II with three different assumptions about the magnitude of total net immigration (sum of net lawful permanent resident (LPR) immigration and net other-than-LPR immigration). See section V.A.3 for more information on immigration assumptions and methods. Under the Trustees' assumptions, total net annual immigration averages 829,000 persons, 1,245,000 persons, and 1,683,000 persons for the period 2033 through 2097 under alternatives III, II, and I, respectively.

Table VI.D3.—Sensitivity of OASDI Measures to Total Net Immigration Assumptions
[As a percentage of taxable payroll]

Valuation period	Average annual total net immigration[a] [b] 829,000	1,245,000	1,683,000
Summarized income rate:			
25-year: 2023-47	14.37	14.34	14.31
50-year: 2023-72	13.94	13.90	13.86
75-year: 2023-97	13.82	13.78	13.73
Summarized cost rate:			
25-year: 2023-47	17.09	16.85	16.61
50-year: 2023-72	17.50	17.14	16.79
75-year: 2023-97	17.85	17.38	16.94
Actuarial balance:			
25-year: 2023-47	-2.71	-2.50	-2.30
50-year: 2023-72	-3.56	-3.24	-2.92
75-year: 2023-97	-4.02	-3.61	-3.21
Annual balance for 2097	-5.17	-4.35	-3.66
Year of combined trust fund reserve depletion	2034	2034	2034

[a] Average annual total net immigration is the annual total net immigration to the Social Security area, including both LPR and other-than-LPR immigration, averaged for 2033 through 2097.
[b] The total net immigration assumptions used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For all three periods, when total net immigration increases, the cost rate decreases. For the 25-year period, the cost rate decreases from 17.09 percent of taxable payroll (for average annual total net immigration of 829,000 persons for 2033 through 2097) to 16.61 percent (for an average annual total net immigration of 1,683,000 persons for 2033 through 2097). For the 50-year period, it decreases from 17.50 percent to 16.79 percent, and for the 75-year period, it decreases from 17.85 percent to 16.94 percent. The actuarial balance increases from -2.71 percent to -2.30 percent for the 25-year period, from -3.56 percent to -2.92 percent for the 50-year period, and from -4.02 percent to -3.21 percent for the 75-year period.

The cost rate decreases with an increase in total net immigration because immigration occurs at relatively young ages, thereby increasing the numbers of covered workers earlier than the numbers of beneficiaries. Increasing average annual total net immigration by 100,000 persons increases (improves) the long-range actuarial balance by about 0.09 percent of taxable payroll.

4. Real Wage Growth

Table VI.D4 shows selected measures of OASDI actuarial status on the basis of alternative II with three different assumptions about the real growth rate in the average annual wage in OASDI covered employment. Under the Trust-

ees' assumptions, the average annual real growth rate in the average wage in covered employment from 2032 to 2097 is 0.54 percent, 1.14 percent, and 1.74 percent under alternatives III, II, and I, respectively.

Table VI.D4.—Sensitivity of OASDI Measures to Real Wage Growth Assumptions
[As a percentage of taxable payroll]

	Average annual real wage growth [a b]		
Valuation period	0.54	1.14	1.74
Summarized income rate:			
25-year: 2023-47	14.46	14.34	14.22
50-year: 2023-72	14.05	13.90	13.76
75-year: 2023-97	13.94	13.78	13.62
Summarized cost rate:			
25-year: 2023-47	17.68	16.85	16.03
50-year: 2023-72	18.36	17.14	15.97
75-year: 2023-97	18.75	17.38	16.05
Actuarial balance:			
25-year: 2023-47	-3.22	-2.50	-1.81
50-year: 2023-72	-4.30	-3.24	-2.21
75-year: 2023-97	-4.81	-3.61	-2.44
Annual balance for 2097	-6.36	-4.35	-2.60
Year of combined trust fund reserve depletion	2033	2034	2035

[a] The average annual real wage growth is the average annual real growth rate in the average wage in OASDI covered employment from 2032 to 2097.
[b] The real wage growth assumptions used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate decreases from 17.68 percent (for a real growth rate in the average wage in OASDI covered employment of 0.54 percent) to 16.03 percent (for a real growth rate of 1.74 percent). For the 50-year period, it decreases from 18.36 percent to 15.97 percent, and for the 75-year period it decreases from 18.75 percent to 16.05 percent. The actuarial balance increases from -3.22 percent to -1.81 percent for the 25-year period, from -4.30 percent to -2.21 percent for the 50-year period, and from -4.81 percent to -2.44 percent for the 75-year period.

The cost rate decreases with increasing real wage growth. Higher wages increase taxable payroll immediately, but they increase benefit levels only gradually as new beneficiaries become entitled. In addition, cost-of-living adjustments (COLA) to benefits depend not on changes in wages, but on changes in prices. Each 0.1-percentage-point increase in real wage growth increases (improves) the long-range actuarial balance by about 0.20 percent of taxable payroll.

5. Consumer Price Index

Table VI.D5 shows selected measures of OASDI actuarial status on the basis of alternative II with three different assumptions about the rate of increase for the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI). Under the Trustees' assumptions, the annual increase in the CPI is 3.00 percent, 2.40 percent, and 1.80 percent under alternatives I, II, and III, respectively. These ultimate rates of increase are reached by 2026 under all three alternatives.

Table VI.D5.—Sensitivity of OASDI Measures to CPI-Increase Assumptions
[As a percentage of taxable payroll]

	Ultimate annual increase in CPI[a]		
Valuation period	3.00	2.40	1.80
Summarized income rate:			
25-year: 2023-47	14.32	14.34	14.36
50-year: 2023-72	13.89	13.90	13.92
75-year: 2023-97	13.76	13.78	13.79
Summarized cost rate:			
25-year: 2023-47	16.74	16.85	16.94
50-year: 2023-72	17.00	17.14	17.28
75-year: 2023-97	17.23	17.38	17.53
Actuarial balance:			
25-year: 2023-47	-2.42	-2.50	-2.59
50-year: 2023-72	-3.12	-3.24	-3.36
75-year: 2023-97	-3.47	-3.61	-3.74
Annual balance for 2097	-4.17	-4.35	-4.51
Year of combined trust fund reserve depletion	2034	2034	2034

[a] The CPI assumptions used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For all three periods, the cost rate increases when the assumed rates of increase in the CPI are smaller. For the 25-year period, the cost rate increases from 16.74 percent (for a CPI increase of 3.00 percent) to 16.94 percent (for a CPI increase of 1.80 percent). For the 50-year period, it increases from 17.00 percent to 17.28 percent, and for the 75-year period, it increases from 17.23 percent to 17.53 percent. The actuarial balance decreases from -2.42 percent to -2.59 percent for the 25-year period, from -3.12 percent to -3.36 percent for the 50-year period, and from -3.47 percent to -3.74 percent for the 75-year period.

The time lag between the effects of the CPI changes on taxable payroll and on scheduled benefits explains these patterns. When the rate of increase in the CPI is greater and real wage growth is constant, then: (1) the effect on taxable payroll due to a greater rate of increase in average wages occurs immediately and (2) the effect on benefits due to a larger COLA occurs with

a lag of about 1 year. As a result of these effects, the higher taxable payrolls have a stronger effect than the higher benefits, which results in lower cost rates. Each 0.1-percentage-point decrease in the rate of the change in the CPI decreases (worsens) the long-range actuarial balance by about 0.02 percent of taxable payroll.

6. Real Interest Rate

Table VI.D6 shows selected measures of OASDI actuarial status under alternative II with three different assumptions about the annual real interest rate (compounded semiannually) for special public-debt obligations issuable to the trust funds. Under the Trustees' assumptions, the ultimate annual real interest rate is 1.8 percent, 2.3 percent, and 2.8 percent under alternatives III, II, and I, respectively. These ultimate rates are reached by 2033 under all three alternatives. In each case, the ultimate annual increase in the CPI is 2.40 percent, which is consistent with alternative II. Therefore, the ultimate annual yields are 4.2, 4.8, and 5.3 percent, respectively.

Table VI.D6.—Sensitivity of OASDI Measures to Real Interest Rate Assumptions
[As a percentage of taxable payroll]

Valuation period	Ultimate annual real interest rate[a] [b]		
	1.8 percent	2.3 percent	2.8 percent
Summarized income rate:			
25-year: 2023-47	14.30	14.34	14.38
50-year: 2023-72	13.85	13.90	13.95
75-year: 2023-97	13.72	13.78	13.83
Summarized cost rate:			
25-year: 2023-47	16.90	16.85	16.79
50-year: 2023-72	17.24	17.14	17.05
75-year: 2023-97	17.51	17.38	17.26
Actuarial balance:			
25-year: 2023-47	-2.60	-2.50	-2.41
50-year: 2023-72	-3.39	-3.24	-3.09
75-year: 2023-97	-3.79	-3.61	-3.43
Annual balance for 2097	-4.35	-4.35	-4.35
Year of combined trust fund reserve depletion	2034	2034	2034

[a] The annual real interest rate is the effective annual yield on asset reserves held by the trust funds divided by the annual rate of growth in the CPI.
[b] The real interest rate assumptions used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate decreases with increasing real interest rates from 16.90 percent (for an ultimate real interest rate of 1.8 percent) to 16.79 percent (for an ultimate real interest rate of 2.8 percent). For the 50-year period, it decreases from 17.24 percent to 17.05 percent and, for the 75-year period, it decreases from 17.51 percent to 17.26 percent. The actuar-

ial balance increases from -2.60 percent to -2.41 percent for the 25-year period, from -3.39 percent to -3.09 percent for the 50-year period, and from -3.79 percent to -3.43 percent for the 75-year period. A relatively higher real interest rate has the effect of discounting more distant future years relatively more. To the extent that annual cost rates and annual deficits are larger in later years, a higher interest rate decreases the summarized rates, and a lower interest rate increases the summarized rates. Each 0.1-percentage-point increase in the real interest rate increases (improves) the long-range actuarial balance by about 0.04 percent of taxable payroll.

7. Taxable Ratio

Table VI.D7 shows selected measures of OASDI actuarial status under alternative II with three different assumptions about the ratio of taxable payroll to OASDI covered earnings (the taxable ratio). Note that covered earnings are the sum of wages and net self-employment earnings covered by Social Security, and taxable payroll is essentially the amount of covered earnings subject to the Social Security payroll tax up to the contribution and benefit base ($160,200 for 2023). Under the Trustees' assumptions, the taxable ratio at the end of the short-range period (2032) is 81.0 percent, 82.5 percent, and 84.0 percent under alternatives III, II, and I, respectively.

Table VI.D7.—Sensitivity of OASDI Measures to Taxable Ratio Assumptions
[As a percentage of taxable payroll]

Valuation period	Taxable ratio in 2032[a] [b]		
	81.0 percent	82.5 percent	84.0 percent
Summarized income rate:			
25-year: 2023-47	14.37	14.34	14.31
50-year: 2023-72	13.92	13.90	13.88
75-year: 2023-97	13.80	13.78	13.76
Summarized cost rate:			
25-year: 2023-47	17.08	16.85	16.61
50-year: 2023-72	17.37	17.14	16.93
75-year: 2023-97	17.58	17.38	17.19
Actuarial balance:			
25-year: 2023-47	-2.71	-2.50	-2.30
50-year: 2023-72	-3.44	-3.24	-3.05
75-year: 2023-97	-3.79	-3.61	-3.43
Annual balance for 2097	-4.46	-4.35	-4.23
Year of combined trust fund reserve depletion	2033	2034	2034

[a] The taxable ratio is the ratio of taxable payroll to OASDI covered earnings. These concepts are described in further detail in section V.C.6 of this report.
[b] The taxable ratio assumptions used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

Because the combined employee-employer tax rate of 12.4 percent is unchanged across all alternatives, the income rate changes a relatively small amount as the taxable ratio increases, due to changes in taxation of benefits and the initial fund as a percentage of taxable payroll.

For the 25-year period, the cost rate decreases with increasing taxable ratios, from 17.08 percent (for a taxable ratio in 2032 of 81.0 percent) to 16.61 percent (for a taxable ratio in 2032 of 84.0 percent). For the 50-year period, it decreases from 17.37 percent to 16.93 percent and, for the 75-year period, it decreases from 17.58 percent to 17.19 percent. The actuarial balance increases from -2.71 percent to -2.30 percent for the 25-year period, from -3.44 percent to -3.05 percent for the 50-year period, and from -3.79 percent to -3.43 percent for the 75-year period.

The cost rate decreases with an increase in taxable payroll because the increase in taxable payroll occurs immediately. The increase in benefit amounts occurs much more gradually as new beneficiaries become entitled. In addition, the change in the taxable ratio does not affect COLAs or the national average wage index. Each 1.0 percentage-point increase in the taxable ratio in 2032 increases (improves) the long-range actuarial balance by about 0.12 percent of taxable payroll.

8. Disability Incidence Rates

Table VI.D8 shows selected measures of OASDI actuarial status on the basis of alternative II with three different assumptions about future disability incidence rates. Under the Trustees' assumptions, the ultimate age-sex-adjusted[1] incidence rate is 3.8, 4.8, and 5.8 awards per thousand exposed for alternatives I, II, and III, respectively. These ultimate rates are reached by 2032 under all three alternatives. Under the Trustees' assumptions, incidence rates by age and sex for all three alternatives vary during the early years of the projection period before reaching their long-term average values.

[1] Age-sex-adjusted to the disability-exposed population as of the year 2000.

Table VI.D8.—Sensitivity of OASDI Measures to Disability Incidence Assumptions
[As a percentage of taxable payroll]

Valuation period	Ultimate disability incidence rate[a] 3.8	4.8	5.8
Summarized income rate:			
25-year: 2023-47	14.33	14.34	14.35
50-year: 2023-72	13.89	13.90	13.92
75-year: 2023-97	13.76	13.78	13.79
Summarized cost rate:			
25-year: 2023-47	16.53	16.85	17.15
50-year: 2023-72	16.78	17.14	17.50
75-year: 2023-97	17.01	17.38	17.77
Actuarial balance:			
25-year: 2023-47	-2.20	-2.50	-2.79
50-year: 2023-72	-2.89	-3.24	-3.58
75-year: 2023-97	-3.25	-3.61	-3.98
Annual balance for 2097	-3.92	-4.35	-4.89
Year of combined trust fund reserve depletion	2034	2034	2033

[a] The disability incidence rates used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate increases with increasing disability incidence rates, from 16.53 percent (for the relatively low rates assumed for alternative I) to 17.15 percent (for the relatively high rates assumed for alternative III). For the 50-year period, it increases from 16.78 percent to 17.50 percent, and for the 75-year period, it increases from 17.01 percent to 17.77 percent. The actuarial balance decreases from -2.20 percent to -2.79 percent for the 25-year period, from -2.89 percent to -3.58 percent for the 50-year period, and from -3.25 percent to -3.98 percent for the 75-year period.

9. Disability Termination Rates

Table VI.D9 shows selected measures of OASDI actuarial status on the basis of alternative II with three different assumptions about future disability termination rates, including deaths and recoveries.

Under the Trustees' assumptions, death rates for disabled-worker beneficiaries for all three alternatives decline throughout the long-range period. The age-sex-adjusted death rate[1] of 28.6 deaths per thousand disabled-worker beneficiaries in 2022 declines to 21.5, 12.4, and 6.1 deaths per thousand in 2097 for alternatives I, II, and III, respectively. These levels are about 25 percent, 57 percent, and 79 percent lower, respectively, than the level in

[1] Age-sex-adjusted to the disabled-worker population as of the year 2000.

2022. For this sensitivity analysis, total population death rates by age and sex are assumed to be the same as those used for the alternative II assumptions.

The ultimate age-sex-adjusted recovery rate[1] used for this analysis is 12.5 recoveries per thousand disabled-worker beneficiaries for the alternative I assumptions, 10.4 recoveries per thousand disabled-worker beneficiaries for the alternative II assumptions, and 8.3 recoveries per thousand disabled-worker beneficiaries for the alternative III assumptions.

Table VI.D9.—Sensitivity of OASDI Measures to Disability Termination Assumptions
[As a percentage of taxable payroll]

Valuation period	Disability termination rates (death; recovery)[a] 21.5; 12.5	12.4; 10.4	6.1; 8.3
Summarized income rate:			
25-year: 2023-47	14.34	14.34	14.34
50-year: 2023-72	13.90	13.90	13.90
75-year: 2023-97	13.77	13.78	13.78
Summarized cost rate:			
25-year: 2023-47	16.79	16.85	16.89
50-year: 2023-72	17.07	17.14	17.20
75-year: 2023-97	17.31	17.38	17.45
Actuarial balance:			
25-year: 2023-47	-2.45	-2.50	-2.55
50-year: 2023-72	-3.18	-3.24	-3.29
75-year: 2023-97	-3.53	-3.61	-3.67
Annual balance for 2097	-4.23	-4.35	-4.50
Year of combined trust fund reserve depletion	2034	2034	2034

[a] The disability termination rates used for this analysis are consistent with those assumed for the three alternative scenarios. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate increases with decreasing disability termination rates, from 16.79 percent (for the relatively high termination rates assumed for alternative I) to 16.89 percent (for the relatively low termination rates assumed for alternative III). For the 50-year period, it increases from 17.07 percent to 17.20 percent, and for the 75-year period, it increases from 17.31 percent to 17.45 percent. The actuarial balance decreases from -2.45 percent to -2.55 percent for the 25-year period, from -3.18 percent to -3.29 percent for the 50-year period, and from -3.53 percent to -3.67 percent for the 75-year period.

[1] Age-sex-adjusted to the disabled-worker population as of the year 2000. The disability recovery rates for each alternative vary slightly over the last 65 years of the 75-year projection period, so the ultimate rates are presented as averages for years 2033 through 2097.

E. STOCHASTIC PROJECTIONS AND UNCERTAINTY

Significant uncertainty surrounds the estimates under the intermediate assumptions, especially for a period as long as 75 years. This appendix presents stochastic projections, a way to illustrate the uncertainty of these estimates. The stochastic projections supplement the traditional methods of examining such uncertainty.

1. Background

The Trustees have traditionally shown estimates using the low-cost and high-cost sets of specified assumptions to illustrate the potential implications of uncertainty. These low-cost and high-cost estimates provide a range of possible outcomes for the projections. However, they do not provide an indication of the probability that actual future experience will be inside or outside this range. This appendix presents the results of a stochastic model that estimates a probability distribution of future outcomes of the financial status of the combined OASI and DI Trust Funds. This model was introduced in the 2003 report and enhanced in the 2021 report to include parameter uncertainty for the expected mean for the key variables described in the next section.

2. Stochastic Methodology

Other sections of this report provide estimates of the financial status of the combined OASI and DI Trust Funds using a scenario-based model. For the scenario-based model, the Trustees use three alternative scenarios (low-cost, intermediate, and high-cost) that use specific assumptions for key variables. In general, the Trustees assume that each of these variables will reach an ultimate value at a specific point during the long-range period, and will maintain that value throughout the remainder of the period. The three alternative scenarios assume separate, specified values for each of these variables. Chapter V contains more details about each of these assumptions.

This appendix presents estimates of the probability that key measures of OASDI solvency will fall in certain ranges, based on 5,000 independent stochastic simulations. Each simulation allows key variables to vary throughout the long-range period. These key variables include total fertility rates, changes in mortality rates, new arrival lawful permanent resident (LPR) and other-than-LPR immigration levels, rates of adjustment of status (from other-than-LPR to LPR), rates of legal emigration (from the population of citizens and LPRs), changes in the Consumer Price Index, changes in average real wages, unemployment rates, trust fund real yield rates, and disability incidence and recovery rates. The fluctuation of each variable over time is simu-

lated using historical data and standard time-series techniques. Generally, each variable is modeled using an equation that: (1) captures a relationship between current and prior years' values of the variable, and (2) introduces random variation based on variation observed in the historical period. For some variables, the equations also reflect relationships with other variables. The equations contain parameters that are estimated using historical data for periods from about 20 years to over 100 years, depending on the nature and quality of the available data. Each time-series equation is designed so that, in the absence of random variation over time, the value of the variable for each year equals its value for the intermediate scenario.[1]

For each equation in a given simulation, the stochastic model assigns random variation to (1) year-by-year error term values and (2) simulation-specific mean term levels that provide variation in the central tendency across simulations. Each simulation produces estimates for all key variables and for the overall financial status of the combined OASI and DI Trust Funds. This appendix shows the distribution of results from 5,000 simulations of the model.

Readers should interpret the results from this model with an understanding of the model's limitations. Results are sensitive to equation specifications, degrees of interdependence among variables, and the historical periods used for estimating model coefficients. For some variables, recent historical variation may not provide a realistic representation of the potential variation for the future. Also, results would differ if additional variables (such as labor force participation rates, retirement rates, marriage rates, and divorce rates) were also allowed to vary randomly. Time-series modeling reflects only what occurred in the historical period. Future uncertainty exists not only for the underlying central tendency but also for the frequency and size of occasional longer-term shifts in the central tendency. Many experts predict, and history suggests, that the future will likely bring substantial shifts that are not fully reflected in the historical period used for the current model. As a result, readers should understand that the true range of uncertainty might be larger than indicated in this appendix.

3. Stochastic Results

This section illustrates the results for the stochastic simulations of two fundamental measures of actuarial status: annual cost rates and trust fund ratios.

[1] More detail on this model, and stochastic modeling in general, is available at www.ssa.gov/OACT/stochastic/index.html.

The latter measure is highlighted in section II.D of this report. Section 4 of this appendix follows with a comparison of stochastic results to results from the alternative scenarios for these and other measures, and an analysis of the differences.

Figure VI.E1 displays the probability distribution of the year-by-year OASDI cost rates (that is, cost as a percentage of taxable payroll). The range of the annual cost rates widens as the projections move further into the future, which reflects increasing uncertainty. Because there is relatively little variation in income rates across the 5,000 stochastic simulations, the figure includes only the income rate for the intermediate scenario. The two outermost cost rate lines in this figure indicate the range within which future annual cost rates are projected to occur 95 percent of the time (i.e., a 95-percent confidence interval). In other words, the current model estimates that there is a 2.5 percent probability that the cost rate for a given year will exceed the upper end of this range and a 2.5 percent probability that it will fall below the lower end of this range. Other lines in the figure delineate the 80-percent confidence interval and the median cost rate. The median (50th percentile) cost rate for each year is the rate for which half of the simulated outcomes are higher and half are lower for that year. These lines do not represent the results of individual stochastic simulations. Instead, for each given year, they represent the percentile distribution of annual cost rates based on all stochastic simulations for that year.

Figure VI.E1.—Long-Range OASDI Cost Rates From Stochastic Modeling

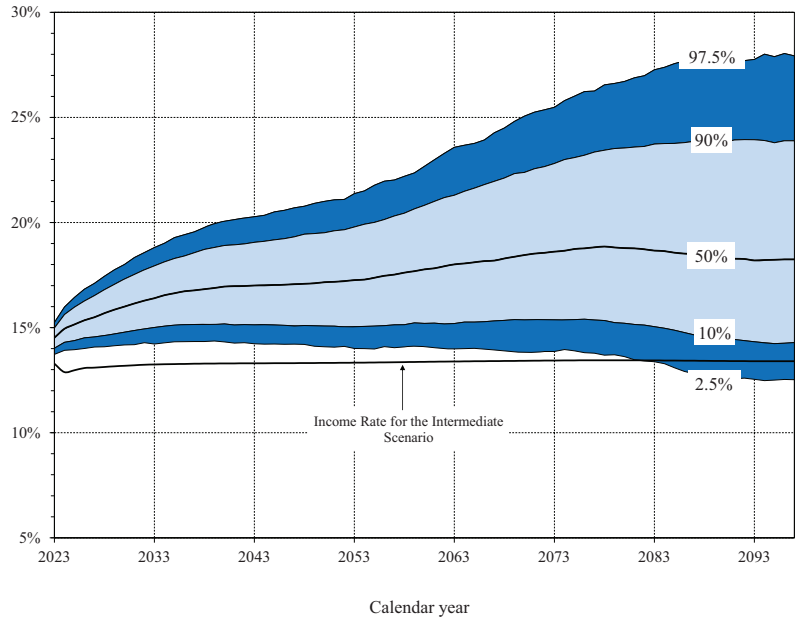
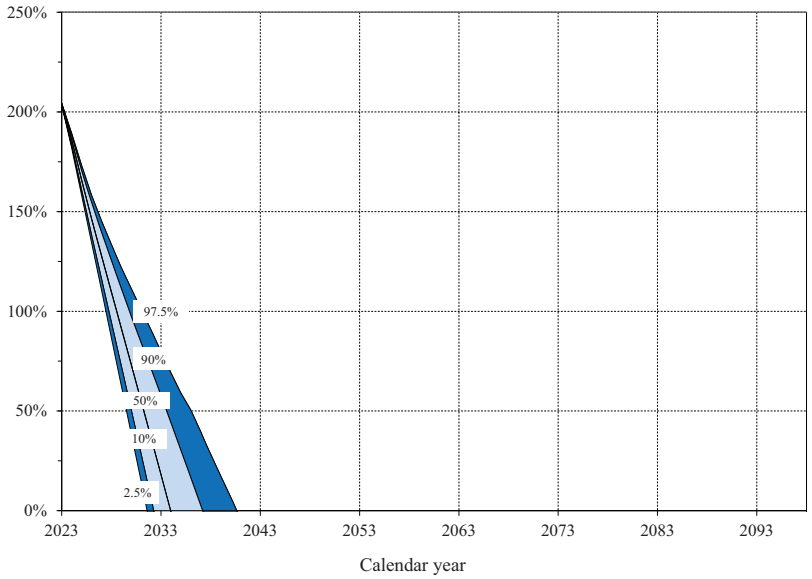


Figure VI.E2 presents the simulated probability distribution of the annual trust fund ratios for the combined OASI and DI Trust Funds. The lines in this figure display the median set (50th percentile) of estimated annual trust fund ratios and delineate the 95-percent and 80-percent confidence intervals estimated for future annual trust fund ratios. Again, none of these lines represent the path of a single simulation. For each given year, they represent the percentile distribution of trust fund ratios based on all stochastic simulations for that year.

Figure VI.E2 shows that the 95-percent confidence interval for the trust fund reserve depletion year ranges from 2031 to 2040, relatively early in the 75-year projection period. The figure also shows that there is a 50-percent probability of trust fund reserve depletion by the end of 2033 (the median reserve depletion year). The median reserve depletion date is late in 2033; the reserve depletion date for the intermediate scenario is in mid-2034.

Figure VI.E2.—Long-Range OASDI Trust Fund Ratios From Stochastic Modeling



4. Comparison of Results: Stochastic to Low-Cost, Intermediate, and High-Cost Alternative Scenarios

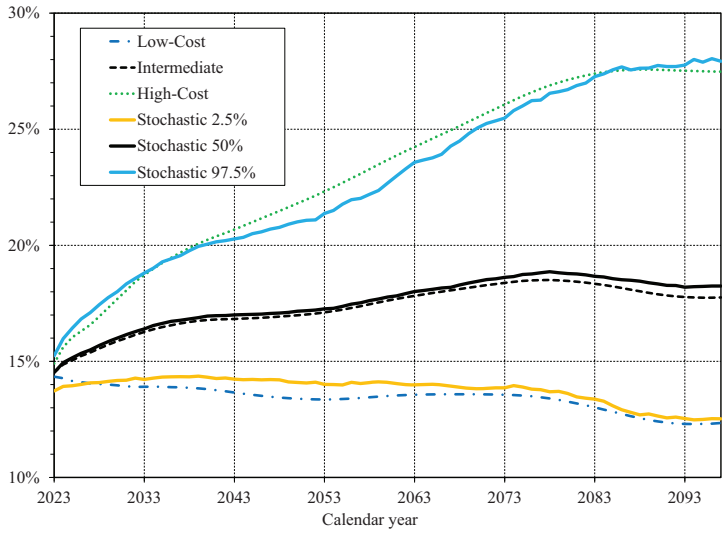
This section compares results from two different approaches for illustrating ranges of uncertainty in measures of trust fund actuarial status. One approach uses results from the low-cost, intermediate, and high-cost alternative scenarios. The other approach uses distributions of results from the stochastic simulations. Each of these approaches provides insights into uncertainty. Comparing the results requires an understanding of fundamental differences in the approaches.

One fundamental difference relates to the presentation of distributional results. Figure VI.E3 shows projected OASDI annual cost rates for the low-cost, intermediate, and high-cost alternative scenarios along with the annual cost rates at the 2.5th percentile, 50th percentile, and 97.5th percentile for the stochastic simulations. While all values on each line for the alternative scenarios are results from a single specified scenario, the values on each stochastic line may be results from different simulations for different years. The one stochastic simulation (from the 5,000 simulations) that yields results closest to a particular percentile for one projected year may yield results that

are distant from that percentile in another projected year. Because each stochastic simulation shows substantial variability from year to year, the range shown between the 2.5th and 97.5th percentiles is broader than would be seen if simulations followed a smooth trend like in the alternative scenarios.

Both the alternative scenarios and the stochastic results suggest that the range of potential cost rates above the central levels (those for the intermediate scenario and for the stochastic median, respectively) is larger than the range below these central results. The difference between the central results and the higher cost levels (the high-cost alternative scenario and the upper end of the 95-percent confidence range, respectively) is about 1.6 to 1.8 times as large as the difference between the central and lower cost levels for both models by the end of the projection period.

Figure VI.E3.—OASDI Cost Rates: Comparison of Stochastic to Low-Cost, Intermediate, and High-Cost Alternative Scenarios
[As a percentage of taxable payroll]



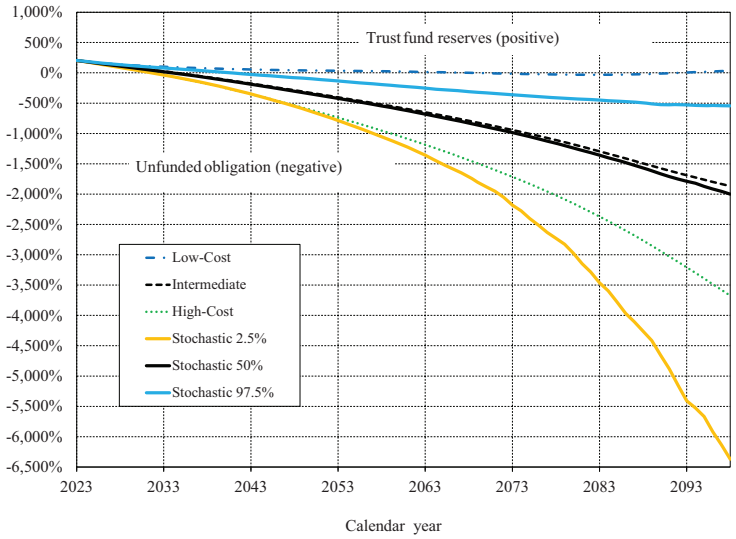
Another fundamental difference between the alternative scenarios and the stochastic simulations is the method of assigning values for assumptions. For the alternative scenarios, specific values are assigned for each of the key demographic, economic, and program-specific variables. The high-cost alternative scenario uses parameter values that increase estimated annual cost as a percent of payroll, while the low-cost alternative scenario uses parameter

values that decrease annual cost as a percent of payroll. (One parameter, the interest rate, has no effect on annual cost as a percent of payroll for either the alternative scenarios or the stochastic simulations.) In contrast, the stochastic method independently assigns random variation to each of the key demographic and economic variables for each year in each of the 5,000 stochastic simulations. For each of the stochastic simulations, the assigned values for different variables result in varying and often offsetting effects on projected cost as a percent of payroll, with some tending toward higher cost and some tending toward lower cost. This difference tends to narrow the range of cost as a percent of payroll across the 95-percent confidence interval.

It is important to understand that the stochastic model's 95-percent confidence intervals for any summary measure of trust fund finances would tend to be narrower than the range produced for the low-cost and high-cost alternative scenarios, even if the stochastic model's 95-percent confidence interval for annual cost rates were identical to the range defined by the low-cost and high-cost scenarios. This is true because summary measures of trust fund finances depend on cost rates for many years, and the probability that annual cost rates, on average for individual stochastic simulations, will be at least as low (high) as the 2.5 (97.5) percentile line is significantly lower than 2.5 percent. As a result, the relationship between the ranges presented for annual cost rates and summary measures of trust fund finances is fundamentally different for the stochastic model than it is for the low-cost and high-cost alternative scenarios.

Figure VI.E4 compares the ranges of trust fund (unfunded obligation) ratios for the alternative scenarios to the 95-percent confidence interval of the stochastic simulations. This figure extends figure VI.E2 to show unfunded obligation ratios, expressed as negative values below the zero percent line. An unfunded obligation ratio is the ratio of the unfunded obligation accumulated through the beginning of the year to the cost for that year.

Figure VI.E4.—OASDI Trust Fund (Unfunded Obligation) Ratios: Comparison of Stochastic to Low-Cost, Intermediate, and High-Cost Alternative Scenarios[a]
[Trust fund reserves (unfunded obligation) as a percentage of annual cost]



[a] An unfunded obligation, shown as a negative value in this figure, is equivalent to the amount the trust funds would need to have borrowed to date in order to pay all scheduled benefits (on a timely basis) after trust fund reserves are depleted. Note that current law does not permit the trust funds to borrow.

As mentioned above, a summary measure that accumulates annual values tends to smooth the kind of annual fluctuations that occur in stochastic simulations. Therefore, one might expect the range across the stochastic confidence interval for trust fund (unfunded obligation) ratios to be narrower and fall within the range seen across the high-cost and low-cost alternative scenarios, as it does for the actuarial balance measure. But this is not the case, largely due to the way interest rates are assigned.

For the stochastic model, real interest rates for each simulation are assigned to be essentially independent of other variables, so the rate for compounding of trust fund reserves (unfunded obligations) is essentially uncorrelated with the level of cost as a percent of payroll. On the other hand, real interest rates are assigned to be higher for the low-cost alternative scenario and lower for the high-cost alternative scenario. High interest rates raise the level of the positive trust fund ratio in the low-cost alternative scenario somewhat, but this effect is limited because the magnitude of reserves is small. However, low interest rates substantially reduce the magnitude of the unfunded obligation ratio for the high-cost alternative scenario because the magnitude of

unfunded obligations is relatively large. As a result, the trust fund (unfunded obligation) ratios are shifted, albeit unevenly, higher (or less negative) for both the high-cost and low-cost alternative scenarios relative to those of the stochastic simulations.

This interest rate effect on the alternative scenarios is not as evident for some other summary measures of actuarial status, such as the actuarial balance. Because the actuarial balance reflects the cumulative effects of interest in both its numerator and denominator, the interest rate effect is much less pronounced. In contrast, cumulative interest affects only the numerator of the trust fund (unfunded obligation) ratio. There is also no significant interest rate effect on the trust fund depletion date.

Other factors also contribute, to varying degrees, to the difference in ranges between the results of the alternative scenarios and the stochastic simulations. The contrasts in results and methods do not mean that either approach to illustrating ranges of uncertainty is superior to the other. The ranges are different and explainable.

Table VI.E1 displays long-range actuarial estimates for the combined OASDI program using the two methods of illustrating uncertainty: alternative scenarios and stochastic simulations. The table shows scenario-based estimates for the intermediate, low-cost, and high-cost assumptions. It also shows stochastic estimates for the median (50th percentile) and for the 80-percent and 95-percent confidence intervals. Each individual stochastic estimate in the table is the level at that percentile from the distribution of the 5,000 simulations. For each given percentile, the values in the table for each long-range actuarial measure are generally from different stochastic simulations.

The median stochastic estimates displayed in table VI.E1 are similar to the intermediate scenario-based estimates. The median estimate of the long-range actuarial balance is -3.69 percent of taxable payroll, about 0.08 percentage point lower (more negative) than projected in the intermediate scenario. The median estimate for the open-group unfunded obligation is $22.8 trillion, about $0.4 trillion larger than the $22.4 trillion estimate in the intermediate scenario. The median first projected year for which cost exceeds non-interest income (as it did in 2010 through 2022), and remains in excess of non-interest income throughout the remainder of the long-range period, is 2023. This is the same year as projected in the intermediate scenario. The median projected date at which trust fund reserves first become depleted is late in 2033; the reserve depletion date for the intermediate scenario is mid-2034. The median estimates of the annual cost rate for the 75th year of the projection period are 18.25 percent of taxable payroll and

6.14 percent of gross domestic product (GDP). The comparable estimates in the intermediate scenario are 17.75 percent of payroll and 5.98 percent of GDP.

For three measures in table VI.E1 (the actuarial balance, the first projected year cost exceeds non-interest income and remains in excess through 2097, and the first year trust fund reserves become depleted), the 95-percent stochastic confidence interval falls within the range defined by the low-cost and high-cost scenarios. For the remaining three measures (the open-group unfunded obligation, the annual cost in the 75th year as a percent of taxable payroll, and the annual cost in the 75th year as a percent of GDP), one or both of the bounds of the 95-percent stochastic confidence interval fall outside the range defined by the low-cost and high-cost scenarios.

Table VI.E1.—Long-Range Estimates Relating to the Actuarial Status of the Combined OASDI Program
[Comparison of scenario-based and stochastic results]

	Traditional scenario-based model			Stochastic model				
					80-percent confidence interval		95-percent confidence interval	
	Intermediate	Low-cost	High-cost	Median 50th percentile	10th percentile	90th percentile	2.5th percentile	97.5th percentile
Actuarial balance	-3.61	-0.10	-8.37	-3.69	-5.75	-2.03	-7.17	-1.18
Open-group unfunded obligation (in trillions)	$22.4	-$.4	$42.9	$22.8	$10.5	$44.3	$5.8	$60.9
First projected year cost exceeds non-interest income and remains in excess through 2097	2023	[a]	2023	2023	2023	2023	2023	[a]
First year trust fund reserves become depleted [b]	2034	2067	2031	2033	2032	2037	2031	2040
Annual cost in 75th year (percent of taxable payroll)	17.75	12.34	27.48	18.25	14.29	23.89	12.52	27.93
Annual cost in 75th year (percent of GDP)	5.98	4.52	8.54	6.14	4.84	7.97	4.25	9.21

[a] Cost is projected to exceed non-interest income for a temporary period, before falling below non-interest income by the end of the projection period.
[b] For the low-cost scenario and for some stochastic simulations, the first year in which trust fund reserves become depleted does not indicate a permanent depletion of reserves.

F. INFINITE HORIZON PROJECTIONS

Another measure of trust fund financial status is the infinite horizon unfunded obligation, which takes account of all past and future annual balances, even those after the next 75 years. The extension of the time period past 75 years assumes that the current law for the OASDI program and the demographic and economic trends used for the 75-year projection continue indefinitely.

Table VI.F1 shows that the OASDI open-group unfunded obligation over the infinite horizon is $65.9 trillion in present value, which is $43.4 trillion larger than for the 75-year period. The $43.4 trillion increment reflects a significant financing gap projected for OASDI for years after 2097 into perpetuity. Of course, the degree of uncertainty associated with estimates increases substantially for years further in the future.

The $65.9 trillion infinite horizon open-group unfunded obligation is equal to 4.6 percent of taxable payroll or 1.4 percent of GDP over the same period. These relative measures of the unfunded obligation over the infinite horizon express its magnitude in relation to the resources potentially available to finance the shortfall.

The summarized shortfalls for the 75-year period and through the infinite horizon both reflect annual cash-flow shortfalls for all years after trust fund reserve depletion. The annual shortfalls after trust fund reserve depletion rise slowly and reflect increases in life expectancy. The summarized shortfalls over the infinite horizon, as percentages of taxable payroll and GDP, are larger than the shortfalls for the 75-year period.

To illustrate the magnitude of the projected infinite horizon shortfall, consider that it could be eliminated with additional revenue equivalent to an immediate increase in the combined payroll tax rate from 12.4 percent to about 17.0 percent,[1] or with cost reductions equivalent to an immediate and permanent reduction in benefits for all current and future beneficiaries by about 26.9 percent.

[1] While an increase in the payroll tax rate would cause some behavioral changes in earnings and ensuing changes in benefit levels, such changes are not included in the calculations because they are assumed to have roughly offsetting effects on OASDI actuarial status over the infinite horizon.

Table VI.F1.—Unfunded OASDI Obligations Through the Infinite Horizon and the 75-Year Projection Period, Based on Intermediate Assumptions
[Present values as of January 1, 2023; dollar amounts in trillions]

		Expressed as a percentage of future payroll and GDP	
	Present value	Taxable payroll	GDP
Unfunded obligation through the infinite horizon[a]	$65.9	4.6	1.4
Unfunded obligation through 2097[b]	22.4	3.4	1.2

[a] Present value of future cost less future non-interest income, reduced by the amount of trust fund asset reserves at the beginning of 2023. Expressed as a percentage of payroll and GDP for the period 2023 through the infinite horizon.
[b] Present value of future cost less future non-interest income through 2097, reduced by the amount of trust fund reserves at the beginning of 2023. Expressed as a percentage of payroll and GDP for the period 2023 through 2097.

Notes:
1. The present values of future taxable payroll for 2023-97 and for 2023 through the infinite horizon are $655.0 trillion and $1,439.1 trillion, respectively.
2. The present values of GDP for 2023-97 and for 2023 through the infinite horizon are $1,865.3 trillion and $4,612.7 trillion, respectively. Present values of GDP shown in the Medicare Trustees Report differ slightly due to the use of discount rates that are specific to each program's trust fund holdings.

Last year, the Trustees projected that the infinite horizon unfunded obligation was $61.8 trillion in present value discounted to January 1, 2022. If the assumptions, methods, and starting values had not changed, moving the valuation date forward by 1 year to January 1, 2023 would have discounted future values by 1 year less, thus increasing the measured unfunded obligation by about $1.4 trillion, to $63.2 trillion. The net effects of changes in assumptions, methods, law, and starting values increased the infinite horizon unfunded obligation by an additional $2.7 trillion. This net increase occurred for a variety of reasons, particularly changes in recent economic data and near-term assumptions, and changes in programmatic data and methods. See section IV.B.6 for details regarding changes in law, data, methods, and assumptions.

Compared to last year's report, the unfunded obligation over the infinite horizon in this year's report increased by 0.1 percentage point as both a share of taxable payroll and a share of GDP. The unfunded obligation over the 75-year projection period increased by 0.2 percentage point as a share of taxable payroll and increased by 0.1 percentage point as a share of GDP.

a. Unfunded Obligations for Past, Current, and Future Participants

Table VI.F2 separates the components of the infinite horizon unfunded obligation (with the exception of General Fund reimbursements) among past, current, and future participants. The table does not separate past General Fund reimbursements among participants because there is no clear basis for attributing the reimbursements across generations.

Past participants are defined as those no longer alive as of the valuation date. Current participants are those age 15 and older as of 2023. Future participants are those under age 15 or not yet born.

The excess of the present value of cost for past and current participants over the present value of dedicated tax income for past and current participants produces an unfunded obligation for past and current participants of $49.1 trillion. Table VI.F2 also shows an unfunded obligation of $48.4 trillion for past and current participants, including past and future General Fund reimbursements. Future participants are scheduled to pay dedicated taxes of $17.5 trillion less into the system than the cost of their scheduled benefits ($148.8 trillion of dedicated tax income as compared to $166.3 trillion of cost). The unfunded obligation for all participants through the infinite horizon thus equals $65.9 trillion.

Making Social Security solvent over the infinite horizon requires some combination of increased revenue or reduced benefits for current and future participants amounting to $65.9 trillion in present value, 4.6 percent of future taxable payroll, or 1.4 percent of future GDP.

Table VI.F2.—Present Values Through the Infinite Horizon for Various Categories of Program Participants, Based on Intermediate Assumptions
[Present values as of January 1, 2023; dollar amounts in trillions]

		Expressed as a percentage of future payroll and GDP	
	Present value	Taxable payroll	GDP
Present value of past cost	$76.4	5.3	1.7
Less present value of past dedicated tax income	78.5	5.5	1.7
Plus present value of future cost for current participants	95.7	6.6	2.1
Less present value of future dedicated tax income for current participants	44.4	3.1	1.0
Equals unfunded obligation for past and current participants excluding General Fund reimbursements	49.1	3.4	1.1
Less present value of past General Fund reimbursements[a]	.7	[b]	[c]
Less present value of future General Fund reimbursements through the infinite horizon[a]	[d]	[b]	[c]
Equals unfunded obligation for past and current participants including General Fund reimbursements	48.4	3.4	1.0
Plus present value of cost for future participants through the infinite horizon	166.3	11.6	3.6
Less present value of dedicated tax income for future participants through the infinite horizon	148.8	10.3	3.2
Equals unfunded obligation for all participants through the infinite horizon	65.9	4.6	1.4

[a] Distribution of General Fund reimbursements among past, current, and future participants cannot be determined.
[b] Less than 0.05 percent of taxable payroll.
[c] Less than 0.05 percent of GDP.
[d] Less than $50 billion.

Notes:

1. The present value of future taxable payroll for 2023 through the infinite horizon is $1,439.1 trillion.
2. The present value of GDP for 2023 through the infinite horizon is $4,612.7 trillion.
3. Components may not sum to totals because of rounding.

G. ESTIMATES FOR OASDI AND HI, SEPARATE AND COMBINED

In this appendix, the Trustees present long-range actuarial estimates for the OASDI and Hospital Insurance (HI) programs both separately and on a combined basis. These estimates facilitate analysis of the adequacy of the income and asset reserves of these programs relative to their cost under current law. This appendix does not include estimates for the Supplementary Medical Insurance (SMI) program because adequate financing is guaranteed in the law and because the SMI program is not financed through a payroll tax. For more information on Medicare estimates, please see the 2023 Medicare Trustees Report.

The information in this appendix on combined operations, while significant, should not obscure the analysis of the financial status of the individual trust funds, which are legally separate and cannot be commingled. In addition, the factors which determine the costs of the OASI, DI, and HI programs differ substantially.

1. Estimates as a Percentage of Taxable Payroll

Comparing cost and income rates for the OASDI and HI programs as percentages of taxable payroll requires a note of caution. The taxable payrolls for the HI program are larger than those for the OASDI program because: (1) a larger maximum taxable amount was established for the HI program in 1991, with the maximum eliminated altogether for the HI program in 1994; (2) larger proportions of Federal, State, and local government employees are covered under the HI program; and (3) the earnings of railroad workers are included directly in the HI taxable payroll but are not included in the OASDI taxable payroll. (Railroad worker contributions for the equivalent of OASDI benefits are accounted for in a net interchange that occurs annually between the OASDI and Railroad Retirement programs.) As a result, the HI taxable payroll is 25 percent larger than the OASDI taxable payroll on average over the long-range period.

As with the OASI and DI Trust Funds, income to the HI Trust Fund comes primarily from contributions paid by employees, employers, and self-employed persons. Table VI.G1 shows the OASDI and HI contribution rates that are authorized in the Federal Insurance Contributions Act.

Table VI.G1.—Payroll Tax Contribution Rates for the OASDI and HI Programs
[In percent]

	Employees and employers, combined[a]		Employees only	Self employed[b]		
Calendar years	OASDI up to base[c]	HI all earnings[d]	HI over limit[e]	OASDI up to base[c]	HI all earnings[d]	HI over limit[e]
1966	7.70	0.70	—	5.80	0.35	—
1967	7.80	1.00	—	5.90	.50	—
1968	7.60	1.20	—	5.80	.60	—
1969-70	8.40	1.20	—	6.30	.60	—
1971-72	9.20	1.20	—	6.90	.60	—
1973	9.70	2.00	—	7.00	1.00	—
1974-77	9.90	1.80	—	7.00	.90	—
1978	10.10	2.00	—	7.10	1.00	—
1979-80	10.16	2.10	—	7.05	1.05	—
1981	10.70	2.60	—	8.00	1.30	—
1982-83	10.80	2.60	—	8.05	1.30	—
1984[f]	11.40	2.60	—	11.40	2.60	—
1985[f]	11.40	2.70	—	11.40	2.70	—
1986-87[f]	11.40	2.90	—	11.40	2.90	—
1988-89[f]	12.12	2.90	—	12.12	2.90	—
1990-2010[g]	12.40	2.90	—	12.40	2.90	—
2011-2012[h]	10.40	2.90	—	10.40	2.90	—
2013 and later	12.40	2.90	0.90	12.40	2.90	0.90

[a] Except as noted below, the combined employee/employer rate is divided equally between employees and employers.

[b] Beginning in 1990, self-employed persons receive a deduction, for purposes of computing their net earnings, equal to half of the combined OASDI and HI contributions that would be payable without regard to the contribution and benefit base. The OASDI contribution rate then applies to net earnings after this deduction, but subject to the OASDI base.

[c] The payroll tax on earnings for the OASDI program applies to annual earnings up to a contribution and benefit base indexed to the average wage level. The base is $160,200 for 2023.

[d] Prior to 1994, the payroll tax on earnings for the HI program applied to annual earnings up to a contribution base. The HI contribution base was eliminated beginning in 1994.

[e] Starting with Federal personal income tax returns for tax year 2013, earned income exceeding $200,000 for individual filers and $250,000 for married couples filing jointly is subject to an additional HI tax of 0.9 percent. These income limits are not indexed after 2013.

[f] In 1984 only, employees received an immediate credit of 0.3 percent of taxable wages against their OASDI payroll tax contributions. The self-employed received similar credits of 2.7 percent, 2.3 percent, and 2.0 percent against their combined OASDI and Hospital Insurance (HI) contributions on net earnings from self-employment in 1984, 1985, and 1986-89, respectively. The General Fund of the Treasury reimbursed the trust funds for these credits.

[g] Public Law 111-147 exempted most employers from paying the employer share of OASDI payroll tax on wages paid during the period March 19, 2010 through December 31, 2010 to certain qualified individuals hired after February 3, 2010. The General Fund of the Treasury reimbursed the trust funds for the payroll tax revenue forgone under this law.

[h] Public Law 111-312, Public Law 112-78, and Public Law 112-96 reduced the OASDI payroll tax rate for 2011 and 2012 by 2 percentage points for employees and for self-employed workers. The General Fund of the Treasury reimbursed the trust funds for the payroll tax revenue forgone under these laws.

Table VI.G2 shows the Trustees' estimates of annual income rates and cost rates for the OASDI program and the HI program under the intermediate, low-cost, and high-cost sets of assumptions described earlier in this report. The income rates reflect the payroll tax rates shown in table VI.G1, revenue from taxation of scheduled OASDI benefits for both the OASDI and HI

Trust Funds, and any reimbursements from the General Fund of the Treasury. For the HI program, the income rates also reflect: (1) the additional 0.9-percent tax on employees for relatively high earnings and the portion of total payroll to which the 0.9-percent rate applies, (2) premium revenues, and (3) monies from fraud and abuse control activities. Annual income and cost rates indicate the cash-flow operation of the programs. Therefore, income rates exclude interest earned on trust fund asset reserves. Table VI.G2 also shows annual balances, which are the differences between annual income rates and cost rates.

The Trustees project that the OASDI and HI cost rates will rise generally above current levels under the intermediate and high-cost sets of assumptions. The greatest increase occurs from 2023 to about 2040 under the intermediate and high-cost assumptions for OASDI and the intermediate assumptions for HI, and from 2023 to 2060 under the high-cost assumptions for HI. Under the intermediate assumptions, the OASDI cost rate increases by 22 percent from its current level by 2097, while under the high-cost assumptions, the cost rate increases by 84 percent by 2097. For HI, cost rates increase by 37 percent and 177 percent from 2023 to 2097 under the intermediate and high-cost assumptions, respectively. Under the low-cost assumptions, the OASDI and HI cost rates decrease from 2023 to 2097 by 14 percent and 36 percent, respectively.

The Trustees project annual deficits for every year of the projection period for both the OASDI and HI programs under the high-cost assumptions and for OASDI under the intermediate assumptions. Under the intermediate assumptions, HI annual balances are projected to be positive in 2023 and 2024 and negative and decreasing from 2025 through 2044. Thereafter, HI annual balances slowly increase (become less negative). Under the low-cost assumptions, OASDI annual balances are negative through 2081, and are positive and mostly increasing thereafter, reaching 0.74 percent of payroll for 2097. HI annual balances as a percent of payroll are positive and mostly increasing throughout the projection period under the low-cost assumptions, reaching 2.24 percent of HI taxable payroll by 2097.

Table VI.G2.—OASDI and HI Annual Income Rates, Cost Rates, and Balances, Calendar Years 2023-2100
[As a percentage of taxable payroll[a]]

	OASDI			HI		
Calendar year	Income rate	Cost rate[b]	Balance[b]	Income rate	Cost rate	Balance
Intermediate:						
2023	13.29	14.53	-1.24	3.43	3.40	0.03
2024	12.89	14.87	-1.98	3.44	3.41	.02
2025	12.97	15.04	-2.07	3.45	3.50	-.05
2026	13.08	15.23	-2.15	3.52	3.59	-.07
2027	13.09	15.38	-2.29	3.55	3.70	-.15
2028	13.13	15.55	-2.42	3.57	3.81	-.24
2029	13.16	15.72	-2.56	3.60	3.93	-.33
2030	13.18	15.87	-2.69	3.62	4.02	-.40
2031	13.21	16.00	-2.79	3.65	4.11	-.46
2032	13.24	16.14	-2.91	3.68	4.22	-.54
2035	13.27	16.48	-3.21	3.75	4.50	-.75
2040	13.30	16.78	-3.48	3.83	4.71	-.89
2045	13.31	16.86	-3.55	3.89	4.81	-.92
2050	13.32	16.99	-3.67	3.96	4.83	-.87
2055	13.34	17.23	-3.89	4.03	4.81	-.78
2060	13.37	17.62	-4.24	4.11	4.81	-.70
2065	13.40	17.95	-4.54	4.18	4.85	-.66
2070	13.42	18.23	-4.81	4.26	4.89	-.64
2075	13.44	18.46	-5.02	4.32	4.92	-.60
2080	13.45	18.47	-5.02	4.37	4.90	-.54
2085	13.43	18.23	-4.79	4.40	4.85	-.45
2090	13.41	17.89	-4.48	4.43	4.77	-.35
2095	13.40	17.74	-4.34	4.45	4.69	-.24
2100	13.41	17.83	-4.42	4.49	4.60	-.12
Low-cost:						
2023	13.22	14.34	-1.12	3.42	3.30	.12
2024	12.90	14.27	-1.38	3.42	3.19	.23
2025	12.93	14.15	-1.22	3.43	3.21	.23
2026	13.02	14.11	-1.08	3.50	3.22	.27
2027	13.03	14.05	-1.03	3.52	3.25	.26
2028	13.05	14.02	-.97	3.54	3.28	.25
2029	13.07	14.00	-.93	3.56	3.32	.24
2030	13.09	13.97	-.88	3.58	3.33	.25
2031	13.10	13.93	-.82	3.60	3.33	.27
2032	13.11	13.90	-.78	3.63	3.35	.28
2035	13.13	13.90	-.77	3.69	3.36	.34
2040	13.14	13.80	-.66	3.78	3.18	.60
2045	13.13	13.56	-.43	3.85	2.94	.91
2050	13.13	13.39	-.27	3.92	2.68	1.25
2055	13.13	13.38	-.25	4.00	2.46	1.54
2060	13.15	13.51	-.36	4.08	2.32	1.75
2065	13.16	13.58	-.42	4.14	2.25	1.89
2070	13.16	13.58	-.42	4.20	2.23	1.97
2075	13.16	13.53	-.37	4.25	2.24	2.01
2080	13.14	13.27	-.12	4.28	2.24	2.05
2085	13.12	12.83	.29	4.30	2.21	2.09
2090	13.09	12.41	.68	4.32	2.18	2.14
2095	13.08	12.30	.78	4.35	2.14	2.21
2100	13.09	12.45	.64	4.39	2.01	2.38

Table VI.G2.—OASDI and HI Annual Income Rates, Cost Rates, and Balances, Calendar Years 2023-2100 (Cont.)
[As a percentage of taxable payroll[a]]

	OASDI			HI		
Calendar year	Income rate	Cost rate[b]	Balance[b]	Income rate	Cost rate	Balance
High-cost:						
2023	13.41	14.91	-1.49	3.43	3.55	-0.12
2024	12.82	15.61	-2.79	3.45	3.67	-.22
2025	13.02	16.04	-3.02	3.47	3.83	-.35
2026	13.13	16.30	-3.17	3.55	3.99	-.44
2027	13.15	16.58	-3.42	3.58	4.18	-.60
2028	13.20	16.94	-3.74	3.61	4.39	-.78
2029	13.24	17.31	-4.07	3.64	4.61	-.97
2030	13.28	17.69	-4.41	3.67	4.80	-1.13
2031	13.32	18.05	-4.73	3.71	5.00	-1.29
2032	13.36	18.43	-5.07	3.75	5.22	-1.48
2035	13.41	19.24	-5.83	3.82	5.88	-2.06
2040	13.48	20.24	-6.76	3.91	6.75	-2.84
2045	13.52	21.00	-7.48	3.98	7.58	-3.60
2050	13.58	21.81	-8.23	4.06	8.40	-4.34
2055	13.63	22.69	-9.06	4.14	9.06	-4.92
2060	13.70	23.68	-9.98	4.23	9.62	-5.39
2065	13.77	24.60	-10.83	4.31	10.06	-5.74
2070	13.83	25.52	-11.69	4.40	10.33	-5.93
2075	13.89	26.43	-12.53	4.48	10.39	-5.92
2080	13.94	27.12	-13.18	4.55	10.36	-5.81
2085	13.97	27.51	-13.53	4.61	10.24	-5.63
2090	13.98	27.56	-13.58	4.65	10.08	-5.43
2095	13.98	27.50	-13.52	4.68	9.92	-5.23
2100	13.98	27.51	-13.53	4.72	10.22	-5.50

[a] The taxable payroll for HI is significantly larger than the taxable payroll for OASDI because the HI taxable maximum amount was eliminated beginning in 1994, and because HI covers all Federal civilian employees, all State and local government employees hired after April 1, 1986, and railroad employees.
[b] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Notes:
1. The income rate excludes interest income.

2. The Trustees show income and cost estimates generally on a cash basis for the OASDI program and on an incurred basis for the HI program.

3. Components may not sum to totals because of rounding.

Table VI.G3 shows summarized values over the 25-year, 50-year, and 75-year valuation periods. For each of those periods, the summarized income rates include beginning trust fund asset reserves, and the summarized cost rates include the cost of accumulating an ending fund reserve equal to 100 percent of annual cost at the end of the period.

Table VI.G3.—Summarized OASDI and HI Income Rates and Cost Rates for Valuation Periods,[a] Calendar Years 2023-2097
[As a percentage of taxable payroll[b]]

Valuation period	OASDI			HI		
	Income rate	Cost rate[c]	Actuarial balance	Income rate	Cost rate	Actuarial balance
Intermediate:						
25-year:						
2023-47	14.34	16.85	-2.50	3.77	4.48	-0.70
50-year:						
2023-72	13.90	17.14	-3.24	3.92	4.63	-.70
75-year:						
2023-97	13.78	17.38	-3.61	4.05	4.67	-.62
Low-cost:						
25-year:						
2023-47	14.10	14.42	-.31	3.73	3.32	.42
50-year:						
2023-72	13.65	13.94	-.29	3.89	2.86	1.04
75-year:						
2023-97	13.49	13.59	-.10	4.02	2.65	1.37
High-cost:						
25-year:						
2023-47	14.60	19.49	-4.89	3.84	5.98	-2.15
50-year:						
2023-72	14.22	21.18	-6.97	4.00	7.46	-3.46
75-year:						
2023-97	14.16	22.52	-8.37	4.14	8.08	-3.94

[a] Income rates include beginning trust fund asset reserves and cost rates include the cost of reaching an ending target trust fund equal to 100 percent of annual cost at the end of the period.
[b] The taxable payroll for HI is significantly larger than the taxable payroll for OASDI because the HI taxable maximum amount was eliminated beginning 1994, and because HI covers all Federal civilian employees, all State and local government employees hired after April 1, 1986, and railroad employees.
[c] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

The Trustees project that the OASDI and HI programs will each experience large actuarial deficits for the 25-year, 50-year, and 75-year valuation periods under the high-cost assumptions. Actuarial deficits under the intermediate assumptions are smaller than those for the high-cost assumptions for all three valuation periods. Under the low-cost assumptions, the OASDI program has relatively small actuarial deficits for all three valuation periods, while the HI program has positive actuarial balances for all three valuation periods.

2. Estimates as a Percentage of Gross Domestic Product

This section presents long-range projections of the operations of the combined Old-Age and Survivors Insurance and Disability Insurance (OASI and DI) Trust Funds and of the Hospital Insurance (HI) Trust Fund, expressed as a percentage of gross domestic product (GDP). While expressing fund operations as a percentage of taxable payroll is a very useful approach for assessing the financial status of the programs (see section IV.B.1), expressing them as a percentage of the total value of goods and services produced in the United States provides an additional perspective.

Table VI.G4 shows non-interest income, total cost, and the resulting balance of the combined OASI and DI Trust Funds, of the HI Trust Fund, and of the combined OASI, DI, and HI Trust Funds, expressed as percentages of GDP on the basis of each of the three alternative sets of assumptions. Table VI.G4 also contains estimates of GDP. For OASDI, non-interest income consists of payroll tax contributions, proceeds from taxation of scheduled OASDI benefits, and any reimbursements from the General Fund of the Treasury. Cost consists of scheduled benefits, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. For HI, non-interest income consists of payroll tax contributions (including contributions from railroad employment), up to an additional 0.9 percent tax on earned income for relatively high earners, proceeds from taxation of scheduled OASDI benefits, premium revenues, monies from fraud and abuse control activities, and any reimbursements from the General Fund of the Treasury. Cost consists of outlays (benefits and administrative expenses) for beneficiaries. The Trustees show income and cost estimates generally on a cash basis for the OASDI program[1] and on an incurred basis for the HI program.

The Trustees project the OASDI annual balance (non-interest income less cost) as a percentage of GDP to be negative throughout the projection period under the intermediate and high-cost assumptions. Under the low-cost assumptions, the OASDI annual deficit as a percentage of GDP increases from 2023 to 2024, and then generally decreases through 2053. After 2053, the annual deficits slightly increase through 2067 and then decrease through 2081 before becoming positive for 2082 and later. Under the intermediate assumptions, the OASDI annual deficits as a percentage of GDP increase

[1] OASDI benefits paid for entitlement for a particular month are generally paid in the succeeding month. There are two primary exceptions to this general rule. First, payments can occur with a greater delay when a benefit award is made after the month of initial benefit entitlement. At the time of benefit award, benefits owed for months of prior entitlement are then also paid to the beneficiary. For the projections in this report, such retroactive payments are included in the period where they are paid (at time of award). Second, when benefit payments scheduled for January 3 are paid on the prior December 31, because January 3 falls on a Sunday, such payments are shown in this report for the period they were scheduled to be paid.

from 2023 through 2077, and generally decrease thereafter. Under the high-cost assumptions, annual deficits increase relatively rapidly through 2086, and then slightly decrease through the end of the projection period.

The Trustees project that the HI annual balance as a percentage of GDP will be positive and mostly increasing throughout the projection period, under the low-cost assumptions. Under the intermediate assumptions, the HI annual balance is positive in 2023 and 2024 and negative in 2025. After 2025, annual deficits increase through 2044, and then decline thereafter. Under the high-cost assumptions, the HI annual balance is negative for all years, with annual deficits reaching a peak in 2070 and declining thereafter.

The combined OASDI and HI annual balance as a percentage of GDP is negative throughout the projection period under both the intermediate and high-cost assumptions. Under the low-cost assumptions, the combined OASDI and HI annual balance is negative through 2039, and then positive and mostly rising thereafter. Under the intermediate assumptions, the combined OASDI and HI annual deficits generally increase through 2076 and then decline thereafter, reaching 1.55 percent of GDP by 2097. Under the high-cost assumptions, combined annual deficits rise to a peak of 6.63 percent in 2081 and decrease thereafter.

By 2097, the combined OASDI and HI annual balances as percentages of GDP range from a positive annual balance of 1.28 percent for the low-cost assumptions to an annual deficit of 6.24 percent for the high-cost assumptions. Annual balances differ by a much smaller amount for the tenth projection year, 2032, ranging from an annual deficit of 0.16 percent for the low-cost assumptions to an annual deficit of 2.48 percent for the high-cost assumptions.

The summarized long-range (75-year) actuarial balance as a percentage of GDP for the combined OASDI and HI programs varies among the three alternatives by a relatively large amount, from a positive actuarial balance of 0.58 percent under the low-cost assumptions to an actuarial deficit of 4.54 percent under the high-cost assumptions. The 25-year summarized actuarial balance varies by a smaller amount, from a positive actuarial balance of 0.07 percent of GDP to an actuarial deficit of 2.70 percent. Summarized rates are calculated on a present-value basis. They include the trust fund reserve balances on January 1, 2023 and the cost of reaching a target trust fund level equal to 100 percent of the following year's annual cost at the end of the period. (See section IV.B.4 for further explanation.)

Table VI.G4.—OASDI and HI Annual and Summarized Income, Cost, and Balance as a Percentage of GDP, Calendar Years 2023-2100

	Percentage of GDP									GDP in dollars
	OASDI			HI			Combined			
Calendar year	Income[a]	Cost[b]	Balance[b]	Income[a]	Cost	Balance	Income[a]	Cost[b]	Balance[b]	(billions)
Intermediate:										
2023	4.77	5.22	-0.45	1.53	1.52	0.01	6.30	6.74	-0.44	$26,592
2024	4.65	5.37	-.72	1.54	1.53	.01	6.19	6.90	-.71	27,655
2025	4.70	5.45	-.75	1.55	1.58	-.02	6.25	7.02	-.77	28,902
2026	4.74	5.52	-.78	1.59	1.62	-.03	6.34	7.15	-.81	30,177
2027	4.76	5.59	-.83	1.61	1.68	-.07	6.37	7.27	-.90	31,478
2028	4.78	5.66	-.88	1.62	1.73	-.11	6.40	7.39	-.99	32,778
2029	4.80	5.73	-.93	1.64	1.79	-.15	6.43	7.52	-1.08	34,125
2030	4.81	5.79	-.98	1.65	1.83	-.18	6.46	7.62	-1.16	35,521
2031	4.82	5.84	-1.02	1.67	1.88	-.21	6.49	7.72	-1.23	36,976
2032	4.82	5.88	-1.06	1.68	1.93	-.25	6.50	7.81	-1.31	38,487
2035	4.81	5.97	-1.16	1.70	2.04	-.34	6.51	8.01	-1.50	43,392
2040	4.78	6.03	-1.25	1.72	2.12	-.40	6.50	8.15	-1.65	52,850
2045	4.74	6.01	-1.27	1.74	2.15	-.41	6.48	8.15	-1.68	64,333
2050	4.71	6.01	-1.30	1.75	2.14	-.39	6.46	8.14	-1.68	78,438
2055	4.68	6.05	-1.37	1.77	2.11	-.34	6.46	8.16	-1.71	95,785
2060	4.66	6.14	-1.48	1.80	2.10	-.31	6.46	8.25	-1.79	116,988
2065	4.64	6.22	-1.58	1.82	2.10	-.29	6.46	8.32	-1.86	142,731
2070	4.63	6.28	-1.66	1.84	2.11	-.28	6.47	8.40	-1.93	173,850
2075	4.61	6.33	-1.72	1.86	2.12	-.26	6.47	8.45	-1.98	211,710
2080	4.59	6.30	-1.71	1.87	2.10	-.23	6.46	8.40	-1.94	258,358
2085	4.57	6.20	-1.63	1.88	2.07	-.19	6.44	8.26	-1.82	316,227
2090	4.54	6.06	-1.52	1.88	2.03	-.15	6.42	8.09	-1.66	387,813
2095	4.52	5.99	-1.46	1.88	1.99	-.10	6.41	7.97	-1.57	475,384
2100	4.51	5.99	-1.48	1.89	1.94	-.05	6.40	7.93	-1.53	581,611
Summarized rates: [c]										
25-year:										
2023-47 . .	5.18	6.08	-.90	1.70	2.02	-.32	6.88	8.10	-1.22	
50-year:										
2023-72 . .	4.94	6.09	-1.15	1.75	2.06	-.31	6.69	8.15	-1.46	
75-year:										
2023-97 . .	4.84	6.10	-1.27	1.78	2.05	-.27	6.62	8.16	-1.54	
Low-cost:										
2023	4.72	5.13	-.40	1.52	1.47	.05	6.24	6.59	-.35	27,042
2024	4.63	5.13	-.49	1.53	1.43	.10	6.16	6.56	-.39	28,782
2025	4.67	5.11	-.44	1.54	1.44	.10	6.21	6.55	-.34	30,730
2026	4.73	5.12	-.39	1.58	1.46	.12	6.31	6.58	-.27	32,533
2027	4.76	5.14	-.38	1.59	1.47	.12	6.35	6.61	-.26	34,356
2028	4.79	5.15	-.36	1.61	1.49	.11	6.40	6.64	-.24	36,241
2029	4.82	5.16	-.34	1.62	1.51	.11	6.44	6.67	-.23	38,217
2030	4.84	5.17	-.33	1.63	1.52	.12	6.48	6.69	-.21	40,290
2031	4.86	5.17	-.31	1.65	1.52	.12	6.51	6.69	-.18	42,475
2032	4.88	5.17	-.29	1.66	1.53	.13	6.54	6.70	-.16	44,755
2035	4.87	5.15	-.29	1.68	1.53	.15	6.55	6.68	-.13	52,381
2040	4.84	5.09	-.24	1.71	1.44	.27	6.55	6.53	.03	67,898
2045	4.81	4.97	-.16	1.74	1.32	.41	6.55	6.29	.26	88,210
2050	4.79	4.89	-.10	1.76	1.20	.56	6.56	6.09	.46	115,112
2055	4.78	4.87	-.09	1.79	1.10	.69	6.57	5.97	.60	150,549
2060	4.78	4.91	-.13	1.82	1.04	.78	6.60	5.95	.65	196,798
2065	4.78	4.93	-.15	1.85	1.00	.84	6.62	5.93	.69	256,786
2070	4.78	4.93	-.15	1.87	1.00	.88	6.65	5.93	.72	334,496
2075	4.78	4.91	-.13	1.90	1.00	.89	6.67	5.91	.76	436,091
2080	4.78	4.82	-.05	1.91	1.00	.91	6.69	5.82	.87	570,560

Table VI.G4.—OASDI and HI Annual and Summarized Income, Cost, and Balance as a Percentage of GDP, Calendar Years 2023-2100 (Cont.)

	Percentage of GDP									GDP in dollars
	OASDI			HI			Combined			
Calendar year	Income[a]	Cost[b]	Balance[b]	Income[a]	Cost	Balance	Income[a]	Cost[b]	Balance[b]	(billions)
Low-cost (Cont.):										
2085	4.78	4.67	0.10	1.93	0.99	0.94	6.70	5.66	1.04	$749,476
2090	4.78	4.53	.25	1.94	.98	.96	6.71	5.51	1.21	985,569
2095	4.78	4.50	.28	1.95	.96	.99	6.74	5.46	1.28	1,292,776
2100	4.80	4.56	.23	1.98	.91	1.07	6.77	5.47	1.31	1,690,135
Summarized rates: [c]										
25-year:										
2023-47 . .	5.19	5.30	-.12	1.69	1.50	.19	6.88	6.80	.07	
50-year:										
2023-72 . .	4.99	5.10	-.11	1.75	1.29	.47	6.75	6.39	.36	
75-year:										
2023-97 . .	4.93	4.97	-.04	1.81	1.19	.61	6.74	6.16	.58	
High-cost:										
2023	4.83	5.37	-.54	1.53	1.58	-.05	6.36	6.95	-.59	25,892
2024	4.61	5.62	-1.01	1.54	1.64	-.10	6.15	7.26	-1.10	26,696
2025	4.68	5.77	-1.09	1.56	1.72	-.16	6.24	7.48	-1.24	27,746
2026	4.73	5.87	-1.14	1.60	1.80	-.20	6.33	7.67	-1.34	28,771
2027	4.74	5.97	-1.23	1.62	1.89	-.27	6.36	7.87	-1.51	29,762
2028	4.76	6.11	-1.35	1.64	1.99	-.35	6.40	8.10	-1.70	30,614
2029	4.77	6.24	-1.47	1.66	2.10	-.44	6.43	8.33	-1.91	31,452
2030	4.78	6.36	-1.59	1.67	2.19	-.51	6.45	8.55	-2.10	32,320
2031	4.78	6.47	-1.70	1.69	2.28	-.59	6.47	8.75	-2.29	33,222
2032	4.77	6.58	-1.81	1.71	2.38	-.67	6.48	8.96	-2.48	34,138
2035	4.76	6.82	-2.07	1.73	2.66	-.93	6.48	9.48	-3.00	37,070
2040	4.73	7.10	-2.37	1.75	3.02	-1.27	6.47	10.12	-3.64	42,423
2045	4.69	7.28	-2.59	1.76	3.36	-1.59	6.45	10.64	-4.19	48,300
2050	4.66	7.48	-2.82	1.78	3.68	-1.90	6.43	11.15	-4.72	54,825
2055	4.62	7.69	-3.07	1.79	3.92	-2.13	6.41	11.62	-5.20	62,192
2060	4.60	7.94	-3.35	1.81	4.12	-2.31	6.41	12.06	-5.65	70,544
2065	4.57	8.16	-3.59	1.83	4.26	-2.44	6.40	12.43	-6.03	79,912
2070	4.54	8.38	-3.84	1.84	4.33	-2.49	6.38	12.71	-6.33	90,302
2075	4.51	8.59	-4.07	1.86	4.32	-2.46	6.37	12.90	-6.53	101,834
2080	4.48	8.72	-4.24	1.87	4.26	-2.39	6.35	12.98	-6.63	114,766
2085	4.45	8.75	-4.31	1.88	4.17	-2.29	6.32	12.92	-6.60	129,504
2090	4.40	8.68	-4.28	1.88	4.07	-2.19	6.28	12.75	-6.47	146,448
2095	4.36	8.58	-4.22	1.87	3.96	-2.09	6.23	12.54	-6.31	165,801
2100	4.32	8.50	-4.18	1.87	4.04	-2.18	6.19	12.54	-6.36	187,740
Summarized rates: [c]										
25-year:										
2023-47 . .	5.18	6.91	-1.74	1.73	2.69	-.97	6.90	9.60	-2.70	
50-year:										
2023-72 . .	4.92	7.33	-2.41	1.76	3.28	-1.52	6.68	10.62	-3.93	
75-year:										
2023-97 . .	4.80	7.64	-2.84	1.79	3.49	-1.70	6.59	11.14	-4.54	

[a] Income for individual years excludes interest on the trust funds. Interest is implicit in all summarized values.

[b] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[c] Summarized rates are calculated on a present-value basis. They include the value of the trust funds on January 1, 2023 and the cost of reaching a target trust fund level equal to 100 percent of annual cost at the end of the period.

Notes:
1. The Trustees show income and cost estimates generally on a cash basis for the OASDI program and on an incurred basis for the HI program.

2. Components may not sum to totals because of rounding.

Table VI.G5 displays annual ratios of OASDI taxable payroll to GDP. These ratios facilitate comparisons of trust fund operations expressed as percentages of taxable payroll and those expressed as percentages of GDP. HI taxable payroll is 25 percent larger than the OASDI taxable payroll on average over the long-range period; see section 1 of this appendix for a detailed description of the difference. For each year, the cost as a percentage of GDP is equal to the cost as a percentage of taxable payroll multiplied by the ratio of taxable payroll to GDP.

Table VI.G5.—Ratio of OASDI Taxable Payroll to GDP, Calendar Years 2023-2100

Calendar year	Intermediate	Low-cost	High-cost
2023	0.359	0.357	0.360
2024	.361	.359	.360
2025	.362	.361	.359
2026	.363	.363	.360
2027	.364	.365	.360
2028	.364	.367	.361
2029	.364	.369	.360
2030	.365	.370	.360
2031	.365	.371	.359
2032	.364	.372	.357
2035	.363	.371	.355
2040	.359	.369	.351
2045	.356	.367	.347
2050	.354	.365	.343
2055	.351	.364	.339
2060	.349	.363	.335
2065	.347	.363	.332
2070	.345	.363	.328
2075	.343	.363	.325
2080	.341	.363	.321
2085	.340	.364	.318
2090	.339	.365	.315
2095	.337	.366	.312
2100	.336	.366	.309

Projections of GDP reflect projected increases in U.S. employment, labor productivity, average hours worked, and the GDP price index (GDP deflator). Projections of taxable payroll reflect the components of growth in GDP along with assumed changes in the ratio of total labor compensation to GDP, the ratio of earnings to total labor compensation, the ratio of OASDI covered earnings to total earnings, and the ratio of taxable to total covered earnings.

Over the long-range period, the ratio of OASDI taxable payroll to GDP is projected to decline mostly due to a projected decline in the ratio of wages and salaries to employee compensation. Over the last six complete economic cycles, the ratio of wages and salaries to employee compensation declined at an average annual rate of 0.17 percent. Over the 65-year period ending in 2097, the ratio of wages and salaries to employee compensation is projected to remain the same for the low-cost assumptions and decline at an average annual rate of 0.10, and 0.20 percent for the intermediate and high-cost assumptions, respectively.

3. Estimates in Dollars

This section presents long-range projections, in dollars, of the operations of the combined OASI and DI Trust Funds and in some cases the HI Trust Fund. Comparing current dollar values over long periods of time is difficult because of the effect of inflation. In order to compare dollar values in a meaningful way, table VI.G6 provides several economic series or indices which can be used to adjust current dollars for changes in prices, wages, or other aspects of economic growth during the projection period. Any series of values can be adjusted by dividing the value for each year by the corresponding index value for the year.

One of the most common forms of standardization is price indexing, which uses some measure of change in the prices of consumer goods. The Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W, hereafter referred to as CPI), published by the Bureau of Labor Statistics, Department of Labor, is one such price index. Consistent with the law, the Social Security Administration (SSA) uses this index to determine the annual cost-of-living increases for OASDI monthly benefits. The ultimate annual rate of increase in the CPI is assumed to be 3.0, 2.4, and 1.8 percent for the low-cost, intermediate, and high-cost sets of assumptions, respectively. Table VI.G7 provides CPI-indexed dollar values (those adjusted using the CPI in table VI.G6), which indicate the relative purchasing power of the values over time.

Wage indexing is another type of standardization. It combines the effects of price inflation and real wage growth. The wage index presented here is the national average wage index, as defined in section 209(k)(1) of the Social Security Act. SSA uses this index to annually adjust the contribution and benefit base and other earnings-related program amounts. The average wage is assumed to grow by an average rate of 4.8, 3.6, and 2.4 percent under the low-cost, intermediate, and high-cost assumptions, respectively, between 2032 and 2097. Wage-indexed values indicate the level of a series of values relative to the changing standard of living of workers over time.

The taxable payroll series is used as an index to adjust for the effects of changes in the number of workers and changes in the proportion of earnings that are taxable, as well as for the effects of price inflation and real wage growth. The OASDI taxable payroll consists of all earnings subject to OASDI taxation, with an adjustment for the lower effective tax rate on multiple-employer excess wages. A series of values, divided by the taxable payroll, indicates the percentage of payroll that each value represents, and thus

the extent to which the series of values increases or decreases as a percent of payroll over time.

The GDP series is used as an index to adjust for the growth in the aggregate amount of goods and services produced in the United States. Values adjusted by GDP (see section 2 of this appendix) indicate their relative share of the total output of the economy. No direct assumption is made about growth in taxable payroll or GDP. These series reflect the basic demographic and economic assumptions, as discussed in sections V.A and V.B, respectively.

Discounting at the rate of interest is another way of standardizing current dollars. The compound new-issue interest factor shown in table VI.G6 increases each year by the assumed effective annual nominal yield for special public-debt obligations issuable to the trust funds in the 12 months of the prior year. The compound effective trust-fund interest factor shown in table VI.G6 uses the effective annual yield on all currently-held securities in the combined OASI and DI Trust Funds. The reciprocal of the compound effective trust-fund interest factor approximates the cumulative discount factor used to convert nominal dollar values to present values as of the start of the valuation period in order to create summarized values for this report.

Table VI.G6.—Selected Economic Variables, Calendar Years 2022-2100
[GDP and taxable payroll in billions]

Calendar year	Adjusted CPI[a]	Average wage index	Taxable payroll[b]	Gross domestic product	Compound new-issue interest factor[c]	Compound effective trust-fund interest factor[d]
Intermediate:						
2022	96.15	$63,467.98	$9,069	$25,422	0.9711	0.9884
2023	100.00	66,147.17	9,552	26,592	1.0000	1.0117
2024	102.53	68,627.58	9,986	27,655	1.0357	1.0356
2025	104.99	71,411.99	10,465	28,902	1.0727	1.0602
2026	107.51	74,348.48	10,944	30,177	1.1112	1.0862
2027	110.09	77,393.67	11,443	31,478	1.1530	1.1140
2028	112.73	80,510.73	11,934	32,778	1.1985	1.1442
2029	115.44	83,757.03	12,438	34,125	1.2492	1.1768
2030	118.21	87,106.49	12,954	35,521	1.3051	1.2123
2031	121.04	90,574.48	13,492	36,976	1.3656	1.2512
2032	123.95	93,995.33	14,023	38,487	1.4295	1.2946
2035	133.09	104,726.27	15,730	43,392	1.6429	1.4693
2040	149.85	125,312.66	18,992	52,850	2.0725	1.8502
2045	168.71	149,423.47	22,925	64,333	2.6144	2.3337
2050	189.95	177,750.26	27,736	78,438	3.2980	2.9438
2055	213.87	211,432.09	33,623	95,785	4.1603	3.7136
2060	240.79	251,610.19	40,795	116,988	5.2481	4.6846
2065	271.11	299,758.28	49,472	142,731	6.6204	5.9095
2070	305.24	357,187.25	59,924	173,850	8.3514	7.4546
2075	343.67	425,523.96	72,602	211,710	10.5351	9.4038
2080	386.94	506,962.67	88,194	258,358	13.2897	11.8627
2085	435.65	603,863.51	107,502	316,227	16.7646	14.9644
2090	490.50	719,124.11	131,330	387,813	21.1481	18.8772
2095	552.26	856,091.73	160,374	475,384	26.6778	23.8131
2100	621.79	1,019,162.94	195,457	581,611	33.6533	30.0396
Low-cost:						
2022	96.24	63,432.25	9,065	25,463	.9711	.9884
2023	100.00	66,442.68	9,665	27,042	1.0000	1.0120
2024	103.02	70,258.88	10,343	28,782	1.0425	1.0369
2025	106.12	74,575.71	11,089	30,730	1.0886	1.0639
2026	109.30	78,782.82	11,816	32,533	1.1411	1.0937
2027	112.58	83,005.63	12,555	34,356	1.2005	1.1276
2028	115.96	87,405.28	13,307	36,241	1.2672	1.1661
2029	119.43	92,010.68	14,090	38,217	1.3379	1.2096
2030	123.02	96,841.91	14,910	40,290	1.4125	1.2586
2031	126.71	101,915.61	15,771	42,475	1.4915	1.3140
2032	130.51	107,046.81	16,650	44,755	1.5776	1.3764
2035	142.61	123,656.58	19,420	52,381	1.8728	1.6083
2040	165.32	157,054.51	25,023	67,898	2.4925	2.1267
2045	191.66	198,412.60	32,341	88,210	3.3174	2.8275
2050	222.18	250,115.49	42,038	115,112	4.4152	3.7630
2055	257.57	315,518.44	54,815	150,549	5.8762	5.0083
2060	298.59	398,402.81	71,511	196,798	7.8208	6.6656
2065	346.15	503,681.03	93,206	256,786	10.4088	8.8714
2070	401.29	636,729.90	121,376	334,496	13.8533	11.8071
2075	465.20	804,422.07	158,315	436,091	18.4376	15.7143
2080	539.29	1,016,051.44	207,395	570,560	24.5389	20.9144
2085	625.19	1,283,116.99	272,944	749,476	32.6594	27.8354
2090	724.77	1,619,988.11	359,689	985,569	43.4670	37.0466
2095	840.20	2,044,788.30	472,758	1,292,776	57.8510	49.3061
2100	974.03	2,581,302.68	619,206	1,690,135	76.9950	65.6224

Table VI.G6.—Selected Economic Variables, Calendar Years 2022-2100 (Cont.)
[GDP and taxable payroll in billions]

Calendar year	Adjusted CPI[a]	Average wage index	Taxable payroll[b]	Gross domestic product	Compound new-issue interest factor[c]	Compound effective trust-fund interest factor[d]
High-cost:						
2022	95.64	$63,460.05	$9,067	$25,417	0.9711	0.9884
2023	100.00	64,726.55	9,322	25,892	1.0000	1.0117
2024	102.92	67,055.34	9,613	26,696	1.0347	1.0352
2025	104.83	69,534.32	9,974	27,746	1.0650	1.0589
2026	106.72	71,952.76	10,360	28,771	1.0951	1.0831
2027	108.64	74,431.84	10,727	29,762	1.1282	1.1083
2028	110.60	76,626.52	11,038	30,614	1.1641	1.1346
2029	112.59	78,738.96	11,334	31,452	1.2018	1.1619
2030	114.61	80,892.11	11,623	32,320	1.2413	1.1911
2031	116.68	83,098.17	11,914	33,222	1.2835	1.2216
2032	118.78	85,191.64	12,189	34,138	1.3290	1.2601
2035	125.31	91,526.06	13,149	37,070	1.4792	1.4026
2040	137.00	103,154.86	14,877	42,423	1.7680	1.6765
2045	149.78	116,129.77	16,748	48,300	2.1134	2.0039
2050	163.75	130,383.43	18,799	54,825	2.5261	2.3952
2055	179.03	146,212.61	21,086	62,192	3.0194	2.8630
2060	195.74	163,914.93	23,657	70,544	3.6092	3.4222
2065	214.00	183,892.10	26,514	79,912	4.3140	4.0906
2070	233.96	206,377.12	29,646	90,302	5.1566	4.8895
2075	255.79	231,654.52	33,081	101,834	6.1637	5.8444
2080	279.66	260,139.82	36,896	114,766	7.3674	6.9858
2085	305.75	292,107.05	41,212	129,504	8.8063	8.3501
2090	334.28	328,026.09	46,140	146,448	10.5262	9.9810
2095	365.46	368,262.47	51,724	165,801	12.5820	11.9303
2100	399.56	413,333.48	57,994	187,740	15.0393	14.2603

[a] CPI-W indexed to calendar year 2023.
[b] Total earnings subject to OASDI contribution rates, adjusted to reflect the lower effective contribution rates (compared to the combined employee-employer rate) that apply to multiple-employer "excess wages."
[c] For each alternative, incorporates the average of the assumed annual yield for special public-debt obligations issuable to the trust funds in the 12 months of the prior year.
[d] For each alternative, incorporates the annual effective yield for all outstanding special public-debt obligations held by the trust fund, with a half-year's interest effect in each row. The effective yield for a period equals total interest earned during the period divided by the total exposure to interest on asset reserves and all income and cost items during the period. The reciprocals of the factors approximate the discounting/accumulation factors that are used to calculate summarized rates and balances in this report.

Table VI.G7 shows the operations of the combined OASI and DI Trust Funds in CPI-indexed 2023 dollars—that is, adjusted by the CPI indexing series as discussed above. The following items are presented in the table: (1) non-interest income, (2) interest income, (3) total income, (4) cost, and (5) asset reserves at the end of the year. Non-interest income consists of payroll tax contributions, income from taxation of scheduled OASDI benefits, and any reimbursements from the General Fund of the Treasury. Cost consists of scheduled benefits, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. Table VI.G7 shows trust fund operations under the intermediate, low-cost, and high-cost sets of assumptions.

Table VI.G7.—Operations of the Combined OASI and DI Trust Funds, in CPI-Indexed 2023 Dollars,[a] Calendar Years 2023-2100
[In billions]

Calendar year	Non-interest income	Interest income	Total income	Cost[b]	Asset reserves at end of year[b]
Intermediate:					
2023	$1,269.0	$65.7	$1,334.7	$1,387.9	$2,776.7
2024	1,255.0	62.4	1,317.4	1,448.0	2,577.6
2025	1,293.2	58.6	1,351.8	1,499.5	2,369.5
2026	1,331.5	55.8	1,387.3	1,550.7	2,150.6
2027	1,361.1	53.0	1,414.2	1,598.9	1,915.4
2028	1,390.1	49.3	1,439.4	1,646.7	1,663.3
2029	1,418.1	44.5	1,462.6	1,693.7	1,393.2
2030	1,444.9	38.8	1,483.7	1,739.3	1,105.0
2031	1,472.7	31.9	1,504.6	1,783.8	800.0
2032[c]	1,497.7	23.7	1,521.3	1,826.6	476.0
Low-cost:					
2023	1,277.3	67.4	1,344.8	1,386.0	2,788.7
2024	1,294.7	67.1	1,361.8	1,432.8	2,635.9
2025	1,351.5	67.6	1,419.1	1,479.1	2,499.0
2026	1,407.8	70.4	1,478.3	1,524.9	2,379.6
2027	1,452.7	74.4	1,527.2	1,567.4	2,270.1
2028	1,497.9	78.1	1,575.9	1,609.4	2,170.4
2029	1,542.2	81.3	1,623.5	1,651.5	2,079.2
2030	1,585.9	84.6	1,670.5	1,692.7	1,996.5
2031	1,630.8	88.3	1,719.1	1,733.3	1,924.1
2032	1,673.1	91.5	1,764.6	1,773.1	1,859.5
2035	1,788.0	93.5	1,881.5	1,893.3	1,673.8
2040	1,988.7	80.7	2,069.4	2,088.9	1,362.2
2045	2,215.9	67.0	2,282.9	2,288.0	1,118.0
2050	2,483.7	59.8	2,543.6	2,533.9	987.0
2055	2,794.7	55.1	2,849.8	2,847.0	893.2
2060	3,148.5	43.8	3,192.3	3,235.4	661.5
2065	3,542.4	20.6	3,562.9	3,656.1	220.0
2070	[d]	[d]	[d]	[d]	[d]
2075	[d]	[d]	[d]	[d]	[d]
2080	[d]	[d]	[d]	[d]	[d]
2085	[d]	[d]	[d]	[d]	[d]
2090	[d]	[d]	[d]	[d]	[d]
2095	7,361.7	93.8	7,455.5	6,923.4	1,719.1
2100	8,324.1	243.3	8,567.4	7,917.5	4,367.9
High-cost:					
2023	1,250.6	65.4	1,316.0	1,390.0	2,755.9
2024	1,197.1	59.3	1,256.3	1,458.1	2,476.0
2025	1,238.4	52.5	1,290.9	1,525.9	2,195.8
2026	1,274.7	46.7	1,321.4	1,582.3	1,896.1
2027	1,298.7	40.7	1,339.5	1,636.6	1,565.4
2028	1,317.4	33.0	1,350.5	1,690.4	1,197.9
2029	1,333.1	24.5	1,357.6	1,742.7	791.6
2030[c]	1,346.7	15.3	1,362.0	1,793.7	346.0

[a] CPI-indexed 2023 dollars equal current dollars adjusted by the CPI indexing series in table VI.G6.
[b] Benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.
[c] The combined OASI and DI Trust Funds become depleted in 2034 under the intermediate assumptions and in 2031 under the high-cost assumptions, so estimates for later years are not shown.
[d] The combined OASI and DI Trust Funds become depleted in 2067 under the low-cost assumptions, but combined asset reserves become positive again by the beginning of 2093 and remain positive through the remainder of the projection period. Estimates are not shown for years in which asset reserves are negative.

Note: Components may not sum to totals because of rounding.

Figure VI.G1 compares annual cost with annual total income and annual non-interest income. The figure shows only the OASDI program under intermediate assumptions, and presents values in CPI-indexed 2023 dollars, consistent with table VI.G7. The difference between the income values for each year is equal to the trust fund interest earnings. The figure illustrates that, under intermediate assumptions, annual cost exceeds both total income and non-interest income for 2023 through 2034, when trust fund reserves become depleted. Estimates after reserve depletion are not shown. For 2023 through 2033 (the year preceding the year of trust fund reserve depletion), annual cost is covered by drawing down combined trust fund reserves. Note that income for 2023 is relatively high because of an estimated large positive adjustment to payroll tax contributions to be made in June 2023.

Figure VI.G1.—Estimated OASDI Income and Cost in CPI-Indexed 2023 Dollars, Based on Intermediate Assumptions
[In billions]

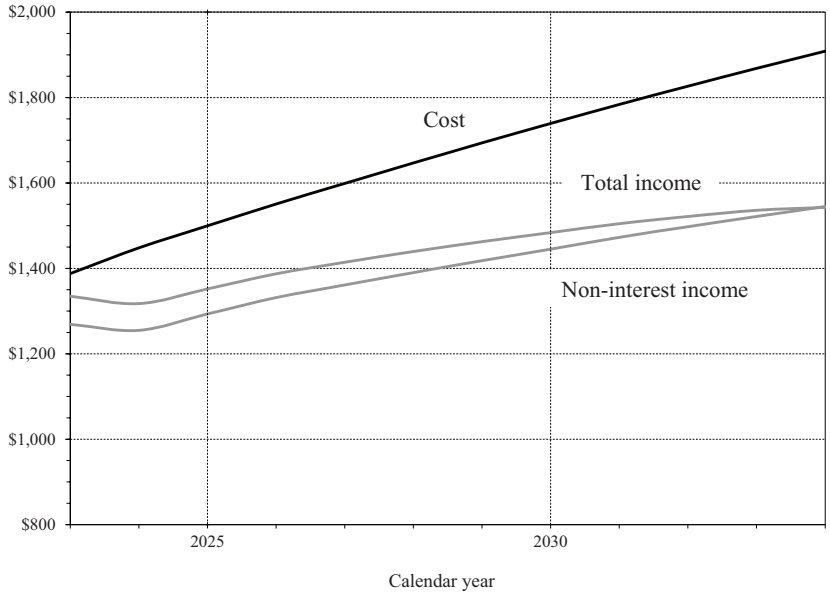


Table VI.G8 presents the operations of the combined OASI and DI Trust Funds in current, or nominal, dollars—that is, in dollars unadjusted for inflation. The following items are presented in the table: (1) non-interest income, (2) interest income, (3) total income, (4) cost, and (5) asset reserves at the end of the year. These estimates are presented using the intermediate, low-cost, and high-cost sets of demographic and economic assumptions to facilitate independent analysis.

Table VI.G8.—Operations of the Combined OASI and DI Trust Funds, in Current Dollars, Calendar Years 2023-2100
[In billions]

Calendar year	Non-interest income	Interest income	Total income	Cost[a]	Asset reserves at end of year[a]
Intermediate:					
2023	$1,269.0	$65.7	$1,334.7	$1,387.9	$2,776.7
2024	1,286.7	64.0	1,350.7	1,484.6	2,642.8
2025	1,357.7	61.6	1,419.3	1,574.3	2,487.7
2026	1,431.5	60.0	1,491.5	1,667.2	2,312.0
2027	1,498.5	58.4	1,556.9	1,760.2	2,108.7
2028	1,567.0	55.6	1,622.7	1,856.3	1,875.1
2029	1,637.0	51.4	1,688.4	1,955.2	1,608.3
2030	1,707.9	45.9	1,753.9	2,056.0	1,306.2
2031	1,782.6	38.6	1,821.3	2,159.1	968.3
2032[b]	1,856.3	29.3	1,885.7	2,264.1	589.9
Low-cost:					
2023	1,277.3	67.4	1,344.8	1,386.0	2,788.7
2024	1,333.9	69.1	1,403.0	1,476.1	2,715.6
2025	1,434.1	71.7	1,505.8	1,569.6	2,651.8
2026	1,538.8	77.0	1,615.7	1,666.7	2,600.9
2027	1,635.5	83.8	1,719.2	1,764.5	2,555.6
2028	1,736.8	90.5	1,827.4	1,866.2	2,516.7
2029	1,841.9	97.1	1,939.0	1,972.4	2,483.3
2030	1,950.9	104.1	2,055.1	2,082.3	2,456.0
2031	2,066.4	111.8	2,178.2	2,196.2	2,438.0
2032	2,183.6	119.4	2,302.9	2,314.1	2,426.8
2035	2,549.9	133.3	2,683.2	2,700.0	2,387.0
2040	3,287.8	133.5	3,421.2	3,453.5	2,252.0
2045	4,246.9	128.5	4,375.4	4,385.2	2,142.8
2050	5,518.4	132.9	5,651.4	5,629.9	2,192.9
2055	7,198.4	142.0	7,340.3	7,332.9	2,300.5
2060	9,401.2	130.7	9,531.9	9,660.7	1,975.2
2065	12,262.0	71.2	12,333.2	12,655.7	761.5
2070	[c]	[c]	[c]	[c]	[c]
2075	[c]	[c]	[c]	[c]	[c]
2080	[c]	[c]	[c]	[c]	[c]
2085	[c]	[c]	[c]	[c]	[c]
2090	[c]	[c]	[c]	[c]	[c]
2095	61,853.4	788.2	62,641.7	58,170.7	14,443.6
2100	81,078.6	2,369.9	83,448.5	77,118.8	42,544.3
High-cost:					
2023	1,250.6	65.4	1,316.0	1,390.0	2,755.9
2024	1,232.0	61.0	1,293.0	1,500.7	2,548.2
2025	1,298.2	55.1	1,353.3	1,599.6	2,301.9
2026	1,360.4	49.8	1,410.2	1,688.7	2,023.5
2027	1,411.0	44.2	1,455.2	1,778.0	1,700.7
2028	1,457.1	36.5	1,493.6	1,869.5	1,324.8
2029	1,500.9	27.6	1,528.5	1,962.0	891.3
2030[b]	1,543.5	17.6	1,561.1	2,055.8	396.5

[a] Benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[b] The combined OASI and DI Trust Funds become depleted in 2034 under the intermediate assumptions and in 2031 under the high-cost assumptions, so estimates for later years are not shown.

[c] The combined OASI and DI Trust Funds become depleted in 2067 under the low-cost assumptions, but combined asset reserves become positive again by the beginning of 2093 and remain positive through the remainder of the projection period. Estimates are not shown for years in which asset reserves are negative.

Note: Components may not sum to totals because of rounding.

Table VI.G9 presents values in CPI-indexed 2023 dollars—that is, adjusted by the CPI indexing series discussed at the beginning of this section. This table contains the annual non-interest income and cost of the combined OASI and DI Trust Funds, of the HI Trust Fund, and of the combined OASI, DI, and HI Trust Funds, based on the intermediate, low-cost, and high-cost sets of assumptions. For OASDI, non-interest income consists of payroll tax contributions, proceeds from taxation of scheduled OASDI benefits, and any reimbursements from the General Fund of the Treasury. Cost consists of scheduled benefits, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. For HI, non-interest income consists of payroll tax contributions (including contributions from railroad employment), up to an additional 0.9 percent tax on earned income for relatively high earners, proceeds from the taxation of scheduled OASDI benefits, premium revenues, monies from fraud and abuse control activities, and any reimbursements from the General Fund of the Treasury. Total cost consists of scheduled benefits and administrative expenses. The Trustees show income and cost estimates generally on a cash basis for the OASDI program[1] and on an incurred basis for the HI program. Table VI.G9 also shows the annual balance, which equals the difference between non-interest income and cost.

[1] OASDI benefits paid for entitlement for a particular month are generally paid in the succeeding month. There are two primary exceptions to this general rule. First, payments can occur with a greater delay when a benefit award is made after the month of initial benefit entitlement. At the time of benefit award, benefits owed for months of prior entitlement are then also paid to the beneficiary. For the projections in this report, such retroactive payments are included in the period where they are paid (at time of award). Second, when benefit payments scheduled for January 3 are paid on the prior December 31, because January 3 falls on a Sunday, such payments are shown in this report for the period they were scheduled to be paid.

Table VI.G9.—OASDI and HI Annual Non-Interest Income, Cost, and Balance in CPI-Indexed 2023 Dollars,[a] Calendar Years 2023-2100
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[b]	Balance[b]	Non-interest income	Cost	Balance	Non-interest income	Cost[b]	Balance[b]
Intermediate:									
2023	$1,269	$1,388	-$119	$407	$404	$3	$1,676	$1,792	-$116
2024	1,255	1,448	-193	416	413	3	1,671	1,861	-190
2025	1,293	1,500	-206	428	434	-6	1,721	1,934	-213
2026	1,332	1,551	-219	447	456	-9	1,778	2,006	-228
2027	1,361	1,599	-238	460	479	-20	1,821	2,078	-257
2028	1,390	1,647	-257	472	503	-31	1,862	2,150	-288
2029	1,418	1,694	-276	484	528	-44	1,902	2,222	-320
2030	1,445	1,739	-294	496	551	-54	1,941	2,290	-349
2031	1,473	1,784	-311	509	574	-64	1,982	2,357	-375
2032	1,498	1,827	-329	522	598	-76	2,019	2,425	-405
2035	1,568	1,948	-379	554	665	-111	2,122	2,613	-491
2040	1,685	2,127	-442	607	748	-141	2,292	2,875	-582
2045	1,808	2,291	-483	662	818	-156	2,470	3,109	-639
2050	1,945	2,480	-535	723	882	-159	2,668	3,363	-694
2055	2,098	2,709	-611	794	947	-153	2,891	3,656	-765
2060	2,266	2,985	-719	872	1,022	-149	3,138	4,006	-868
2065	2,445	3,275	-829	957	1,108	-151	3,402	4,383	-981
2070	2,635	3,579	-944	1,047	1,204	-157	3,682	4,783	-1,101
2075	2,840	3,901	-1,061	1,144	1,303	-159	3,984	5,204	-1,220
2080	3,065	4,209	-1,144	1,248	1,401	-153	4,313	5,610	-1,297
2085	3,315	4,498	-1,183	1,362	1,500	-138	4,677	5,997	-1,321
2090	3,591	4,791	-1,200	1,486	1,602	-116	5,077	6,393	-1,316
2095	3,892	5,153	-1,260	1,622	1,709	-88	5,514	6,862	-1,348
2100	4,216	5,604	-1,388	1,769	1,815	-46	5,985	7,419	-1,434
Low-cost:									
2023	1,277	1,386	-109	411	397	14	1,688	1,782	-94
2024	1,295	1,433	-138	427	399	29	1,722	1,831	-109
2025	1,351	1,479	-128	447	417	30	1,799	1,897	-98
2026	1,408	1,525	-117	470	434	36	1,878	1,959	-81
2027	1,453	1,567	-115	486	450	36	1,939	2,017	-78
2028	1,498	1,609	-112	502	466	36	2,000	2,075	-76
2029	1,542	1,651	-109	518	483	35	2,060	2,134	-74
2030	1,586	1,693	-107	535	497	38	2,121	2,190	-69
2031	1,631	1,733	-103	552	511	42	2,183	2,244	-61
2032	1,673	1,773	-100	569	525	44	2,242	2,298	-56
2035	1,788	1,893	-105	618	562	56	2,406	2,455	-49
2040	1,989	2,089	-100	703	592	111	2,692	2,681	11
2045	2,216	2,288	-72	799	609	190	3,015	2,897	117
2050	2,484	2,534	-50	912	623	290	3,396	3,157	240
2055	2,795	2,847	-52	1,046	644	402	3,841	3,491	350
2060	3,148	3,235	-87	1,200	684	516	4,348	3,919	430
2065	3,542	3,656	-114	1,371	745	627	4,914	4,401	513
2070	3,980	4,109	-129	1,562	831	731	5,542	4,939	603
2075	4,478	4,604	-125	1,778	939	839	6,256	5,542	714
2080	5,055	5,103	-48	2,024	1,057	967	7,079	6,160	919
2085	5,727	5,601	125	2,308	1,186	1,122	8,035	6,788	1,248
2090	6,496	6,160	337	2,634	1,327	1,307	9,130	7,487	1,643
2095	7,362	6,923	438	3,007	1,480	1,527	10,368	8,403	1,965
2100	8,324	7,918	407	3,429	1,571	1,858	11,753	9,489	2,265

Table VI.G9.—OASDI and HI Annual Non-Interest Income, Cost, and Balance in CPI-Indexed 2023 Dollars,[a] Calendar Years 2023-2100 (Cont.)
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[b]	Balance[b]	Non-interest income	Cost	Balance	Non-interest income	Cost[b]	Balance[b]
High-cost:									
2023	$1,251	$1,390	-$139	$396	$410	-$14	$1,646	$1,800	-$153
2024	1,197	1,458	-261	399	425	-25	1,596	1,883	-286
2025	1,238	1,526	-288	412	454	-42	1,651	1,980	-329
2026	1,275	1,582	-308	432	486	-54	1,707	2,068	-361
2027	1,299	1,637	-338	444	519	-75	1,743	2,156	-413
2028	1,317	1,690	-373	454	552	-98	1,771	2,242	-471
2029	1,333	1,743	-410	463	586	-123	1,796	2,328	-533
2030	1,347	1,794	-447	472	617	-145	1,819	2,410	-592
2031	1,360	1,844	-483	482	649	-167	1,842	2,493	-651
2032	1,371	1,892	-521	491	684	-193	1,862	2,576	-714
2035	1,407	2,019	-612	511	787	-276	1,918	2,805	-888
2040	1,463	2,198	-734	541	935	-394	2,005	3,133	-1,128
2045	1,512	2,348	-836	568	1,082	-514	2,080	3,430	-1,350
2050	1,559	2,504	-945	594	1,231	-636	2,153	3,734	-1,581
2055	1,606	2,673	-1,067	622	1,362	-740	2,228	4,035	-1,807
2060	1,656	2,862	-1,206	653	1,484	-832	2,309	4,346	-2,038
2065	1,706	3,048	-1,342	683	1,592	-909	2,388	4,640	-2,252
2070	1,752	3,233	-1,481	712	1,672	-960	2,464	4,906	-2,441
2075	1,797	3,418	-1,621	740	1,719	-978	2,537	5,137	-2,599
2080	1,840	3,579	-1,739	768	1,748	-980	2,608	5,327	-2,719
2085	1,884	3,707	-1,824	795	1,766	-971	2,678	5,473	-2,795
2090	1,930	3,804	-1,874	821	1,781	-959	2,751	5,585	-2,834
2095	1,978	3,891	-1,913	848	1,797	-948	2,827	5,688	-2,861
2100	2,029	3,993	-1,964	878	1,900	-1,023	2,907	5,893	-2,986

[a] CPI-indexed 2023 dollars equal current dollars adjusted by the CPI indexing series in table VI.G6.
[b] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

Table VI.G10 shows values in current, or nominal, dollars—that is, in dollars unadjusted for inflation. This table presents the annual non-interest income, cost, and balance of the combined OASI and DI Trust Funds, of the HI Trust Fund, and of the combined OASI, DI, and HI Trust Funds, based on the intermediate, low-cost, and high-cost sets of assumptions.

Table VI.G10.—OASDI and HI Annual Non-Interest Income, Cost, and Balance in Current Dollars, Calendar Years 2023-2100
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[a]	Balance[a]	Non-interest income	Cost	Balance	Non-interest income	Cost[a]	Balance[a]
Intermediate:									
2023	$1,269	$1,388	-$119	$407	$404	$3	$1,676	$1,792	-$116
2024	1,287	1,485	-198	426	423	3	1,713	1,908	-195
2025	1,358	1,574	-217	449	456	-7	1,807	2,030	-223
2026	1,432	1,667	-236	480	490	-10	1,912	2,157	-245
2027	1,498	1,760	-262	506	528	-22	2,004	2,288	-283
2028	1,567	1,856	-289	532	567	-35	2,099	2,423	-325
2029	1,637	1,955	-318	558	610	-51	2,195	2,565	-369
2030	1,708	2,056	-348	587	651	-64	2,295	2,707	-412
2031	1,783	2,159	-377	616	694	-78	2,399	2,853	-454
2032	1,856	2,264	-408	647	741	-95	2,503	3,005	-502
2035	2,087	2,592	-505	738	886	-148	2,825	3,477	-653
2040	2,525	3,187	-662	910	1,121	-211	3,435	4,308	-872
2045	3,051	3,866	-815	1,117	1,380	-264	4,168	5,246	-1,079
2050	3,695	4,712	-1,017	1,374	1,676	-302	5,069	6,388	-1,319
2055	4,486	5,794	-1,308	1,697	2,025	-328	6,183	7,819	-1,635
2060	5,456	7,187	-1,731	2,100	2,460	-360	7,556	9,647	-2,091
2065	6,629	8,878	-2,248	2,594	3,004	-410	9,224	11,882	-2,658
2070	8,044	10,925	-2,881	3,196	3,675	-479	11,239	14,599	-3,360
2075	9,760	13,405	-3,645	3,931	4,478	-547	13,691	17,883	-4,192
2080	11,859	16,286	-4,427	4,829	5,422	-593	16,689	21,708	-5,020
2085	14,442	19,594	-5,153	5,932	6,533	-601	20,374	26,127	-5,754
2090	17,615	23,499	-5,884	7,287	7,858	-571	24,902	31,357	-6,455
2095	21,496	28,457	-6,961	8,955	9,438	-483	30,451	37,895	-7,444
2100	26,211	34,844	-8,633	11,001	11,286	-285	37,213	46,131	-8,918
Low-cost:									
2023	1,277	1,386	-109	411	397	14	1,688	1,782	-94
2024	1,334	1,476	-142	440	411	29	1,774	1,887	-113
2025	1,434	1,570	-135	474	443	31	1,909	2,013	-104
2026	1,539	1,667	-128	514	474	40	2,053	2,141	-88
2027	1,635	1,765	-129	547	507	41	2,183	2,271	-88
2028	1,737	1,866	-129	582	540	42	2,319	2,407	-88
2029	1,842	1,972	-131	619	577	42	2,461	2,549	-89
2030	1,951	2,082	-131	658	611	47	2,609	2,694	-84
2031	2,066	2,196	-130	700	647	53	2,766	2,843	-77
2032	2,184	2,314	-131	743	685	57	2,926	3,000	-73
2035	2,550	2,700	-150	881	801	80	3,431	3,501	-70
2040	3,288	3,453	-166	1,162	978	184	4,450	4,432	18
2045	4,247	4,385	-138	1,531	1,168	363	5,778	5,553	225
2050	5,518	5,630	-111	2,027	1,384	644	7,546	7,014	532
2055	7,198	7,333	-135	2,695	1,658	1,036	9,893	8,991	902
2060	9,401	9,661	-259	3,583	2,041	1,542	12,984	11,702	1,283
2065	12,262	12,656	-394	4,747	2,578	2,169	17,009	15,234	1,775
2070	15,973	16,488	-516	6,268	3,333	2,935	22,241	19,821	2,419
2075	20,833	21,416	-583	8,270	4,367	3,902	29,102	25,783	3,319
2080	27,261	27,518	-257	10,917	5,702	5,215	38,177	33,220	4,958
2085	35,803	35,020	783	14,432	7,416	7,017	50,235	42,435	7,799
2090	47,084	44,643	2,441	19,090	9,620	9,470	66,174	54,263	11,911
2095	61,853	58,171	3,683	25,262	12,434	12,828	87,115	70,605	16,510
2100	81,079	77,119	3,960	33,401	15,303	18,097	114,479	92,422	22,057

Table VI.G10.—OASDI and HI Annual Non-Interest Income, Cost, and Balance in Current Dollars, Calendar Years 2023-2100 (Cont.)
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[a]	Balance[a]	Non-interest income	Cost	Balance	Non-interest income	Cost[a]	Balance[a]
High-cost:									
2023	$1,251	$1,390	-$139	$396	$410	-$14	$1,646	$1,800	-$153
2024	1,232	1,501	-269	411	437	-26	1,643	1,938	-295
2025	1,298	1,600	-301	432	476	-44	1,731	2,076	-345
2026	1,360	1,689	-328	461	518	-58	1,821	2,207	-386
2027	1,411	1,778	-367	483	564	-81	1,894	2,342	-448
2028	1,457	1,869	-412	502	610	-109	1,959	2,480	-521
2029	1,501	1,962	-461	521	659	-139	2,022	2,621	-600
2030	1,543	2,056	-512	541	707	-166	2,085	2,763	-678
2031	1,587	2,151	-564	562	757	-195	2,149	2,908	-759
2032	1,629	2,247	-618	583	812	-229	2,211	3,059	-848
2035	1,763	2,530	-766	640	986	-346	2,403	3,515	-1,112
2040	2,005	3,011	-1,006	742	1,281	-539	2,746	4,292	-1,545
2045	2,265	3,517	-1,252	851	1,621	-770	3,116	5,138	-2,022
2050	2,552	4,100	-1,548	974	2,015	-1,042	3,526	6,115	-2,590
2055	2,875	4,785	-1,910	1,114	2,439	-1,325	3,989	7,224	-3,235
2060	3,241	5,602	-2,360	1,277	2,906	-1,628	4,519	8,507	-3,989
2065	3,650	6,523	-2,873	1,461	3,407	-1,946	5,111	9,929	-4,819
2070	4,100	7,565	-3,465	1,666	3,913	-2,247	5,766	11,477	-5,712
2075	4,596	8,743	-4,146	1,894	4,397	-2,503	6,490	13,139	-6,649
2080	5,145	10,008	-4,863	2,148	4,889	-2,741	7,293	14,897	-7,605
2085	5,759	11,336	-5,577	2,430	5,399	-2,969	8,189	16,735	-8,546
2090	6,451	12,717	-6,266	2,746	5,953	-3,207	9,197	18,670	-9,473
2095	7,230	14,222	-6,992	3,101	6,566	-3,465	10,331	20,788	-10,456
2100	8,108	15,954	-7,846	3,507	7,593	-4,086	11,615	23,547	-11,931

[a] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

H. ANALYSIS OF BENEFIT PAYMENTS FROM THE OASI TRUST FUND WITH RESPECT TO DISABLED BENEFICIARIES

(Required by section 201(c) of the Social Security Act)

Effective January 1957, the OASI Trust Fund pays monthly benefits to disabled children aged 18 and over of retired and deceased workers if the disability began before age 18. The age by which disability must have begun was later changed to age 22. Effective February 1968, the OASI Trust Fund pays reduced monthly benefits to disabled widows and widowers at ages 50 and over. Effective January 1991, the requirements for the disability of the widow or widower were made less restrictive.

At the end of 2022, the OASI Trust Fund was providing monthly benefit payments to about 1,128,000 people because of their disabilities or the disabilities of children. This total includes approximately 21,000 mothers and fathers (wives or husbands under normal retirement age of retired-worker beneficiaries and widows or widowers of deceased insured workers) who met all other qualifying requirements and were receiving unreduced benefits solely because they had disabled-child beneficiaries (or disabled children aged 16 or 17) in their care. In calendar year 2022, the OASI Trust Fund paid a total of $13,266 million to the people described above. Table VI.H1 shows OASI scheduled benefits for disability for selected calendar years during 1960 through 2022 and estimates for 2023 through 2032 based on the intermediate set of assumptions.

Table VI.H1.—Scheduled Benefit Payments From the OASI Trust Fund With Respect to Disabled Beneficiaries

[Beneficiaries in thousands; scheduled benefits in millions]

	Disabled beneficiaries, end of year			Amount of scheduled benefits[a b]		
Calendar year	Total	Children[c]	Widows-widowers[d]	Total	Children[c]	Widows-widowers[e]
Historical data:						
1960	117	117	—	$59	$59	—
1965	214	214	—	134	134	—
1970	316	281	36	301	260	$41
1975	435	376	58	664	560	104
1980	519	460	59	1,223	1,097	126
1985	594	547	47	2,072	1,885	187
1990	662	613	49	2,882	2,649	233
1995	772	681	91	4,202	3,672	531
2000	811	707	104	5,203	4,523	680
2005	836	728	108	6,449	5,556	834
2010	996	879	117	8,671	7,662	1,008
2015	1,096	972	124	10,640	9,528	1,109
2016	1,109	988	121	10,909	9,818	1,087
2017	1,124	1,006	117	11,222	10,156	1,061
2018	1,139	1,027	112	11,767	10,729	1,031
2019	1,144	1,041	103	12,148	11,152	983
2020	1,147	1,051	95	12,351	11,403	934
2021	1,136	1,050	86	12,453	11,578	861
2022	1,128	1,051	78	13,266	12,414	829
Estimates under the intermediate assumptions:						
2023	1,141	1,069	71	14,514	13,669	822
2024	1,153	1,084	69	15,265	14,419	822
2025	1,170	1,102	68	15,939	15,088	826
2026	1,189	1,121	68	16,706	15,828	853
2027	1,209	1,140	69	17,515	16,606	883
2028	1,227	1,157	70	18,343	17,395	921
2029	1,246	1,177	69	19,204	18,224	952
2030	1,264	1,196	68	20,081	19,092	960
2031	1,284	1,216	68	21,006	19,989	987
2032	1,305	1,236	69	21,996	20,938	1,028

[a] Beginning in 1966, includes payments for vocational rehabilitation services.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Also includes certain mothers and fathers (see text).

[d] In 1984 and later years, includes only disabled widows and widowers aged 50-59, because disabled widows and widowers age 60 and older are eligible for the same benefit as a nondisabled aged widow or widower. Therefore, they are not receiving benefits solely because of a disability.

[e] In 1983 and prior years, includes the offsetting effect of lower benefits payable to disabled widows and widowers who continued to receive benefits after attaining age 60 (62, for disabled widowers prior to 1973), compared to the higher nondisabled widow's and widower's benefits that would otherwise be payable. In 1984 and later years, includes only scheduled benefits to disabled widows and widowers aged 50-59 (see footnote d).

Note: Components may not sum to totals because of rounding.

Under the intermediate assumptions, estimated total scheduled benefits paid from the OASI Trust Fund with respect to disabled beneficiaries will increase from $14,514 million in calendar year 2023 to $21,996 million in calendar year 2032.

In calendar year 2022, benefit payments (including payments for vocational rehabilitation services) with respect to disabled persons from the OASI Trust Fund and from the DI Trust Fund (including payments from the DI fund to all children and spouses of disabled-worker beneficiaries) totaled $156,861 million. Of this amount, $13,266 million, or 8.5 percent, represented payments from the OASI Trust Fund. Table VI.H2 contains these and similar figures for selected calendar years during 1960 through 2022 and estimates for calendar years 2023 through 2032.

Table VI.H2.—Scheduled Benefit Payments[a] Under the OASDI Program With Respect to Disabled Beneficiaries
[Amounts in millions]

Calendar year	Total[b]	DI Trust Fund[c]	OASI Trust Fund	
			Amount[d]	Percentage of total
Historical data:				
1960	$627	$568	$59	9.4
1965	1,707	1,573	134	7.9
1970	3,386	3,085	301	8.9
1975	9,169	8,505	664	7.2
1980	16,738	15,515	1,223	7.3
1985	20,908	18,836	2,072	9.9
1990	27,717	24,835	2,882	10.4
1995	45,140	40,937	4,202	9.3
2000	60,204	55,001	5,203	8.6
2005	91,835	85,386	6,449	7.0
2010	132,916	124,245	8,671	6.5
2015	154,028	143,388	10,640	6.9
2016	153,709	142,800	10,909	7.1
2017	154,048	142,826	11,222	7.3
2018	155,526	143,760	11,767	7.6
2019	157,289	145,141	12,148	7.7
2020	155,933	143,582	12,351	7.9
2021	152,538	140,085	12,453	8.2
2022	156,861	143,595	13,266	8.5
Estimates under the intermediate assumptions:				
2023	162,584	148,070	14,514	8.9
2024	170,786	155,521	15,265	8.9
2025	181,291	165,353	15,939	8.8
2026	192,051	175,345	16,706	8.7
2027	201,292	183,777	17,515	8.7
2028	209,539	191,196	18,343	8.8
2029	216,103	196,899	19,204	8.9
2030	222,804	202,723	20,081	9.0
2031	230,957	209,952	21,006	9.1
2032	240,239	218,243	21,996	9.2

[a] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[b] Beginning in 1966, includes payments for vocational rehabilitation services.

[c] Scheduled benefits for disabled workers and their children and spouses.

[d] Scheduled benefits for disabled children aged 18 and over, for certain mothers and fathers (see text), and for disabled widows and widowers (see footnote e, table VI.H1).

Note: Components may not sum to totals because of rounding.

I. GLOSSARY

Actuarial balance. The difference between the summarized income rate and the summarized cost rate as a percentage of taxable payroll over a given valuation period.

Actuarial deficit. A negative actuarial balance.

Administrative expenses. Expenses incurred by the Social Security Administration and the Department of the Treasury in administering the OASDI program and the provisions of the Internal Revenue Code relating to the collection of contributions. Such administrative expenses are paid from the OASI and DI Trust Funds.

Advance tax transfers. Amounts representing the estimated total OASDI tax contributions for a given month. From May 1983 through November 1990, such amounts were credited to the OASI and DI Trust Funds at the beginning of each month. The trust funds reimbursed the General Fund of the Treasury for the associated loss of interest. Advance tax transfers are no longer made unless needed in order to pay benefits.

Alternatives I, II, or III. See "Assumptions."

Annual balance. The difference between the income rate and the cost rate for a given year.

Asset reserves. See "Trust fund reserves".

Assumptions. Values related to future trends in key factors that affect the trust funds. Demographic assumptions include fertility, mortality, net immigration, marriage, and divorce. Economic assumptions include unemployment rates, average earnings, inflation, interest rates, and productivity. Program-specific assumptions include retirement patterns, and disability incidence and termination rates. This report presents three sets of demographic, economic, and program-specific assumptions:

- Alternative II is the intermediate set of assumptions, and represents the Trustees' best estimates of likely future demographic, economic, and program-specific conditions.
- Alternative I is a low-cost set of assumptions—it assumes relatively rapid economic growth, high inflation, and favorable (from the standpoint of program financing) demographic and program-specific conditions.
- Alternative III is a high-cost set of assumptions—it assumes relatively slow economic growth, low inflation, and unfavorable (from the standpoint of program financing) demographic and program-specific conditions.

See tables V.A2, V.B1, and V.B2.

Automatic cost-of-living benefit increase. The annual increase in benefits, effective for December, reflecting the increase, if any, in the cost of living. A

benefit increase is applicable only after a beneficiary becomes eligible for benefits. In general, the benefit increase equals the percentage increase in the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) measured from the third quarter of the last year for which there was an increase to the third quarter of the current year. If there is no increase in the CPI-W, there is no cost-of-living benefit increase. See table V.C1.

Auxiliary benefits. Monthly benefits payable to a spouse or child of a retired or disabled worker, or to a survivor of a deceased worker.

Average indexed monthly earnings—AIME. The measure of lifetime earnings used in determining the primary insurance amount (PIA) for most workers who attain age 62, become disabled, or die after 1978. A worker's actual past earnings are adjusted by changes in the average wage index, in order to bring them up to their approximately equivalent value at the time of retirement or other eligibility for benefits.

Average wage index—AWI. A series that generally increases with the average amount of total wages per worker with any wages for each year after 1950, including wages in noncovered employment and wages in covered employment in excess of the OASDI contribution and benefit base. (See Title 20, Chapter III, section 404.211(c) of the Code of Federal Regulations for a more precise definition.) The average wage index is used to index the taxable earnings of most workers first becoming eligible for benefits in 1979 or later, and for automatic adjustments in the contribution and benefit base, bend points, earnings test exempt amounts, and other wage-indexed amounts. See tables V.C1 and VI.G6.

Award. An administrative determination that an individual is entitled to receive a specified type of OASDI benefit. Awards can represent not only new entrants to the benefit rolls but also persons already on the rolls who become entitled to a different type of benefit. Awards usually result in the immediate payment of benefits, although payments may be deferred or withheld depending on the individual's particular circumstances.

Baby boom. The period from the end of World War II (1946) through 1965 marked by unusually high birth rates.

Bend points. The dollar amounts defining the AIME or PIA brackets in the benefit formulas. For the bend points for years 1979 and later, see table V.C2.

Beneficiary. A person who has been awarded benefits on the basis of his or her own or another's earnings record. The benefits may be either in current-payment status or withheld.

Benefit award. See "Award."

Benefit conversion. See "Disability conversion."

Benefit payments. The amounts disbursed for OASI and DI benefits by the Department of the Treasury.

Benefit termination. See "Termination."

Best estimate assumptions. See "Assumptions."

Board. See "Board of Trustees."

Board of Trustees. A Board established by the Social Security Act to oversee the financial operations of the Federal Old-Age and Survivors Insurance Trust Fund and the Federal Disability Insurance Trust Fund. The Board is composed of six members. Four members serve by virtue of their positions in the Federal Government: the Secretary of the Treasury, who is the Managing Trustee; the Secretary of Labor; the Secretary of Health and Human Services; and the Commissioner of Social Security. The President appoints and the Senate confirms the other two members to serve as public representatives. Also referred to as the "Board" or the "Trustees."

Cash flow. Actual or projected revenue (other than interest paid to the trust funds) and costs reflecting the levels of payroll tax contribution rates and benefits scheduled in the law. Net cash flow is the difference between noninterest income and cost.

Consumer Price Index—CPI. An official measure of inflation in consumer prices. In this report, CPI refers to the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). The Bureau of Labor Statistics, Department of Labor, publishes historical values for the CPI-W.

Contribution and benefit base. Annual dollar amount above which earnings in employment covered under the OASDI program are neither taxable nor creditable for benefit-computation purposes. (Also referred to as maximum contribution and benefit base, annual creditable maximum, taxable maximum, and maximum taxable.) See tables V.C1 and V.C6. See "Hospital Insurance (HI) contribution base."

Contributions. See "Payroll tax contributions."

Conversion. See "Disability conversion."

Cost. The cost shown for a year includes benefits scheduled for payment in the year (without regard to the ability to make the payments in full), administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries.

Cost-of-living adjustment. See "Automatic cost-of-living benefit increase."

Cost rate. The cost rate for a year is the ratio of the cost of the program to the taxable payroll for the year.

Covered earnings. Wages or earnings from self-employment covered by the OASDI program.

Covered employment. All employment for which earnings are creditable for Social Security purposes. The program covers almost all employment. Some exceptions are:

- State and local government employees whose employer has not elected to be covered under Social Security and who are participating in an employer-provided pension plan.
- Current Federal civilian workers hired before 1984 who have not elected to be covered.
- Self-employed workers earning less than $400 in a calendar year.

Covered worker. A person who has earnings creditable for Social Security purposes based on services for wages in covered employment or income from covered self-employment.

CPI-indexed dollars. Amounts adjusted by the CPI to the value of the dollar in a particular year.

Creditable earnings. Wages or self-employment earnings posted to a worker's earnings record. Such earnings determine eligibility for benefits and the amount of benefits on that worker's record. The contribution and benefit base is the maximum amount of creditable earnings for each worker in a calendar year.

Current-cost financing. See "Pay-as-you-go financing."

Current dollars. Amounts expressed in nominal dollars with no adjustment for inflation.

Currently insured status. A worker is currently insured when he or she has accumulated six quarters of coverage during the 13-quarter period ending with the current quarter.

Current-payment status. Status of a beneficiary to whom a benefit is being paid for a given month (with or without deductions, provided the deductions add to less than a full month's benefit).

Deemed filing. Under certain circumstances, a person applying for or receiving either an aged-spouse benefit or a retired-worker benefit is required to also file for the other of these two types of benefits. For those first eligible for benefits before 2016, this requirement applies to any person under normal retirement age who is eligible for the other benefit as of the starting month for the first benefit. For those first eligible for benefits in 2016 and later, this requirement applies whenever the person is eligible for the other benefit. This can occur at any age, and in months after the starting month of the first benefit.

Deemed wage credit. See "Military service wage credits."

Delayed retirement credits. Increases in the benefit amount for certain individuals who did not receive benefits for months after attaining normal retirement age but before age 70. Delayed retirement credits apply to benefits for

January of the year following the year they are earned or for the month of attainment of age 70, whichever comes first. See table V.C3.

Demographic assumptions. See "Assumptions."

Disability. For Social Security purposes, the inability to engage in any substantial gainful activity (see "Substantial gainful activity—SGA") by reason of any medically determinable physical or mental impairment that can be expected to result in death or to last for a continuous period of not less than 12 months. Special rules apply for workers at ages 55 and over whose disability is based on blindness.

The law generally requires that a person be disabled continuously for 5 months before he or she can qualify for a disabled-worker benefit.

Disability conversion ratio. For a given year, the ratio of the number of disability conversions to the average number of disabled-worker beneficiaries at all ages during the year.

Disability conversion. Upon attainment of normal retirement age, a disabled-worker beneficiary is automatically converted to retired-worker status.

Disability incidence rate. The proportion of workers in a given year, insured for but not receiving disability benefits, who apply for and are awarded disability benefits.

Disability Insurance (DI) Trust Fund. See "Trust fund."

Disability insured status. A worker is disability insured if he or she is: (1) a fully insured worker who has accumulated 20 quarters of coverage during the 40-quarter period ending with the current quarter, (2) a fully insured worker aged 24-30 who has accumulated quarters of coverage during one-half of the quarters elapsed after the quarter of attainment of age 21 and up to and including the current quarter, or (3) a fully insured worker under age 24 who has accumulated six quarters of coverage during the 12-quarter period ending with the current quarter.

Disability prevalence rate. The proportion of persons insured for disability benefits who are disabled-worker beneficiaries in current-payment status.

Disability termination rate. The proportion of disabled-worker beneficiaries in a given year whose disability benefits terminate as a result of their recovery or death.

Disabled-worker benefit. A monthly benefit payable to a disabled worker under normal retirement age and insured for disability. Before November 1960, disability benefits were limited to disabled workers aged 50-64.

Dual entitlement. A person may be entitled to more than one benefit at the same time. For example, a person may be entitled as a retired worker on his or her own record and as a spouse on another record. However, a person's benefit amount can never exceed the highest single benefit to which that per-

son is entitled. Some benefits are calculated independently with the larger benefit being paid or the smaller benefit being paid plus the excess amount of the larger one.

Earnings. Unless otherwise qualified, all wages from employment and net earnings from self-employment, whether or not they are taxable or covered.

Earnings test. The provision requiring the withholding of benefits if beneficiaries under normal retirement age have earnings in excess of certain exempt amounts. See table V.C1.

Economic assumptions. See "Assumptions."

Effective interest rate. See "Interest rate."

Excess wages. Wages in excess of the contribution and benefit base on which a worker initially makes payroll tax contributions, usually as a result of working for more than one employer during a year. Employee payroll taxes on excess wages are refundable to affected employees, while the employer taxes are not refundable.

Expenditures. Actual payments made or expected to be made under current law, including benefits paid or payable, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. Includes only the portion of cost that is payable with the financing provisions in current law.

Exposed population. For any event (such as being awarded a benefit, or dying), the group that is exposed to the possibility of experiencing the event. For example, the exposed population for disabled worker awards (incidence) is the disability insured population less those already receiving benefits.

Federal Insurance Contributions Act—FICA. Provision authorizing payroll taxes on the wages of employed persons to provide for Old-Age, Survivors, and Disability Insurance, and for Hospital Insurance. Workers and their employers generally pay the tax in equal amounts.

Financial interchange. Provisions of the Railroad Retirement Act providing for transfers between the trust funds and the Social Security Equivalent Benefit Account of the Railroad Retirement program in order to place each trust fund in the same financial position it would have been had railroad employment always been covered under Social Security.

Fiscal year. The accounting year of the United States Government. Starting in 1976, a fiscal year is the 12-month period ending September 30. For example, fiscal year 2023 began October 1, 2022, and will end September 30, 2023.

Full advance funding. A financing method in which contributions are established to match the full cost of future benefits as these costs are incurred through current service. Such financing methods also provide for amortization over a fixed period of any financial obligation that is incurred at the

beginning of the program (or subsequent modification) as a result of granting credit for past service.

Fully insured status. A worker is fully insured when his or her total number of quarters of coverage is greater than or equal to the number of years elapsed after the year of attainment of age 21 (but not less than six). Once a worker has accumulated 40 quarters of coverage, he or she remains permanently fully insured.

General Fund of the Treasury. Funds held by the Treasury of the United States, other than income collected for a specific purpose (such as Social Security), and maintained in a separate account for that purpose.

General Fund reimbursements. Payments from the General Fund of the Treasury to the trust funds for specific items defined in the law, including:

- The cost of noncontributory wage credits for military service before 1957, and periodic adjustments of previous determinations.
- The cost in 1971-82 of deemed wage credits for military service performed after 1956.
- The cost of benefits to certain uninsured persons who attained age 72 before 1968.
- The cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21.
- The cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246.
- Payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.
- A portion of proceeds from repayments of loans authorized under Public Law 116-136.

The General Fund also reimburses the trust funds for various other items, including interest on checks which are not negotiated 6 months after the month of issue and costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI and DI programs.

Gross domestic product—GDP. The total dollar value of all goods and services produced by labor and property located in the United States, regardless of who supplies the labor or property.

Hospital Insurance (HI) contribution base. Annual dollar amount above which earnings in employment covered under the HI program are not taxable. (Also referred to as maximum contribution base, taxable maximum, and maximum taxable.) Beginning in 1994, the HI contribution base was eliminated.

High-cost assumptions. See "Assumptions."

Hospital Insurance (HI) Trust Fund. See "Trust fund."

Immigration. See "Lawful permanent resident (LPR) immigration" and "Other-than-LPR immigration."

Income. Income for a given year is the sum of tax revenue on a cash basis (payroll tax contributions and income from the taxation of scheduled benefits), reimbursements from the General Fund of the Treasury, if any, and interest credited to the trust funds.

Income rate. Ratio of non-interest income to the OASDI taxable payroll for the year.

Infinite horizon. The period extending indefinitely into the future.

Inflation. An increase in the general price level of goods and services.

Insured status. The state or condition of having sufficient quarters of coverage to meet the eligibility requirements for retired-worker or disabled-worker benefits, or to permit the worker's spouse and children or survivors to establish eligibility for benefits in the event of his or her disability, retirement, or death. See "Quarter of coverage."

Interest. A payment in exchange for the use of money during a specified period.

Interest rate. Interest rates on new public-debt obligations issuable to Federal trust funds (see "Special public-debt obligation") are determined monthly. Such rates are equal to the average market yield on all outstanding marketable U.S. securities not due or callable until after 4 years from the date the rate is determined. See table V.B2 for historical and assumed future interest rates on new special-issue securities. The effective interest rate for a trust fund is the ratio of the interest earned by the fund over a given period of time to the average level of asset reserves held by the fund during the period. The effective rate of interest thus represents a measure of the overall average interest earnings on the fund's portfolio of investments. See table VI.G6 for projected compound new-issue interest factors and compound effective trust-fund interest factors.

Interfund borrowing. The borrowing of asset reserves by a trust fund (OASI, DI, or HI) from another trust fund when the first fund is in danger of depletion. The Social Security Act permitted interfund borrowing only during 1982 through 1987, and required all amounts borrowed to be repaid prior to the end of 1989. The only exercise of this authority occurred in 1982, when the OASI Trust Fund borrowed from the DI and HI Trust Funds. The final repayment of borrowed amounts occurred in 1986.

Intermediate assumptions. See "Assumptions."

Lawful permanent resident (LPR) immigration. Persons who enter the Social Security area population and are granted LPR status, or who are already in the Social Security area population and adjust their status to become LPRs. Persons who enter the country with legal visas but without

LPR status, such as temporary foreign workers and students, are not included in the "LPR immigration" category.

Legal emigration. Lawful permanent residents and citizens who leave the Social Security area population.

Life expectancy. Average remaining number of years expected prior to death. Period life expectancy is calculated for a given year using the actual or expected death rates at each age for that year. Cohort life expectancy, sometimes referred to as generational life expectancy, is calculated for individuals at a specific age in a given year using actual or expected death rates from the years in which the individuals would actually reach each succeeding age if they survive.

Long-range. The first 75 projection years. The Trustees make long-range actuarial estimates for this period because it covers approximately the maximum remaining lifetime for virtually all current Social Security participants.

Low-cost assumptions. See "Assumptions."

Lump-sum death payment. A lump sum, generally $255, payable on the death of a fully or currently insured worker. The lump sum is payable to the surviving spouse of the worker, under most circumstances, or to the worker's children.

Maximum family benefit. The maximum monthly amount that can be paid on a worker's earnings record. Whenever the total of the individual monthly benefits payable to all the beneficiaries entitled on one earnings record exceeds the maximum, each dependent's or survivor's benefit is proportionately reduced. Benefits payable to divorced spouses or surviving divorced spouses are not reduced under the family maximum provision.

Medicare. A nationwide, Federally administered health insurance program authorized in 1965 under Title XVIII of the Social Security Act to cover the cost of hospitalization, medical care, and some related services for most persons age 65 and over. In 1972, lawmakers extended coverage to persons receiving Social Security Disability Insurance payments for 2 years and persons with End-Stage Renal Disease. (For beneficiaries whose primary or secondary diagnosis is Amyotrophic Lateral Sclerosis, the 2-year waiting period is waived.) In 2010, persons exposed to environmental health hazards within areas under a corresponding emergency declaration became Medicare-eligible. In 2006, prescription drug coverage was added as well. Medicare consists of two separate but coordinated trust funds—Hospital Insurance (HI, Part A) and Supplementary Medical Insurance (SMI). The SMI Trust Fund is composed of two separate accounts—the Part B account and the Part D account. Almost all persons who are aged 65 and over or disabled and who are entitled to HI are eligible to enroll in Part B and Part D on a voluntary basis by paying monthly premiums.

Military service wage credits. Credits toward OASDI earnings records for benefit computation purposes, recognizing that military personnel receive non-wage compensation (such as food and shelter) in addition to their basic pay and other cash payments. Military personnel do not pay payroll taxes on these credits. Noncontributory wage credits of $160 were provided for each month of active military service from September 16, 1940, through December 31, 1956. For years after 1956, the basic pay of military personnel is covered under the Social Security program on a contributory basis. In addition to the contributory credits for basic pay, noncontributory wage credits of $300 were granted for each calendar quarter, from January 1957 through December 1977, in which a person received pay for military service. Noncontributory wage credits of $100 were granted for each $300 of military wages, up to a maximum credit of $1,200 per calendar year, from January 1978 through December 2001.

National average wage index—AWI. See "Average wage index—AWI."

Non-interest income. Non-interest income for a given year is the sum of tax revenue on a cash basis (payroll tax contributions and income from the taxation of scheduled benefits) and reimbursements from the General Fund of the Treasury, if any.

Nonresident alien beneficiary. An OASDI beneficiary who is not a U.S. citizen and who is living abroad while receiving benefits.

Normal retirement age—NRA. The age at which a person may first become entitled to retirement benefits without reduction based on age. For persons reaching age 62 before 2000, the normal retirement age is 65. It increases gradually to 67 for persons reaching age 62 in 2022 or later, beginning with an increase to 65 years and 2 months for persons reaching age 62 in 2000. See table V.C3.

Old-Age and Survivors Insurance (OASI) Trust Fund. See "Trust fund."

Old-law base. Amount the contribution and benefit base would have been if the 1977 amendments had not provided for ad hoc increases. The Social Security Amendments of 1972 provided for automatic annual indexing of the contribution and benefit base. The Social Security Amendments of 1977 specified ad hoc bases for 1978-81, with subsequent bases updated in accordance with the normal indexing procedure. See table V.C2.

Open-group unfunded obligation. See "Unfunded obligation."

Other-than-LPR emigration. Other-than-LPR immigrants who leave the Social Security area population or who adjust their status to become LPRs.

Other-than-LPR immigration. Persons who enter the Social Security area population and stay to the end of the year without being granted LPR status, such as undocumented immigrants, and foreign workers and students entering with temporary visas.

Par value. The value printed on the face of a bond. For special issues held by the trust funds, par value is the redemption value at any time up to maturity.

Partial advance funding. A financing method in which contribution levels are established to provide a substantial accumulation of trust fund asset reserves, thereby generating interest income to the trust funds and reducing the need for contribution increases or cost reductions in periods when costs are relatively high or income is relatively low. The trust fund buildup under partial advance funding is smaller than it would be with full advance funding.

Pay-as-you-go financing. A financing method in which contribution levels are established with the intent to produce annual income levels required to pay current benefits, with trust fund asset reserves built up only to the extent needed to prevent immediate depletion of the fund reserves by random fluctuations.

Payroll tax contributions. The amount based on a percent of earnings, up to an annual maximum, that must be paid by:

- employers and employees on wages from employment under the Federal Insurance Contributions Act,
- the self-employed on net earnings from self-employment under the Self-Employment Contributions Act, and
- States on the wages paid in 1986 and earlier to State and local government employees covered under the Social Security Act through voluntary agreements under section 218 of the act.

Also referred to as payroll taxes.

Population in the Social Security area. See "Social Security area population."

Potential GDP. Sustainable trend level of GDP (see "Gross domestic product—GDP"). That is, the hypothetical level of GDP that would be achieved at full sustainable employment and use of capital. For the purposes of this report, potential GDP is estimated consistent with long-range ultimate assumptions for the unemployment rate and other economic variables and can be interpreted as the hypothetical level of GDP in the absence of business cycles and other short-term fluctuations.

Present value. The equivalent value, at the present time, of a stream of values (either income or cost, past or future). Present value is used widely in calculations involving financial transactions over long periods of time to account for the time value of money, by discounting or accumulating these transactions at the rate of interest. Present-value calculations for this report use the effective yield on combined OASI and DI Trust Fund asset reserves.

Primary insurance amount—PIA. The monthly amount payable to a retired worker who begins to receive benefits at normal retirement age or, generally, to a disabled worker. This amount, which is typically related to the worker's average monthly wage or average indexed monthly earnings, is also used as a base for computing all types of benefits payable on an individual's earnings record.

Primary-insurance-amount formula. The mathematical formula relating the PIA to the AIME for workers who attain age 62, become disabled, or die after 1978. The PIA is equal to the sum of 90 percent of AIME up to the first bend point, plus 32 percent of AIME above the first bend point up to the second bend point, plus 15 percent of AIME in excess of the second bend point. Automatic benefit increases are applied beginning with the year of eligibility. See table V.C2 for historical and assumed future bend points and table V.C1 for historical and assumed future benefit increases.

Quarter of coverage. Basic unit of measurement for determining insured status. For 1978, a worker earned one quarter of coverage, up to four, for each $250 of that worker's annual covered earnings. After 1978, the $250 amount increases automatically with increases in the national average wage index. See table V.C2.

Railroad Retirement. A Federal insurance program, similar to Social Security, designed for workers in the railroad industry. The provisions of the Railroad Retirement Act provide for a system of coordination and financial interchange between the Railroad Retirement program and the Social Security program.

Reallocation of payroll tax rates. An increase in the payroll tax rate for either the OASI or DI Trust Fund, with a corresponding reduction in the rate for the other fund, so that the total OASDI payroll tax rate is not changed.

Real wage differential. The difference between the percentage increases in: (1) the average annual wage in covered employment and (2) the average annual Consumer Price Index. See section V.B.

Recession. A period of adverse economic conditions, generally defined as two or more successive calendar quarters of negative real growth in gross domestic product.

Reserves. See "Trust fund reserves."

Retired-worker benefit. A monthly benefit payable to a fully insured retired worker aged 62 or older or to a person entitled under the transitionally insured status provision in the law.

Retirement earnings test. See "Earnings test."

Retirement eligibility age. The age, currently age 62, at which a fully insured individual first becomes eligible to receive retired-worker benefits.

Scheduled benefits. The level of benefits specified under current law.

Scenario-based model. A model with specified assumptions for and relationships among variables. Under such a model, any specified set of assumptions determines a single outcome directly reflecting the specifications.

Self-employment. Operation of a trade or business by an individual or by a partnership in which an individual is a member.

Self-Employment Contributions Act–SECA. Provision authorizing Social Security payroll taxes on the net earnings of most self-employed persons.

Short-range. The first 10 projection years. The Social Security Act requires estimates for 5 years; the Trustees prepare estimates for an additional 5 years to help clarify trends that are only starting to develop in the mandated first 5-year period.

Social Security Act. Provisions of the law governing most operations of the Social Security program. The original Social Security Act is Public Law 74-271, enacted August 14, 1935. With subsequent amendments, the Social Security Act consists of 21 titles, of which three have been repealed. Title II of the Social Security Act authorizes the Old-Age, Survivors, and Disability Insurance program.

Social Security area population. The population composed of: (1) residents of the 50 States and the District of Columbia (adjusted for net census undercount); (2) civilian residents of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Northern Mariana Islands; (3) Federal civilian employees and persons in the U.S. Armed Forces abroad and their dependents; (4) non-citizens living abroad who are insured for Social Security benefits; and (5) all other U.S. citizens abroad.

Solvency. A program is solvent at a point in time if it is able to pay scheduled benefits when due with scheduled financing. For example, the OASDI program is solvent over any period for which the trust funds maintain a positive level of asset reserves.

Special public-debt obligation. Securities of the United States Government issued exclusively to the OASI, DI, HI, and SMI Trust Funds and other Federal trust funds. Section 201(d) of the Social Security Act provides that the public-debt obligations issued for purchase by the OASI and DI Trust Funds shall have maturities fixed with due regard for the needs of the funds. The usual practice has been to spread the holdings of special issues, as of each June 30, so that the amounts maturing in each of the next 15 years are approximately equal. Special public-debt obligations are redeemable at par value at any time and carry interest rates determined by law (see "Interest rate"). See tables VI.A4 and VI.A5 for a listing of the obligations held by the OASI and DI Trust Funds, respectively.

Stochastic model. A model used for projecting a probability distribution of potential outcomes. Such models allow for random variation in one or more variables through time. The random variation is generally based on fluctuations observed in historical data for a selected period. A large number of sim-

ulations, each of which reflects random variation in the variable(s), produce a distribution of potential outcomes.

Substantial gainful activity—SGA. The level of work activity used to establish disability. A finding of disability requires that a person be unable to engage in substantial gainful activity. A person who earns more than a certain monthly amount (net of impairment-related work expenses) is ordinarily considered to be engaging in SGA. The amount of monthly earnings considered as SGA depends on the nature of a person's disability. The Social Security Act specifies a higher SGA amount for statutorily blind individuals; Federal regulations specify a lower SGA amount for non-blind individuals. Both SGA amounts increase with increases in the national average wage index.

Summarized balance. The difference between the summarized income rate and the summarized cost rate, expressed as a percentage of GDP. The difference between the summarized income rate and cost rate as a percentage of taxable payroll is referred to as the actuarial balance.

Summarized cost rate. The ratio of the present value of cost to the present value of the taxable payroll (or GDP) for the years in a given period, expressed as a percentage. To evaluate the financial adequacy of the program, the summarized cost rate is adjusted to include the cost of reaching and maintaining a target trust fund level. A trust fund level of about 1 year's cost is considered to be an adequate reserve for unforeseen contingencies; therefore, the targeted trust fund ratio is 100 percent of annual cost. Accordingly, the adjusted summarized cost rate is equal to the ratio of: (1) the sum of the present value of the cost during the period plus the present value of the targeted ending trust fund level to (2) the present value of the taxable payroll (or GDP) during the projection period.

Summarized income rate. The ratio of the present value of scheduled noninterest income to the present value of taxable payroll (or GDP) for the years in a given period, expressed as a percentage. To evaluate the financial adequacy of the program, the summarized income rate is adjusted to include asset reserves on hand at the beginning of the period. Accordingly, the adjusted summarized income rate equals the ratio of: (1) the sum of the trust fund reserve at the beginning of the period plus the present value of noninterest income during the period to (2) the present value of the taxable payroll (or GDP) for the years in the period.

Supplemental Security Income—SSI. A Federally administered program (often with State supplementation) of cash assistance for needy aged, blind, or disabled persons. The General Fund of the Treasury funds Federal expenditures for the SSI program. The Social Security Administration administers it.

Supplementary Medical Insurance (SMI) Trust Fund. See "Trust fund."

Survivor benefit. Benefit payable to a survivor of a deceased worker.

Sustainable solvency. Sustainable solvency for the financing of the program under a specified set of assumptions is achieved when the projected trust fund ratio is positive throughout the 75-year projection period and is either stable or rising at the end of the period.

Taxable earnings. Wages or self-employment income, in employment covered by the OASDI or HI programs, that is under the applicable annual maximum taxable limit. For 1994 and later, no maximum taxable limit applies to the HI program.

Taxable payroll. A weighted sum of taxable wages and taxable self-employment income. When multiplied by the combined employee-employer payroll tax rate, taxable payroll yields the total amount of payroll taxes incurred by employees, employers, and the self-employed for work during the period.

Taxable self-employment income. The maximum amount of net earnings from self-employment by an earner which, when added to any taxable wages, does not exceed the contribution and benefit base. For HI beginning in 1994, all net earnings from self-employment.

Taxable wages. See "Taxable earnings."

Taxation of benefits. Beginning in 1984, Federal law subjected up to 50 percent of an individual's or a couple's OASDI benefits to Federal income taxation under certain circumstances. Treasury allocates the revenue derived from this provision to the OASI and DI Trust Funds on the basis of the income taxes paid on the benefits from each fund. Beginning in 1994, the law increased the maximum percentage from 50 percent to 85 percent. The HI Trust Fund receives the additional tax revenue resulting from the increase to 85 percent.

Taxes. See "Payroll tax contributions" and "Taxation of benefits."

Termination. Cessation of payment because the beneficiary is no longer entitled to receive a specific type of benefit. For example, benefits might terminate as a result of the death of the beneficiary, the recovery of a disabled beneficiary, or the attainment of age 18 by a child beneficiary. In some cases, an individual may cease one benefit and this is not a termination because they become immediately entitled to another type of benefit, such as the conversion of a disabled-worker beneficiary at normal retirement age to a retired-worker beneficiary.

Test of long-range close actuarial balance. The conditions required to meet this test are:

- The trust fund satisfies the test of short-range financial adequacy; and
- The trust fund ratio stays above zero throughout the 75-year projection period, such that benefits would be payable in a timely manner throughout the period.

The Trustees apply the test to OASI, DI, and the combined OASDI program based on the intermediate set of assumptions.

Test of short-range financial adequacy. The conditions required to meet this test are:

- If the trust fund ratio is at least 100 percent at the beginning of the 10-year projection period, then it must remain at or above 100 percent throughout the entire projection period;
- If the ratio is initially less than 100 percent, then it must reach at least 100 percent within 5 years (without reserve depletion at any time during this period) and then remain at or above 100 percent throughout the remainder of the 10-year period.

The Trustees apply the test to OASI, DI, and the combined OASDI program based on the intermediate set of assumptions.

Total-economy productivity. The ratio of real GDP to hours worked by all workers. Also referred to as "labor productivity."

Total fertility rate. The sum of the single-year-of-age birth rates for girls and women aged 14 through 49, where the rate for age 14 includes births to girls aged 14 and under, and the rate for age 49 includes births to women aged 49 and over. The total fertility rate may be interpreted as the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, a specified year, and if she were to survive the entire childbearing period.

Trust fund. Separate accounts in the United States Treasury which hold the payroll taxes received under the Federal Insurance Contributions Act and the Self-Employment Contributions Act; payroll taxes resulting from coverage of State and local government employees; any sums received under the financial interchange with the railroad retirement account; voluntary hospital and medical insurance premiums; and reimbursements or payments from the General Fund of the Treasury. As required by law, the Department of the Treasury invests funds not required to meet current expenditures in interest-bearing securities backed by the full faith and credit of the U.S. Government. The interest earned is also deposited in the trust funds.

- **Old-Age and Survivors Insurance (OASI).** The trust fund used for paying monthly benefits to retired-worker (old-age) beneficiaries, their spouses and children, and to survivors of deceased insured workers.
- **Disability Insurance (DI).** The trust fund used for paying monthly benefits to disabled-worker beneficiaries, their spouses and children, and for providing rehabilitation services to the disabled.

- **Hospital Insurance (HI).** The Medicare trust fund that covers specified inpatient hospital services, posthospital skilled nursing care, home health services, and hospice care for aged and disabled individuals who meet the eligibility requirements. Also known as Medicare Part A.
- **Supplementary Medical Insurance (SMI).** The Medicare trust fund composed of the Part B Account, the Part D Account, and the Transitional Assistance Account. The Part B Account pays for a portion of the costs of physicians' services, outpatient hospital services, and other related medical and health services for voluntarily enrolled aged and disabled individuals. The Part D Account pays private plans to provide prescription drug coverage, beginning in 2006. The Transitional Assistance Account paid for transitional assistance under the prescription drug card program in 2004 and 2005.

The trust funds are distinct legal entities which operate independently. Fund operations are sometimes combined on a hypothetical basis.

Trust fund ratio. A measure of trust fund adequacy. The asset reserves at the beginning of a year (equal to the reserves at the end of the prior year), which do not include advance tax transfers, expressed as a percentage of the cost for the year. The trust fund ratio represents the proportion of a year's cost which could be paid solely with the reserves at the beginning of the year.

Trust fund reserve depletion. The point at which reserves in a trust fund are insufficient to pay scheduled benefits in full and on time.

Trust fund reserves. The cumulative excess of trust fund income over trust fund cost over all years to date. These reserves are held by the trust funds in the form of Treasury notes and bonds, other securities guaranteed by the Federal Government, certain Federally sponsored agency obligations, and cash.

Trustees. See "Board of Trustees."

Undisbursed balances. In general, refers to the cumulative differences between the actual cash payments for a month compared to security redemptions from the trust fund reserves made on a preliminary basis to cover such cash payments during the same month. On a monthly basis, the Social Security Administration (SSA) pays benefits and makes payments for other programmatic expenses associated with the trust funds. During each month, SSA draws cash from the trust funds on a preliminary basis, which results in Treasury redeeming invested securities to cover such payments. This monthly difference can be either positive or negative depending on net monthly activity, and is added to the balance at the end of the prior month.

A net positive undisbursed balance represents a situation where cumulative redemptions from the trust fund's securities are more than was needed to cover actual program cash payments through the end of the month. A net negative balance represents a situation where cumulative program cash pay-

ments exceeded the amount redeemed from the invested securities. A negative value requires future redemption of additional invested securities.

In addition, about every seven years, when January 3 falls on a Sunday, benefit payments scheduled to be paid on January 3rd are actually paid on December 31 of the preceding year, as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Consistent with practice in prior reports and for comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year. Therefore, such advance payments are included as positive values in the undisbursed balance at the end of the calendar years in which the advance payments are made.

Unfunded obligation. A measure of the shortfall of trust fund income to fully cover program cost through a specified date after depletion of trust fund asset reserves. This measure can be expressed in present value dollars, discounted to the beginning of the valuation period, by computing the excess of the present value of the projected cost of the program through a specified date over the sum of: (1) the value of trust fund reserves at the beginning of the valuation period; and (2) the present value of the projected non-interest income of the program through a specified date, assuming scheduled tax rates and benefit levels. This measure can apply for all participants through a specified date, i.e., the open group, or be limited to a specified subgroup of participants.

Unfunded obligation ratio. The unfunded obligation accumulated through the beginning of a year expressed as a percentage of the cost for the year.

Unnegotiated check. A check which has not been cashed 6 months after the end of the month in which the check was issued. When a check has been outstanding for a year, the Department of the Treasury administratively cancels the check and reimburses the issuing trust fund separately for the amount of the check and interest for the period the check was outstanding. The appropriate trust fund also receives an interest adjustment for the time the check was outstanding if it is cashed 6 to 12 months after the month of issue. If a check is presented for payment after it has been administratively canceled, a replacement check is issued.

Valuation period. A period of years which is considered as a unit for purposes of calculating the financial status of a trust fund.

Vocational rehabilitation (VR). Services provided to disabled persons to help them to return to gainful employment. VR services are designed to provide an individual with the training or other services that are needed to return to work, to begin working, or to enter a new line of work. The trust funds, and the General Fund in the case of individuals also receiving Supplemental

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STATEMENT OF ACTUARIAL OPINION

It is my opinion that: (1) the techniques and methodology used herein to evaluate the actuarial status of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds are based upon sound principles of actuarial practice and are generally accepted within the actuarial profession; and (2) the assumptions used and the resulting actuarial estimates are, individually and in the aggregate, reasonable for the purpose of evaluating the actuarial status of the trust funds, taking into consideration the past experience and future expectations for the population, the economy, and the program. I am a member of the American Academy of Actuaries and I meet the Qualification Standards of the American Academy of Actuaries to render this actuarial opinion.

Stephen C. Goss

Associate, Society of Actuaries
Member, American Academy of Actuaries
Chief Actuary, Social Security Administration

Occupational separations and openings

Top

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Table 1.10 Occupational separations and openings, projected 2024–34 (Employment in thousands)

Matrix title	Matrix code	2024 National Employment type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Total, all occupations	00-0000	Summary	169,956.1	175,167.9	5,211.8	3.1	4.7	5.9	10.6	8,155.0	10,187.1	18,342.1	18,863.3
Management occupations	11-0000	Summary	13,607.6	14,441.0	833.4	6.1	2.8	4.7	7.6	398.9	665.6	1,064.5	1,147.9
Top executives	11-1000	Summary	4,049.9	4,228.1	178.2	4.4	2.4	5.2	7.6	98.2	217.1	315.3	333.1
Chief executives	11-1011	Line item	309.4	322.7	13.3	4.3	3.0	3.6	6.6	9.5	11.4	20.9	22.2
General and operations managers	11-1021	Line item	3,712.9	3,876.8	164.0	4.4	2.3	5.4	7.7	87.9	204.5	292.3	308.7
Legislators	11-1031	Line item	27.7	28.6	0.9	3.4	2.9	4.5	7.4	0.8	1.3	2.1	2.2
Advertising, marketing, promotions, public relations, and sales managers	11-2000	Summary	1,182.4	1,243.5	61.2	5.2	2.2	5.2	7.4	26.9	62.5	89.5	95.6
Advertising and promotions managers	11-2011	Line item	27.0	26.4	-0.6	-2.2	2.4	5.5	7.9	0.6	1.5	2.1	2.1
Marketing and sales managers	11-2020	Summary	1,026.5	1,082.2	55.7	5.4	2.2	5.2	7.4	23.2	54.5	77.7	83.3
Marketing managers	11-2021	Line item	407.0	433.7	26.7	6.6	2.1	5.4	7.5	8.8	22.8	31.7	34.3
Sales managers	11-2022	Line item	619.5	648.5	29.0	4.7	2.3	5.0	7.3	14.4	31.7	46.1	49.0
Public relations and fundraising managers	11-2030	Summary	128.9	134.9	6.1	4.7	2.3	5.0	7.3	3.1	6.6	9.6	10.2
Public relations managers	11-2032	Line item	83.2	87.3	4.1	5.0	2.3	5.0	7.3	2.0	4.2	6.2	6.6
Fundraising managers	11-2033	Line item	45.7	47.6	1.9	4.2	2.3	5.0	7.3	1.1	2.3	3.4	3.6
Operations specialties managers	11-3000	Summary	2,789.5	3,072.3	282.7	10.1	2.5	4.5	6.9	72.3	131.2	203.5	231.7
Administrative services and facilities managers	11-3010	Summary	422.6	440.9	18.3	4.3	3.4	4.6	8.0	14.7	19.9	34.6	36.4
Administrative services managers	11-3012	Line item	271.2	283.8	12.6	4.6	3.2	4.7	7.9	8.9	13.0	22.0	23.2
Facilities managers	11-3013	Line item	151.4	157.1	5.7	3.8	3.7	4.4	8.2	5.8	6.8	12.6	13.2
Computer and information systems managers	11-3021	Line item	667.1	768.7	101.6	15.2	1.8	4.5	6.3	13.1	32.3	45.4	55.6
Financial managers	11-3031	Line item	868.6	997.4	128.8	14.8	2.5	4.1	6.6	23.4	38.3	61.7	74.6
Industrial production managers	11-3051	Line item	241.9	246.5	4.6	1.9	2.4	4.4	6.8	5.8	10.8	16.7	17.1
Purchasing managers	11-3061	Line item	83.5	86.1	2.6	3.1	2.7	4.6	7.3	2.3	3.9	6.2	6.4
Transportation, storage, and distribution managers	11-3071	Line item	216.7	229.8	13.1	6.1	2.5	5.2	7.7	5.6	11.6	17.2	18.5
Compensation and benefits managers	11-3111	Line item	20.9	20.9	0.0	0.2	2.9	4.1	7.0	0.6	0.9	1.5	1.5
Human resources managers	11-3121	Line item	221.9	233.0	11.1	5.0	2.5	4.9	7.4	5.7	11.1	16.7	17.9
Training and development managers	11-3131	Line item	46.4	49.2	2.7	5.8	2.4	5.1	7.5	1.1	2.4	3.6	3.8
Other management occupations	11-9000	Summary	5,585.8	5,897.1	311.3	5.6	3.5	4.4	7.9	201.5	254.8	456.3	487.4
Farmers, ranchers, and other agricultural managers	11-9013	Line item	836.1	825.0	-11.1	-1.3	7.1	3.3	10.4	59.0	27.6	86.6	85.5

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Construction managers	11-9021	Line item	550.3	598.4	48.1	8.7	2.5	4.9	7.3	14.1	27.9	42.0	46.8
Education and childcare administrators	11-9030	Summary	710.2	708.2	-2.0	-0.3	2.4	4.0	6.5	17.1	28.6	45.8	45.6
Education and childcare administrators, preschool and daycare	11-9031	Line item	90.2	87.9	-2.3	-2.5	2.4	4.0	6.5	2.2	3.6	5.7	5.5
Education administrators, kindergarten through secondary	11-9032	Line item	333.3	328.1	-5.1	-1.5	2.4	4.0	6.5	8.0	13.3	21.3	20.8
Education administrators, postsecondary	11-9033	Line item	226.6	230.5	4.0	1.7	2.4	4.0	6.5	5.5	9.2	14.8	15.1
Education administrators, all other	11-9039	Line item	60.2	61.7	1.5	2.5	2.4	4.0	6.5	1.5	2.5	3.9	4.1
Architectural and engineering managers	11-9041	Line item	212.5	220.5	8.0	3.8	2.2	4.2	6.3	4.7	9.0	13.7	14.5
Food service managers	11-9051	Line item	352.8	375.3	22.6	6.4	3.5	7.4	10.9	12.7	27.0	39.8	42.0
Entertainment and recreation managers	11-9070	Summary	48.3	51.7	3.4	7.0	4.4	7.1	11.6	2.2	3.6	5.8	6.1
Gambling managers	11-9071	Line item	5.1	5.2	0.1	1.2	4.4	7.1	11.6	0.2	0.4	0.6	0.6
Entertainment and recreation managers, except gambling	11-9072	Line item	43.2	46.5	3.3	7.7	4.4	7.1	11.6	2.0	3.2	5.2	5.5
Lodging managers	11-9081	Line item	52.0	53.8	1.8	3.4	3.9	6.0	9.9	2.0	3.2	5.2	5.4
Medical and health services managers	11-9111	Line item	616.2	759.1	142.9	23.2	2.6	4.3	7.0	18.0	29.8	47.8	62.1
Natural sciences managers	11-9121	Line item	104.3	108.2	3.9	3.7	2.2	5.4	7.6	2.3	5.8	8.1	8.5
Postmasters and mail superintendents	11-9131	Line item	13.1	12.7	-0.5	-3.5	2.9	4.5	7.4	0.4	0.6	1.0	0.9
Property, real estate, and community association managers	11-9141	Line item	466.1	483.1	17.0	3.6	4.3	3.6	7.9	20.2	17.1	37.3	39.0
Social and community service managers	11-9151	Line item	219.8	233.9	14.1	6.4	3.0	4.5	7.6	6.9	10.2	17.2	18.6
Emergency management directors	11-9161	Line item	13.2	13.6	0.4	3.0	2.9	4.6	7.5	0.4	0.6	1.0	1.0
Personal service managers	11-9170	Summary	57.1	60.1	3.0	5.2	2.9	4.5	7.4	1.7	2.6	4.3	4.6
Funeral home managers	11-9171	Line item	32.1	33.4	1.3	4.1	2.9	4.5	7.4	1.0	1.5	2.4	2.6
Personal service managers, all other	11-9179	Line item	25.1	26.7	1.6	6.5	2.9	4.5	7.4	0.8	1.2	1.9	2.1
Managers, all other	11-9199	Line item	1,333.7	1,393.5	59.8	4.5	2.9	4.5	7.4	39.6	61.1	100.7	106.7
Business and financial operations occupations	13-0000	Summary	11,262.0	11,848.9	586.9	5.2	3.0	4.6	7.6	348.6	535.2	883.8	942.5
Business operations specialists	13-1000	Summary	7,921.1	8,356.3	435.2	5.5	3.0	4.9	7.9	247.8	398.6	646.4	689.9
Agents and business managers of artists, performers, and athletes	13-1011	Line item	21.4	23.2	1.9	8.7	3.7	5.5	9.2	0.8	1.2	2.1	2.2
Buyers and purchasing agents	13-1020	Line item	522.2	552.3	30.1	5.8	3.9	5.2	9.2	21.2	28.1	49.2	52.2
Claims adjusters, appraisers, examiners, and investigators	13-1030	Summary	365.3	346.3	-18.9	-5.2	2.5	4.1	6.6	9.0	14.5	23.5	21.6
Claims adjusters, examiners, and investigators	13-1031	Line item	356.1	337.9	-18.2	-5.1	2.5	4.1	6.6	8.8	14.1	22.9	21.1
Insurance appraisers, auto damage	13-1032	Line item	9.2	8.4	-0.8	-8.2	2.5	4.1	6.6	0.2	0.4	0.6	0.5
Compliance officers	13-1041	Line item	418.0	430.3	12.3	3.0	3.3	4.2	7.6	14.1	17.9	32.0	33.3
Cost estimators	13-1051	Line item	221.4	212.1	-9.3	-4.2	2.8	5.4	8.2	6.2	11.7	17.9	16.9
Human resources workers	13-1070	Summary	1,013.7	1,072.3	58.6	5.8	2.8	5.0	7.8	29.6	51.7	81.3	87.2
Human resources specialists	13-1071	Line item	944.3	1,002.7	58.4	6.2	2.8	5.0	7.8	27.7	48.2	75.9	81.8

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Farm labor contractors	13-1074	Line item	3.9	4.2	0.2	6.0	2.8	5.0	7.8	0.1	0.2	0.3	0.3
Labor relations specialists	13-1075	Line item	65.4	65.4	-0.1	-0.1	2.8	5.0	7.8	1.9	3.2	5.1	5.1
Logisticians and project management specialists	13-1080	Summary	1,287.2	1,386.2	99.0	7.7	2.4	4.7	7.1	31.6	63.2	94.8	104.7
Logisticians	13-1081	Line item	241.0	281.3	40.3	16.7	2.5	6.0	8.6	6.6	15.8	22.4	26.4
Project management specialists	13-1082	Line item	1,046.3	1,105.0	58.7	5.6	2.3	4.4	6.7	25.0	47.4	72.4	78.2
Management analysts	13-1111	Line item	1,075.1	1,169.7	94.5	8.8	3.5	4.4	7.9	38.9	49.8	88.7	98.1
Meeting, convention, and event planners	13-1121	Line item	155.8	163.3	7.5	4.8	3.6	5.7	9.3	5.7	9.1	14.8	15.5
Fundraisers	13-1131	Line item	134.4	140.2	5.8	4.3	3.0	4.1	7.0	4.1	5.6	9.7	10.2
Compensation, benefits, and job analysis specialists	13-1141	Line item	107.0	112.7	5.6	5.3	2.9	4.3	7.2	3.2	4.7	7.9	8.5
Training and development specialists	13-1151	Line item	452.3	501.0	48.7	10.8	3.0	5.2	8.2	14.3	24.8	39.1	43.9
Market research analysts and marketing specialists	13-1161	Line item	941.7	1,004.7	63.0	6.7	2.8	5.5	8.3	27.4	53.5	80.9	87.2
Business operations specialists, all other	13-1199	Line item	1,205.7	1,242.0	36.3	3.0	3.4	5.1	8.5	41.8	62.8	104.6	108.2
Financial specialists	13-2000	Summary	3,340.9	3,492.6	151.7	4.5	3.0	4.0	6.9	100.8	136.6	237.4	252.6
Accountants and auditors	13-2011	Line item	1,579.8	1,652.6	72.8	4.6	3.1	4.2	7.2	49.7	67.2	116.9	124.2
Property appraisers and assessors	13-2020	Line item	77.3	80.2	2.9	3.8	4.5	3.1	7.6	3.5	2.4	6.0	6.3
Budget analysts	13-2031	Line item	50.4	51.0	0.5	1.0	2.2	3.8	6.0	1.1	1.9	3.0	3.1
Credit analysts	13-2041	Line item	67.8	64.8	-3.0	-4.4	1.9	4.2	6.1	1.2	2.8	4.0	3.7
Financial analysts and advisors	13-2050	Summary	881.9	934.9	53.0	6.0	2.6	3.7	6.3	23.2	33.8	57.0	62.3
Financial and investment analysts	13-2051	Line item	368.5	389.6	21.1	5.7	2.1	4.0	6.1	7.9	15.1	23.0	25.1
Personal financial advisors	13-2052	Line item	326.0	357.2	31.2	9.6	2.8	3.3	6.1	9.6	11.3	21.0	24.1
Insurance underwriters	13-2053	Line item	127.0	123.7	-3.3	-2.6	3.1	3.7	6.8	3.9	4.7	8.6	8.2
Financial risk specialists	13-2054	Line item	60.5	64.4	3.9	6.5	2.8	4.2	7.1	1.8	2.6	4.4	4.8
Financial examiners	13-2061	Line item	65.1	77.2	12.1	18.5	3.3	3.1	6.3	2.3	2.2	4.5	5.7
Credit counselors and loan officers	13-2070	Summary	333.2	339.3	6.1	1.8	2.7	3.8	6.5	9.0	12.9	21.9	22.5
Credit counselors	13-2071	Line item	31.8	32.9	1.1	3.3	2.7	3.8	6.5	0.9	1.2	2.1	2.2
Loan officers	13-2072	Line item	301.4	306.5	5.0	1.7	2.7	3.8	6.5	8.1	11.7	19.8	20.3
Tax examiners, collectors and preparers, and revenue agents	13-2080	Summary	148.2	151.2	3.0	2.1	4.6	5.0	9.6	6.8	7.5	14.4	14.7
Tax examiners and collectors, and revenue agents	13-2081	Line item	57.6	56.5	-1.0	-1.8	3.7	4.0	7.7	2.1	2.3	4.4	4.3
Tax preparers	13-2082	Line item	90.6	94.7	4.1	4.5	5.1	5.6	10.8	4.7	5.2	10.0	10.4
Financial specialists, all other	13-2099	Line item	137.1	141.4	4.3	3.1	2.8	4.2	7.1	4.0	5.9	9.8	10.3
Computer and mathematical occupations	15-0000	Summary	5,416.7	5,962.3	545.6	10.1	2.1	3.2	5.3	117.6	183.2	300.8	355.4
Computer occupations	15-1200	Summary	4,985.6	5,414.4	428.8	8.6	2.0	3.2	5.3	106.5	168.3	274.8	317.7
Computer and information analysts	15-1210	Summary	703.8	801.4	97.6	13.9	2.3	3.0	5.4	17.6	22.9	40.4	50.2
Computer systems analysts	15-1211	Line item	521.1	566.5	45.5	8.7	2.5	2.9	5.5	13.8	15.9	29.7	34.2
Information security analysts	15-1212	Line item	182.8	234.9	52.1	28.5	1.8	3.4	5.2	3.7	7.0	10.8	16.0
Computer and information research scientists	15-1221	Line item	40.3	48.3	7.9	19.7	1.7	3.7	5.4	0.8	1.6	2.4	3.2
Computer support specialists	15-1230	Summary	882.3	858.0	-24.2	-2.7	2.4	3.7	6.1	21.0	31.9	52.9	50.5
Computer network support specialists	15-1231	Line item	152.7	155.5	2.8	1.8	2.4	3.7	6.1	3.7	5.7	9.4	9.6
Computer user support specialists	15-1232	Line item	729.5	702.5	-27.0	-3.7	2.4	3.7	6.1	17.3	26.3	43.5	40.8

Source: Employment Projections program, U.S. Bureau of Labor Statistics

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Database and network administrators and architects	15-1240	Summary	655.6	668.4	12.9	2.0	1.9	3.0	4.8	12.5	19.6	32.0	33.3
Computer network architects	15-1241	Line item	179.2	200.6	21.4	11.9	1.7	3.1	4.8	3.2	5.8	9.0	11.2
Database administrators	15-1242	Line item	78.0	77.5	-0.5	-0.7	2.1	2.8	4.9	1.6	2.2	3.8	3.8
Database architects	15-1243	Line item	66.9	72.7	5.8	8.7	2.1	2.8	4.9	1.5	2.0	3.4	4.0
Network and computer systems administrators	15-1244	Line item	331.5	317.7	-13.8	-4.2	1.9	2.9	4.8	6.1	9.5	15.7	14.3
Software and web developers, programmers, and testers	15-1250	Summary	2,231.5	2,527.7	296.1	13.3	1.8	3.2	5.0	43.2	76.3	119.6	149.2
Computer programmers	15-1251	Line item	121.2	113.9	-7.2	-6.0	2.2	3.0	5.3	2.6	3.6	6.2	5.5
Software developers	15-1252	Line item	1,693.8	1,961.4	267.7	15.8	1.7	3.2	4.8	30.7	57.7	88.4	115.2
Software quality assurance analysts and testers	15-1253	Line item	201.7	221.9	20.2	10.0	2.4	3.3	5.7	5.0	7.0	12.0	14.0
Web developers	15-1254	Line item	86.0	92.5	6.5	7.5	1.9	3.5	5.4	1.7	3.1	4.8	5.4
Web and digital interface designers	15-1255	Line item	128.9	137.9	9.0	7.0	2.4	3.7	6.1	3.2	4.9	8.2	9.1
Computer occupations, all other	15-1299	Line item	472.0	510.5	38.5	8.2	2.3	3.2	5.6	11.5	15.9	27.4	31.3
Mathematical science occupations	15-2000	Summary	431.1	547.9	116.8	27.1	2.3	3.0	5.3	11.1	14.9	26.1	37.7
Actuaries	15-2011	Line item	33.6	40.9	7.3	21.8	1.8	2.6	4.4	0.7	1.0	1.6	2.4
Mathematicians	15-2021	Line item	2.4	2.4	0.0	-0.7	2.0	3.2	5.3	0.0	0.1	0.1	0.1
Operations research analysts	15-2031	Line item	112.1	136.2	24.1	21.5	3.1	2.7	5.8	3.9	3.3	7.2	9.6
Statisticians	15-2041	Line item	32.2	34.9	2.7	8.5	2.0	3.2	5.3	0.7	1.1	1.8	2.0
Data scientists	15-2051	Line item	245.9	328.3	82.5	33.5	2.0	3.2	5.3	5.8	9.3	15.1	23.4
Mathematical science occupations, all other	15-2099	Line item	5.0	5.2	0.2	4.0	2.0	3.2	5.3	0.1	0.2	0.3	0.3
Architecture and engineering occupations	17-0000	Summary	2,648.4	2,788.3	139.9	5.3	2.5	3.8	6.3	68.4	104.1	172.5	186.5
Architects, surveyors, and cartographers	17-1000	Summary	215.0	223.9	8.9	4.1	2.9	3.3	6.2	6.3	7.2	13.5	14.4
Architects, except naval	17-1010	Summary	145.4	151.0	5.6	3.8	2.6	3.4	6.0	3.9	5.0	8.9	9.5
Architects, except landscape and naval	17-1011	Line item	123.6	128.4	4.8	3.9	2.5	3.3	5.8	3.1	4.2	7.3	7.8
Landscape architects	17-1012	Line item	21.8	22.6	0.8	3.5	3.4	4.0	7.3	0.7	0.9	1.6	1.7
Surveyors, cartographers, and photogrammetrists	17-1020	Summary	69.6	72.9	3.3	4.8	3.4	3.1	6.4	2.4	2.2	4.6	4.9
Cartographers and photogrammetrists	17-1021	Line item	13.4	14.3	0.9	6.4	3.4	3.1	6.4	0.5	0.4	0.9	1.0
Surveyors	17-1022	Line item	56.1	58.6	2.5	4.4	3.4	3.1	6.4	1.9	1.8	3.7	3.9
Engineers	17-2000	Summary	1,790.3	1,913.3	123.0	6.9	2.1	3.4	5.5	39.7	62.6	102.3	114.6
Aerospace engineers	17-2011	Line item	71.6	75.9	4.4	6.1	2.4	3.1	5.5	1.8	2.3	4.1	4.5
Agricultural engineers	17-2021	Line item	1.7	1.8	0.1	5.9	2.0	3.4	5.4	0.0	0.1	0.1	0.1
Bioengineers and biomedical engineers	17-2031	Line item	22.2	23.3	1.1	5.2	2.0	3.4	5.4	0.5	0.8	1.2	1.3
Chemical engineers	17-2041	Line item	21.6	22.1	0.6	2.6	1.6	3.2	4.8	0.4	0.7	1.1	1.1
Civil engineers	17-2051	Line item	368.9	387.5	18.5	5.0	2.1	3.7	5.8	7.8	14.0	21.8	23.6
Computer hardware engineers	17-2061	Line item	76.8	82.4	5.6	7.3	2.0	3.2	5.2	1.6	2.6	4.2	4.7
Electrical and electronics engineers	17-2070	Summary	287.9	307.6	19.7	6.9	2.2	3.0	5.2	6.6	8.9	15.5	17.5
Electrical engineers	17-2071	Line item	192.0	205.7	13.8	7.2	2.2	3.0	5.2	4.4	5.9	10.4	11.7
Electronics engineers, except computer	17-2072	Line item	95.9	101.8	6.0	6.2	2.2	3.0	5.2	2.2	2.9	5.2	5.7
Environmental engineers	17-2081	Line item	39.4	41.0	1.5	3.9	3.2	3.8	7.0	1.3	1.5	2.8	3.0
Industrial engineers, including health and safety	17-2110	Summary	374.9	414.5	39.6	10.6	2.2	3.6	5.8	8.5	14.2	22.8	26.8
Health and safety engineers, except mining safety	17-2111	Line item	23.8	24.9	1.1	4.4	2.2	3.6	5.8	0.5	0.9	1.4	1.5

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
engineers and inspectors													
Industrial engineers	17-2112	Line item	351.1	389.6	38.5	11.0	2.2	3.6	5.8	8.0	13.4	21.4	25.2
Marine engineers and naval architects	17-2121	Line item	8.5	9.0	0.5	5.8	2.7	3.9	6.6	0.2	0.3	0.6	0.6
Materials engineers	17-2131	Line item	23.0	24.3	1.3	5.7	2.5	3.1	5.6	0.6	0.7	1.3	1.5
Mechanical engineers	17-2141	Line item	293.1	319.6	26.5	9.1	1.9	3.2	5.1	5.8	9.7	15.5	18.1
Mining and geological engineers, including mining safety engineers	17-2151	Line item	7.0	7.0	0.0	0.7	2.0	4.0	6.0	0.1	0.3	0.4	0.4
Nuclear engineers	17-2161	Line item	15.4	15.3	-0.2	-1.1	2.3	3.3	5.6	0.4	0.5	0.9	0.8
Petroleum engineers	17-2171	Line item	19.6	19.8	0.2	1.3	2.0	4.0	6.0	0.4	0.8	1.2	1.2
Engineers, all other	17-2199	Line item	158.8	162.1	3.3	2.1	2.3	3.3	5.6	3.7	5.3	9.0	9.3
Drafters, engineering technicians, and mapping technicians	17-3000	Summary	643.1	651.2	8.1	1.3	3.5	5.3	8.8	22.5	34.3	56.7	57.5
Drafters	17-3010	Summary	192.1	191.5	-0.6	-0.3	3.6	4.8	8.5	7.0	9.3	16.2	16.2
Architectural and civil drafters	17-3011	Line item	110.5	115.1	4.6	4.1	3.8	4.6	8.4	4.3	5.2	9.5	10.0
Electrical and electronics drafters	17-3012	Line item	21.6	20.4	-1.2	-5.6	3.4	5.1	8.5	0.7	1.1	1.8	1.7
Mechanical drafters	17-3013	Line item	42.9	40.1	-2.8	-6.5	3.4	5.1	8.5	1.4	2.1	3.5	3.3
Drafters, all other	17-3019	Line item	17.1	15.9	-1.2	-6.9	3.4	5.1	8.5	0.6	0.8	1.4	1.3
Engineering technologists and technicians, except drafters	17-3020	Summary	391.6	397.7	6.0	1.5	3.4	5.0	8.4	13.3	19.9	33.1	33.7
Aerospace engineering and operations technologists and technicians	17-3021	Line item	9.3	10.1	0.8	8.1	3.2	5.0	8.3	0.3	0.5	0.8	0.9
Civil engineering technologists and technicians	17-3022	Line item	64.9	66.2	1.4	2.1	3.2	5.0	8.3	2.1	3.3	5.4	5.5
Electrical and electronic engineering technologists and technicians	17-3023	Line item	93.7	94.3	0.6	0.6	3.8	5.0	8.8	3.6	4.7	8.3	8.4
Electro-mechanical and mechatronics technologists and technicians	17-3024	Line item	15.0	15.1	0.2	1.1	3.2	5.0	8.3	0.5	0.8	1.2	1.3
Environmental engineering technologists and technicians	17-3025	Line item	12.9	13.0	0.1	1.2	3.2	5.0	8.3	0.4	0.7	1.1	1.1
Industrial engineering technologists and technicians	17-3026	Line item	74.6	75.9	1.3	1.7	3.2	5.0	8.3	2.4	3.8	6.2	6.3
Mechanical engineering technologists and technicians	17-3027	Line item	38.3	38.3	0.0	0.0	3.2	5.0	8.3	1.2	1.9	3.2	3.2
Calibration technologists and technicians	17-3028	Line item	15.8	16.5	0.7	4.7	3.2	5.0	8.3	0.5	0.8	1.3	1.4
Engineering technologists and technicians, except drafters, all other	17-3029	Line item	67.3	68.3	1.0	1.5	3.2	5.0	8.3	2.2	3.4	5.6	5.7
Surveying and mapping technicians	17-3031	Line item	59.4	62.1	2.7	4.5	3.6	8.5	12.1	2.2	5.2	7.4	7.6
Life, physical, and social science occupations	19-0000	Summary	1,609.5	1,690.4	80.9	5.0	2.0	6.3	8.3	33.3	103.4	136.7	144.7
Life scientists	19-1000	Summary	404.8	428.8	24.0	5.9	1.7	4.5	6.2	7.0	18.9	26.0	28.4
Agricultural and food scientists	19-1010	Summary	38.7	41.0	2.3	5.9	1.5	5.8	7.3	0.6	2.3	2.9	3.1
Animal scientists	19-1011	Line item	2.8	2.9	0.2	5.8	1.5	5.8	7.3	0.0	0.2	0.2	0.2
Food scientists and technologists	19-1012	Line item	15.2	16.2	1.0	6.5	1.5	5.8	7.3	0.2	0.9	1.1	1.2
Soil and plant scientists	19-1013	Line item	20.7	21.8	1.1	5.4	1.5	5.8	7.3	0.3	1.2	1.6	1.7
Biological scientists	19-1020	Summary	138.3	142.3	4.0	2.9	2.0	5.5	7.4	2.8	7.7	10.4	10.8
Biochemists and biophysicists	19-1021	Line item	35.6	37.6	2.1	5.8	2.0	5.5	7.4	0.7	2.0	2.7	2.9

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2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Microbiologists	19-1022	Line item	20.7	21.6	0.8	4.1	2.0	5.5	7.4	0.4	1.2	1.6	1.7
Zoologists and wildlife biologists	19-1023	Line item	18.2	18.5	0.3	1.6	2.0	5.5	7.4	0.4	1.0	1.4	1.4
Biological scientists, all other	19-1029	Line item	63.7	64.5	0.8	1.2	2.0	5.5	7.4	1.3	3.5	4.8	4.8
Conservation scientists and foresters	19-1030	Summary	42.4	43.5	1.1	2.7	2.5	5.6	8.1	1.1	2.4	3.5	3.6
Conservation scientists	19-1031	Line item	28.5	29.5	1.0	3.4	2.5	5.6	8.1	0.7	1.6	2.4	2.5
Foresters	19-1032	Line item	13.8	14.0	0.2	1.2	2.5	5.6	8.1	0.3	0.8	1.1	1.1
Medical scientists	19-1040	Summary	177.6	194.0	16.3	9.2	1.4	3.4	4.7	2.5	6.3	8.8	10.4
Epidemiologists	19-1041	Line item	12.3	14.3	2.0	16.2	1.4	3.4	4.7	0.2	0.4	0.6	0.8
Medical scientists, except epidemiologists	19-1042	Line item	165.3	179.6	14.3	8.7	1.4	3.4	4.7	2.3	5.8	8.1	9.6
Life scientists, all other	19-1099	Line item	7.8	8.1	0.3	3.7	1.4	3.4	4.7	0.1	0.3	0.4	0.4
Physical scientists	19-2000	Summary	284.9	295.7	10.8	3.8	1.8	5.5	7.3	5.4	16.0	21.3	22.4
Astronomers and physicists	19-2010	Summary	26.4	27.4	1.0	3.9	2.4	3.8	6.2	0.6	1.0	1.7	1.8
Astronomers	19-2011	Line item	1.8	1.8	0.0	2.2	2.4	3.8	6.2	0.0	0.1	0.1	0.1
Physicists	19-2012	Line item	24.6	25.6	1.0	4.0	2.4	3.8	6.2	0.6	1.0	1.6	1.7
Atmospheric and space scientists	19-2021	Line item	9.4	9.5	0.1	0.7	1.8	5.8	7.6	0.2	0.5	0.7	0.7
Chemists and materials scientists	19-2030	Summary	95.5	100.2	4.7	4.9	1.6	5.0	6.6	1.6	4.9	6.5	7.0
Chemists	19-2031	Line item	86.8	91.0	4.3	4.9	1.6	5.0	6.6	1.5	4.4	5.9	6.3
Materials scientists	19-2032	Line item	8.7	9.1	0.4	4.9	1.6	5.0	6.6	0.1	0.4	0.6	0.6
Environmental scientists and geoscientists	19-2040	Summary	121.7	126.5	4.8	4.0	2.0	6.5	8.5	2.4	8.0	10.5	11.0
Environmental scientists and specialists, including health	19-2041	Line item	90.3	94.3	4.0	4.4	2.0	6.8	8.8	1.8	6.3	8.1	8.5
Geoscientists, except hydrologists and geographers	19-2042	Line item	25.1	26.0	0.8	3.2	1.9	5.6	7.5	0.5	1.4	1.9	2.0
Hydrologists	19-2043	Line item	6.3	6.3	0.0	-0.1	1.9	5.6	7.5	0.1	0.3	0.5	0.5
Physical scientists, all other	19-2099	Line item	31.9	32.1	0.2	0.6	1.6	4.5	6.1	0.5	1.5	1.9	2.0
Social scientists and related workers	19-3000	Summary	339.9	352.5	12.6	3.7	2.5	3.8	6.3	8.5	13.3	21.8	23.1
Economists	19-3011	Line item	17.6	17.8	0.2	1.2	1.5	3.7	5.2	0.3	0.7	0.9	0.9
Survey researchers	19-3022	Line item	8.8	8.3	-0.5	-5.2	2.0	6.2	8.2	0.2	0.5	0.7	0.7
Psychologists	19-3030	Summary	204.3	216.0	11.8	5.8	2.8	2.7	5.6	5.9	5.7	11.7	12.9
Industrial-organizational psychologists	19-3032	Line item	5.6	5.9	0.3	6.3	3.7	2.7	6.4	0.2	0.2	0.4	0.4
Clinical and counseling psychologists	19-3033	Line item	76.3	84.8	8.5	11.2	2.7	2.2	4.9	2.2	1.8	3.9	4.8
School psychologists	19-3034	Line item	67.2	67.7	0.5	0.7	2.2	3.4	5.6	1.5	2.3	3.8	3.8
Psychologists, all other	19-3039	Line item	55.3	57.7	2.4	4.3	3.7	2.7	6.4	2.1	1.5	3.6	3.9
Sociologists	19-3041	Line item	3.4	3.6	0.1	3.6	2.0	6.2	8.2	0.1	0.2	0.3	0.3
Urban and regional planners	19-3051	Line item	44.7	46.2	1.5	3.4	1.8	5.3	7.1	0.8	2.4	3.3	3.4
Miscellaneous social scientists and related workers	19-3090	Summary	61.0	60.5	-0.5	-0.9	2.0	6.2	8.2	1.2	3.7	5.0	4.9
Anthropologists and archeologists	19-3091	Line item	8.8	9.2	0.3	3.7	2.0	6.2	8.2	0.2	0.6	0.7	0.8
Geographers	19-3092	Line item	1.5	1.5	0.0	-3.1	2.0	6.2	8.2	0.0	0.1	0.1	0.1
Historians	19-3093	Line item	3.4	3.5	0.1	2.2	2.0	6.2	8.2	0.1	0.2	0.3	0.3
Political scientists	19-3094	Line item	6.5	6.3	-0.2	-3.1	2.0	6.2	8.2	0.1	0.4	0.5	0.5
Social scientists and related workers, all other	19-3099	Line item	40.8	40.1	-0.7	-1.7	2.0	6.2	8.2	0.8	2.5	3.3	3.2
Life, physical, and social science technicians	19-4000	Summary	416.2	430.5	14.3	3.4	2.2	9.9	12.1	9.1	42.1	51.2	52.6
Agricultural and food science technicians	19-4010	Summary	38.9	40.7	1.8	4.6	2.1	12.8	14.9	0.8	5.1	5.9	6.1

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Agricultural technicians	19-4012	Line item	18.6	19.4	0.8	4.3	2.1	12.8	14.9	0.4	2.4	2.8	2.9
Food science technicians	19-4013	Line item	20.4	21.3	1.0	4.8	2.1	12.8	14.9	0.4	2.7	3.1	3.2
Biological technicians	19-4021	Line item	82.7	85.6	2.9	3.5	2.0	8.4	10.4	1.7	7.1	8.8	9.1
Chemical technicians	19-4031	Line item	57.0	59.0	2.1	3.7	1.8	9.4	11.3	1.1	5.5	6.5	6.7
Environmental science and geoscience technicians	19-4040	Summary	53.4	55.1	1.7	3.2	2.2	11.0	13.2	1.2	5.9	7.1	7.3
Environmental science and protection technicians, including health	19-4042	Line item	40.4	42.1	1.6	4.0	2.2	11.0	13.2	0.9	4.5	5.4	5.6
Geological technicians, except hydrologic technicians	19-4043	Line item	9.8	10.0	0.1	1.5	2.2	11.0	13.2	0.2	1.1	1.3	1.3
Hydrologic technicians	19-4044	Line item	3.1	3.0	-0.1	-2.1	2.2	11.0	13.2	0.1	0.3	0.4	0.4
Nuclear technicians	19-4051	Line item	6.0	5.5	-0.5	-7.7	2.2	11.0	13.2	0.1	0.6	0.8	0.7
Social science research assistants	19-4061	Line item	40.6	42.3	1.8	4.4	2.3	9.8	12.2	1.0	4.1	5.0	5.2
Forest and conservation technicians	19-4071	Line item	33.8	32.7	-1.1	-3.2	2.3	9.8	12.2	0.8	3.3	4.0	3.9
Miscellaneous life, physical, and social science technicians	19-4090	Summary	103.9	109.5	5.6	5.4	2.3	9.8	12.2	2.5	10.5	13.0	13.5
Forensic science technicians	19-4092	Line item	20.7	23.3	2.6	12.8	2.3	9.8	12.2	0.5	2.2	2.7	2.9
Life, physical, and social science technicians, all other	19-4099	Line item	83.2	86.2	2.9	3.5	2.3	9.8	12.2	2.0	8.3	10.3	10.6
Occupational health and safety specialists and technicians	19-5000	Summary	163.7	183.0	19.2	11.7	1.9	7.6	9.4	3.2	13.2	16.4	18.3
Occupational health and safety specialists	19-5011	Line item	131.9	148.4	16.5	12.5	1.9	7.6	9.4	2.6	10.6	13.2	14.9
Occupational health and safety technicians	19-5012	Line item	31.9	34.6	2.7	8.5	1.9	7.6	9.4	0.6	2.5	3.1	3.4
Community and social service occupations	21-0000	Summary	3,196.9	3,409.2	212.3	6.6	4.0	4.8	8.9	133.0	159.5	292.5	313.7
Counselors, social workers, and other community and social service specialists	21-1000	Summary	2,707.5	2,913.8	206.3	7.6	3.9	4.8	8.7	108.8	136.3	245.1	265.8
Counselors	21-1010	Summary	1,098.6	1,212.8	114.2	10.4	3.6	4.5	8.0	41.5	51.5	93.0	104.4
Educational, guidance, and career counselors and advisors	21-1012	Line item	376.3	389.6	13.3	3.5	3.3	4.4	7.7	12.8	16.8	29.6	31.0
Marriage and family therapists	21-1013	Line item	77.8	87.7	9.8	12.6	4.4	3.7	8.1	3.7	3.0	6.7	7.7
Rehabilitation counselors	21-1015	Line item	91.9	93.2	1.3	1.4	5.3	5.4	10.6	4.9	5.0	9.8	10.0
Substance abuse, behavioral disorder, and mental health counselors	21-1018	Line item	483.5	564.6	81.0	16.8	3.3	4.4	7.7	17.2	23.0	40.2	48.3
Counselors, all other	21-1019	Line item	69.1	77.8	8.7	12.6	3.9	5.0	9.0	2.9	3.7	6.6	7.4
Social workers	21-1020	Summary	810.9	855.6	44.7	5.5	3.9	4.5	8.3	32.4	37.1	69.5	74.0
Child, family, and school social workers	21-1021	Line item	399.9	413.3	13.4	3.4	3.8	4.5	8.3	15.5	18.2	33.7	35.1
Healthcare social workers	21-1022	Line item	193.2	208.1	14.8	7.7	3.7	4.8	8.4	7.3	9.6	17.0	18.4
Mental health and substance abuse social workers	21-1023	Line item	136.8	150.1	13.3	9.7	4.7	3.8	8.5	6.8	5.4	12.2	13.5
Social workers, all other	21-1029	Line item	81.0	84.1	3.1	3.9	3.3	4.7	8.1	2.7	3.9	6.6	7.0
Miscellaneous community and social service specialists	21-1090	Summary	798.0	845.4	47.4	5.9	4.3	5.8	10.1	35.0	47.7	82.7	87.4
Health education specialists	21-1091	Line item	71.8	75.0	3.2	4.5	4.6	5.8	10.3	3.4	4.2	7.6	7.9

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Probation officers and correctional treatment specialists	21-1092	Line item	92.3	94.8	2.4	2.6	2.9	5.3	8.2	2.7	5.0	7.7	7.9
Social and human service assistants	21-1093	Line item	449.6	478.5	28.9	6.4	4.3	5.9	10.3	20.2	27.5	47.7	50.6
Community health workers	21-1094	Line item	65.1	72.5	7.4	11.3	4.6	5.8	10.3	3.2	4.0	7.1	7.8
Community and social service specialists, all other	21-1099	Line item	119.2	124.7	5.5	4.6	4.6	5.8	10.3	5.6	7.0	12.6	13.1
Religious workers	21-2000	Summary	489.4	495.4	6.0	1.2	4.9	4.7	9.6	24.2	23.2	47.3	47.9
Clergy	21-2011	Line item	262.0	264.6	2.6	1.0	4.5	4.1	8.6	11.9	10.8	22.7	23.0
Directors, religious activities and education	21-2021	Line item	138.9	141.8	2.9	2.1	4.5	5.2	9.7	6.3	7.3	13.6	13.8
Religious workers, all other	21-2099	Line item	88.4	89.0	0.6	0.6	6.7	5.7	12.5	6.0	5.1	11.1	11.1
Legal occupations	23-0000	Summary	1,418.2	1,456.5	38.3	2.7	2.2	3.3	5.6	32.3	47.6	80.0	83.8
Lawyers, judges, and related workers	23-1000	Summary	933.2	970.4	37.2	4.0	1.8	1.4	3.2	17.0	13.6	30.6	34.4
Lawyers and judicial law clerks	23-1010	Summary	879.3	915.5	36.2	4.1	1.8	1.4	3.2	16.0	12.9	28.9	32.5
Lawyers	23-1011	Line item	864.8	900.7	35.9	4.1	1.8	1.4	3.2	15.7	12.2	27.9	31.5
Judicial law clerks	23-1012	Line item	14.5	14.9	0.4	2.5	2.4	4.4	6.8	0.4	0.6	1.0	1.0
Judges, magistrates, and other judicial workers	23-1020	Summary	53.9	54.9	0.9	1.8	1.8	1.4	3.2	1.0	0.8	1.7	1.8
Administrative law judges, adjudicators, and hearing officers	23-1021	Line item	17.5	17.4	-0.1	-0.7	1.8	1.4	3.2	0.3	0.2	0.6	0.5
Arbitrators, mediators, and conciliators	23-1022	Line item	9.1	9.5	0.4	4.3	1.8	1.4	3.2	0.2	0.1	0.3	0.3
Judges, magistrate judges, and magistrates	23-1023	Line item	27.3	28.0	0.7	2.5	1.8	1.4	3.2	0.5	0.4	0.9	0.9
Legal support workers	23-2000	Summary	484.9	486.1	1.1	0.2	3.2	7.0	10.2	15.3	34.0	49.3	49.4
Paralegals and legal assistants	23-2011	Line item	376.2	376.8	0.6	0.2	3.2	7.2	10.4	12.0	27.2	39.2	39.3
Miscellaneous legal support workers	23-2090	Summary	108.7	109.3	0.5	0.5	3.1	6.2	9.3	3.4	6.8	10.1	10.2
Title examiners, abstractors, and searchers	23-2093	Line item	57.4	58.5	1.1	2.0	3.0	6.2	9.2	1.7	3.6	5.3	5.4
Legal support workers, all other	23-2099	Line item	51.3	50.7	-0.6	-1.2	3.2	6.2	9.4	1.6	3.2	4.8	4.7
Educational instruction and library occupations	25-0000	Summary	9,813.2	9,875.4	62.2	0.6	4.5	4.5	9.0	439.8	444.3	884.1	890.3
Postsecondary teachers	25-1000	Summary	1,721.2	1,822.1	100.9	5.9	3.9	3.2	7.1	68.9	57.4	126.3	136.4
Business teachers, postsecondary	25-1011	Line item	103.1	109.0	5.8	5.7	3.9	3.2	7.1	4.1	3.4	7.6	8.1
Math and computer science teachers, postsecondary	25-1020	Summary	103.7	107.4	3.7	3.6	3.9	3.2	7.1	4.1	3.4	7.5	7.9
Computer science teachers, postsecondary	25-1021	Line item	44.8	47.2	2.4	5.3	3.9	3.2	7.1	1.8	1.5	3.3	3.5
Mathematical science teachers, postsecondary	25-1022	Line item	58.9	60.2	1.3	2.3	3.9	3.2	7.1	2.3	1.9	4.2	4.4
Engineering and architecture teachers, postsecondary	25-1030	Summary	62.0	66.3	4.3	7.0	3.9	3.2	7.1	2.5	2.1	4.6	5.0
Architecture teachers, postsecondary	25-1031	Line item	11.6	11.9	0.2	2.0	3.9	3.2	7.1	0.5	0.4	0.8	0.9
Engineering teachers, postsecondary	25-1032	Line item	50.3	54.4	4.1	8.1	3.9	3.2	7.1	2.0	1.7	3.7	4.1
Life sciences teachers, postsecondary	25-1040	Summary	78.3	83.6	5.3	6.8	3.9	3.2	7.1	3.1	2.6	5.8	6.3
Agricultural sciences teachers, postsecondary	25-1041	Line item	10.7	11.2	0.4	4.1	3.9	3.2	7.1	0.4	0.4	0.8	0.8
Biological science teachers, postsecondary	25-1042	Line item	66.0	70.8	4.8	7.3	3.9	3.2	7.1	2.7	2.2	4.9	5.4

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Forestry and conservation science teachers, postsecondary	25-1043	Line item	1.6	1.7	0.1	4.0	3.9	3.2	7.1	0.1	0.1	0.1	0.1
Physical sciences teachers, postsecondary	25-1050	Summary	65.5	67.1	1.6	2.5	3.9	3.2	7.1	2.6	2.1	4.7	4.9
Atmospheric, earth, marine, and space sciences teachers, postsecondary	25-1051	Line item	14.0	14.4	0.4	2.6	3.9	3.2	7.1	0.6	0.5	1.0	1.0
Chemistry teachers, postsecondary	25-1052	Line item	25.4	26.0	0.6	2.2	3.9	3.2	7.1	1.0	0.8	1.8	1.9
Environmental science teachers, postsecondary	25-1053	Line item	9.0	9.3	0.3	2.9	3.9	3.2	7.1	0.4	0.3	0.7	0.7
Physics teachers, postsecondary	25-1054	Line item	17.1	17.5	0.4	2.5	3.9	3.2	7.1	0.7	0.6	1.2	1.3
Social sciences teachers, postsecondary	25-1060	Summary	151.2	155.2	4.0	2.7	3.9	3.2	7.1	6.0	5.0	10.9	11.3
Anthropology and archeology teachers, postsecondary	25-1061	Line item	6.5	6.7	0.2	2.7	3.9	3.2	7.1	0.3	0.2	0.5	0.5
Area, ethnic, and cultural studies teachers, postsecondary	25-1062	Line item	14.5	14.8	0.3	2.4	3.9	3.2	7.1	0.6	0.5	1.0	1.1
Economics teachers, postsecondary	25-1063	Line item	15.8	16.1	0.3	2.1	3.9	3.2	7.1	0.6	0.5	1.1	1.2
Geography teachers, postsecondary	25-1064	Line item	4.0	4.2	0.1	3.3	3.9	3.2	7.1	0.2	0.1	0.3	0.3
Political science teachers, postsecondary	25-1065	Line item	21.8	22.2	0.4	2.0	3.9	3.2	7.1	0.9	0.7	1.6	1.6
Psychology teachers, postsecondary	25-1066	Line item	52.5	54.4	1.9	3.6	3.9	3.2	7.1	2.1	1.7	3.8	4.0
Sociology teachers, postsecondary	25-1067	Line item	15.4	15.7	0.3	2.1	3.9	3.2	7.1	0.6	0.5	1.1	1.1
Social sciences teachers, postsecondary, all other	25-1069	Line item	20.7	21.1	0.4	1.7	3.9	3.2	7.1	0.8	0.7	1.5	1.5
Health teachers, postsecondary	25-1070	Summary	381.2	446.6	65.4	17.2	3.9	3.2	7.1	16.1	13.4	29.5	36.0
Health specialties teachers, postsecondary	25-1071	Line item	289.6	339.7	50.1	17.3	3.9	3.2	7.1	12.2	10.2	22.4	27.4
Nursing instructors and teachers, postsecondary	25-1072	Line item	91.6	106.9	15.3	16.8	3.9	3.2	7.1	3.9	3.2	7.1	8.6
Education and library science teachers, postsecondary	25-1080	Summary	80.0	81.8	1.7	2.2	3.9	3.2	7.1	3.1	2.6	5.8	5.9
Education teachers, postsecondary	25-1081	Line item	74.9	76.5	1.6	2.1	3.9	3.2	7.1	2.9	2.5	5.4	5.6
Library science teachers, postsecondary	25-1082	Line item	5.1	5.3	0.2	3.0	3.9	3.2	7.1	0.2	0.2	0.4	0.4
Law, criminal justice, and social work teachers, postsecondary	25-1110	Summary	62.9	64.2	1.4	2.2	3.9	3.2	7.1	2.5	2.1	4.5	4.7
Criminal justice and law enforcement teachers, postsecondary	25-1111	Line item	16.2	16.5	0.3	2.0	3.9	3.2	7.1	0.6	0.5	1.2	1.2
Law teachers, postsecondary	25-1112	Line item	29.5	30.2	0.6	2.2	3.9	3.2	7.1	1.2	1.0	2.1	2.2
Social work teachers, postsecondary	25-1113	Line item	17.1	17.5	0.4	2.3	3.9	3.2	7.1	0.7	0.6	1.2	1.3
Arts, communications, history, and humanities teachers, postsecondary	25-1120	Summary	309.2	312.1	2.9	0.9	3.9	3.2	7.1	12.1	10.1	22.1	22.4
Art, drama, and music teachers,	25-1121	Line item	122.8	124.8	2.1	1.7	3.9	3.2	7.1	4.8	4.0	8.8	9.0

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postsecondary													
Communications teachers, postsecondary	25-1122	Line item	35.8	36.6	0.8	2.1	3.9	3.2	7.1	1.4	1.2	2.6	2.7
English language and literature teachers, postsecondary	25-1123	Line item	72.2	72.2	0.0	0.0	3.9	3.2	7.1	2.8	2.3	5.1	5.1
Foreign language and literature teachers, postsecondary	25-1124	Line item	26.4	26.4	0.0	-0.2	3.9	3.2	7.1	1.0	0.9	1.9	1.9
History teachers, postsecondary	25-1125	Line item	24.6	24.6	-0.1	-0.2	3.9	3.2	7.1	1.0	0.8	1.8	1.7
Philosophy and religion teachers, postsecondary	25-1126	Line item	27.3	27.5	0.2	0.7	3.9	3.2	7.1	1.1	0.9	2.0	2.0
Miscellaneous postsecondary teachers	25-1190	Summary	324.2	328.9	4.7	1.4	3.9	3.2	7.1	12.7	10.6	23.3	23.7
Family and consumer sciences teachers, postsecondary	25-1192	Line item	3.2	3.3	0.1	3.4	3.9	3.2	7.1	0.1	0.1	0.2	0.2
Recreation and fitness studies teachers, postsecondary	25-1193	Line item	15.4	15.7	0.4	2.4	3.9	3.2	7.1	0.6	0.5	1.1	1.1
Career/technical education teachers, postsecondary	25-1194	Line item	122.2	123.0	0.8	0.7	3.9	3.2	7.1	4.8	4.0	8.7	8.8
Postsecondary teachers, all other	25-1199	Line item	183.4	186.8	3.4	1.8	3.9	3.2	7.1	7.2	6.0	13.2	13.5
Preschool, elementary, middle, secondary, and special education teachers	25-2000	Summary	4,500.1	4,453.2	-46.9	-1.0	3.5	3.8	7.3	157.0	168.6	325.6	320.9
Preschool and kindergarten teachers	25-2010	Summary	672.3	693.3	21.0	3.1	4.7	6.4	11.1	32.2	43.9	76.1	78.2
Preschool teachers, except special education	25-2011	Line item	555.1	578.1	22.9	4.1	4.7	6.4	11.1	26.8	36.4	63.2	65.5
Kindergarten teachers, except special education	25-2012	Line item	117.2	115.2	-1.9	-1.6	4.7	6.4	11.1	5.5	7.5	13.0	12.8
Elementary and middle school teachers	25-2020	Summary	2,070.4	2,029.9	-40.6	-2.0	3.4	3.3	6.7	68.8	67.7	136.5	132.4
Elementary school teachers, except special education	25-2021	Line item	1,422.7	1,394.8	-27.9	-2.0	3.4	3.3	6.7	47.3	46.5	93.8	91.0
Middle school teachers, except special and career/technical education	25-2022	Line item	633.7	621.3	-12.4	-2.0	3.4	3.3	6.7	21.1	20.7	41.8	40.5
Career/technical education teachers, middle school	25-2023	Line item	14.0	13.8	-0.3	-2.0	3.4	3.3	6.7	0.5	0.5	0.9	0.9
Secondary school teachers	25-2030	Summary	1,197.9	1,178.2	-19.7	-1.6	3.1	3.2	6.3	36.5	37.9	74.4	72.4
Secondary school teachers, except special and career/technical education	25-2031	Line item	1,094.5	1,076.7	-17.8	-1.6	3.1	3.2	6.3	33.3	34.6	68.0	66.2
Career/technical education teachers, secondary school	25-2032	Line item	103.4	101.5	-1.9	-1.8	3.1	3.2	6.3	3.1	3.3	6.4	6.2
Special education teachers	25-2050	Summary	559.5	551.8	-7.7	-1.4	3.5	3.5	6.9	19.4	19.2	38.6	37.8
Special education teachers, preschool	25-2051	Line item	29.3	29.7	0.4	1.4	3.5	3.5	6.9	1.0	1.0	2.1	2.1
Special education teachers, kindergarten and elementary school	25-2052	Line item	230.2	226.1	-4.1	-1.8	3.5	3.5	6.9	8.0	7.9	15.9	15.4
Special education teachers, middle school	25-2057	Line item	94.8	93.0	-1.8	-1.9	3.5	3.5	6.9	3.3	3.2	6.5	6.3

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Special education teachers, secondary school	25-2058	Line item	164.2	161.5	-2.6	-1.6	3.5	3.5	6.9	5.7	5.6	11.3	11.1
Special education teachers, all other	25-2059	Line item	41.0	41.5	0.4	1.1	3.5	3.5	6.9	1.4	1.4	2.9	2.9
Other teachers and instructors	25-3000	Summary	1,337.7	1,357.1	19.4	1.4	6.4	6.2	12.6	85.9	83.6	169.5	171.4
Adult basic education, adult secondary education, and english as a second language instructors	25-3011	Line item	40.9	35.3	-5.6	-13.7	5.9	5.8	11.7	2.2	2.2	4.5	3.9
Self-enrichment teachers	25-3021	Line item	417.5	433.0	15.5	3.7	5.9	5.8	11.7	24.9	24.9	49.8	51.4
Substitute teachers, short-term	25-3031	Line item	510.1	518.5	8.4	1.6	5.9	5.8	11.7	30.2	30.1	60.2	61.1
Tutors	25-3041	Line item	215.5	216.8	1.3	0.6	9.0	8.1	17.1	19.5	17.4	36.9	37.1
Teachers and instructors, all other	25-3099	Line item	153.8	153.5	-0.2	-0.1	5.9	5.8	11.7	9.0	9.0	18.0	18.0
Librarians, curators, and archivists	25-4000	Summary	260.8	260.1	-0.7	-0.3	6.5	5.5	12.0	16.9	14.4	31.3	31.2
Archivists, curators, and museum technicians	25-4010	Summary	40.2	42.4	2.3	5.6	5.5	5.5	11.0	2.3	2.3	4.6	4.8
Archivists	25-4011	Line item	9.3	9.7	0.4	3.8	5.5	5.5	11.0	0.5	0.5	1.0	1.1
Curators	25-4012	Line item	15.1	16.2	1.1	7.0	5.5	5.5	11.0	0.9	0.9	1.7	1.8
Museum technicians and conservators	25-4013	Line item	15.7	16.5	0.8	5.4	5.5	5.5	11.0	0.9	0.9	1.8	1.9
Librarians and media collections specialists	25-4022	Line item	142.1	144.5	2.4	1.7	5.3	3.9	9.2	7.6	5.7	13.2	13.5
Library technicians	25-4031	Line item	78.6	73.2	-5.4	-6.8	9.3	8.5	17.8	7.0	6.5	13.5	13.0
Other educational instruction and library occupations	25-9000	Summary	1,993.3	1,982.9	-10.5	-0.5	5.6	6.0	11.6	111.2	120.2	231.5	230.4
Farm and home management educators	25-9021	Line item	12.4	12.1	-0.3	-2.5	4.9	4.3	9.2	0.6	0.5	1.1	1.1
Instructional coordinators	25-9031	Line item	232.6	235.5	2.9	1.3	4.9	4.3	9.2	11.5	10.1	21.6	21.9
Teaching assistants	25-9040	Summary	1,616.3	1,601.3	-15.1	-0.9	5.8	6.5	12.2	92.6	103.9	196.5	195.0
Teaching assistants, postsecondary	25-9044	Line item	193.6	199.6	6.0	3.1	5.8	6.5	12.2	11.3	12.7	24.0	24.6
Teaching assistants, except postsecondary	25-9045	Line item	1,422.8	1,401.7	-21.1	-1.5	5.8	6.5	12.2	81.3	91.2	172.5	170.4
Educational instruction and library workers, all other	25-9099	Line item	132.0	134.0	2.0	1.5	4.9	4.3	9.2	6.5	5.7	12.3	12.5
Arts, design, entertainment, sports, and media occupations	27-0000	Summary	3,021.1	3,104.6	83.5	2.8	3.9	5.2	9.2	120.4	160.6	281.0	289.4
Art and design workers	27-1000	Summary	950.3	971.8	21.5	2.3	3.7	4.9	8.6	35.7	47.0	82.7	84.9
Artists and related workers	27-1010	Summary	244.2	250.8	6.7	2.7	4.1	4.4	8.5	10.2	10.8	21.0	21.7
Art directors	27-1011	Line item	135.0	140.7	5.7	4.2	4.1	4.4	8.5	5.7	6.0	11.7	12.3
Craft artists	27-1012	Line item	11.6	11.9	0.2	2.1	4.1	4.4	8.5	0.5	0.5	1.0	1.0
Fine artists, including painters, sculptors, and illustrators	27-1013	Line item	26.5	26.2	-0.3	-1.2	4.1	4.4	8.5	1.1	1.2	2.2	2.2
Special effects artists and animators	27-1014	Line item	57.1	58.0	0.9	1.6	4.1	4.4	8.5	2.4	2.5	4.9	5.0
Artists and related workers, all other	27-1019	Line item	13.9	14.0	0.1	0.8	4.1	4.4	8.5	0.6	0.6	1.2	1.2
Designers	27-1020	Summary	706.1	721.0	14.9	2.1	3.6	5.1	8.6	25.5	36.2	61.7	63.2
Commercial and industrial designers	27-1021	Line item	30.6	31.6	1.0	3.2	3.0	4.7	7.7	0.9	1.5	2.4	2.5
Fashion designers	27-1022	Line item	25.7	26.2	0.5	2.0	3.4	5.3	8.7	0.9	1.4	2.3	2.3
Floral designers	27-1023	Line item	43.8	41.2	-2.6	-5.9	6.8	5.8	12.6	2.9	2.5	5.4	5.1
Graphic designers	27-1024	Line item	265.9	271.5	5.7	2.1	2.4	4.8	7.2	6.5	13.0	19.5	20.0
Interior designers	27-1025	Line item	87.1	89.9	2.8	3.2	3.9	4.5	8.4	3.5	4.0	7.5	7.8
Merchandise displayers and window trimmers	27-1026	Line item	193.0	199.3	6.2	3.2	4.7	5.6	10.3	9.2	11.0	20.2	20.8
Set and exhibit designers	27-1027	Line item	31.3	32.0	0.7	2.3	2.8	4.8	7.6	0.9	1.5	2.4	2.5

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Designers, all other	27-1029	Line item	28.6	29.2	0.6	2.0	2.8	4.8	7.6	0.8	1.4	2.2	2.2
Entertainers and performers, sports and related workers	27-2000	Summary	854.1	889.4	35.3	4.1	5.0	6.0	11.0	44.0	52.2	96.2	99.7
Actors, producers, and directors	27-2010	Summary	223.9	232.4	8.4	3.8	2.7	5.3	8.0	6.3	12.0	18.3	19.1
Actors	27-2011	Line item	57.0	57.1	0.2	0.3	4.5	6.5	11.0	2.6	3.7	6.3	6.3
Producers and directors	27-2012	Line item	167.0	175.2	8.3	4.9	2.2	4.9	7.0	3.7	8.3	12.0	12.8
Athletes, coaches, umpires, and related workers	27-2020	Summary	344.9	366.6	21.7	6.3	6.2	6.8	13.0	22.0	24.3	46.4	48.5
Athletes and sports competitors	27-2021	Line item	19.1	20.2	1.0	5.5	2.4	7.9	10.3	0.5	1.6	2.0	2.1
Coaches and scouts	27-2022	Line item	306.5	326.0	19.5	6.4	6.0	6.6	12.6	18.9	20.9	39.8	41.8
Umpires, referees, and other sports officials	27-2023	Line item	19.3	20.4	1.1	5.7	13.3	9.3	22.6	2.6	1.8	4.5	4.6
Dancers and choreographers	27-2030	Summary	17.0	17.8	0.8	4.9	5.7	8.1	13.8	1.0	1.4	2.4	2.5
Dancers	27-2031	Line item	12.3	12.9	0.6	4.5	5.7	8.1	13.8	0.7	1.0	1.7	1.8
Choreographers	27-2032	Line item	4.6	4.9	0.3	6.1	5.7	8.1	13.8	0.3	0.4	0.7	0.7
Musicians, singers, and related workers	27-2040	Summary	217.1	218.8	1.7	0.8	5.7	5.1	10.8	12.4	11.2	23.5	23.7
Music directors and composers	27-2041	Line item	47.3	47.2	-0.1	-0.3	4.0	5.1	9.1	1.9	2.4	4.3	4.3
Musicians and singers	27-2042	Line item	169.8	171.6	1.8	1.1	6.1	5.1	11.3	10.5	8.7	19.2	19.4
Miscellaneous entertainers and performers, sports and related workers	27-2090	Summary	51.2	53.9	2.7	5.3	4.4	6.2	10.6	2.3	3.3	5.6	5.8
Disc jockeys, except radio	27-2091	Line item	15.4	16.0	0.6	3.8	3.6	5.4	9.0	0.6	0.8	1.4	1.5
Entertainers and performers, sports and related workers, all other	27-2099	Line item	35.8	38.0	2.1	6.0	4.7	6.6	11.3	1.7	2.4	4.2	4.4
Media and communication workers	27-3000	Summary	824.3	844.4	20.1	2.4	3.6	4.9	8.6	30.2	41.2	71.4	73.4
Broadcast announcers and radio disc jockeys	27-3011	Line item	24.1	22.8	-1.3	-5.5	4.8	5.7	10.5	1.1	1.3	2.5	2.3
News analysts, reporters, and journalists	27-3023	Line item	49.3	47.4	-1.9	-3.9	4.1	4.9	9.0	2.0	2.4	4.3	4.1
Public relations specialists	27-3031	Line item	315.9	331.0	15.0	4.8	2.8	5.3	8.1	9.0	17.1	26.1	27.6
Writers and editors	27-3040	Summary	307.6	313.7	6.1	2.0	4.0	4.7	8.7	12.5	14.6	27.1	27.7
Editors	27-3041	Line item	115.8	116.5	0.7	0.6	3.6	4.8	8.4	4.1	5.6	9.7	9.8
Technical writers	27-3042	Line item	56.4	56.9	0.5	0.9	3.2	4.6	7.8	1.8	2.6	4.4	4.5
Writers and authors	27-3043	Line item	135.4	140.3	4.9	3.6	4.7	4.7	9.4	6.5	6.4	13.0	13.4
Miscellaneous media and communication workers	27-3090	Summary	127.4	129.5	2.2	1.7	4.4	4.5	8.9	5.6	5.8	11.4	11.6
Interpreters and translators	27-3091	Line item	75.3	76.6	1.3	1.7	5.0	4.0	9.0	3.8	3.0	6.8	6.9
Court reporters and simultaneous captioners	27-3092	Line item	17.7	17.7	0.0	-0.3	5.0	4.5	9.5	0.9	0.8	1.7	1.7
Media and communication workers, all other	27-3099	Line item	34.3	35.3	0.9	2.7	2.8	5.6	8.4	1.0	2.0	2.9	3.0
Media and communication equipment workers	27-4000	Summary	392.3	398.9	6.6	1.7	2.7	5.1	7.8	10.5	20.2	30.7	31.4
Broadcast, sound, and lighting technicians	27-4010	Summary	146.1	147.7	1.5	1.0	2.3	5.2	7.5	3.4	7.6	11.0	11.1
Audio and video technicians	27-4011	Line item	92.3	95.4	3.1	3.3	2.3	5.2	7.5	2.2	4.8	7.0	7.3
Broadcast technicians	27-4012	Line item	24.8	24.2	-0.7	-2.8	2.3	5.2	7.5	0.6	1.3	1.8	1.8
Sound engineering technicians	27-4014	Line item	16.9	16.6	-0.3	-1.7	2.3	5.2	7.5	0.4	0.9	1.3	1.2
Lighting technicians	27-4015	Line item	12.1	11.5	-0.6	-4.6	2.3	5.2	7.5	0.3	0.6	0.9	0.8
Photographers	27-4021	Line item	151.2	154.0	2.8	1.8	3.2	4.9	8.1	4.9	7.5	12.4	12.7

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Television, video, and film camera operators and editors	27-4030	Summary	79.9	82.1	2.2	2.7	2.3	5.4	7.7	1.8	4.4	6.2	6.4
Camera operators, television, video, and film	27-4031	Line item	36.4	36.9	0.4	1.2	2.3	5.4	7.7	0.8	2.0	2.8	2.9
Film and video editors	27-4032	Line item	43.5	45.2	1.7	4.0	2.3	5.4	7.7	1.0	2.4	3.4	3.6
Media and communication equipment workers, all other	27-4099	Line item	15.1	15.2	0.1	0.6	2.3	5.2	7.5	0.4	0.8	1.1	1.1
Healthcare practitioners and technical occupations	29-0000	Summary	10,067.5	10,794.4	726.9	7.2	2.9	2.5	5.4	299.5	262.7	562.2	634.9
Healthcare diagnosing or treating practitioners	29-1000	Summary	6,715.1	7,241.6	526.4	7.8	2.6	1.8	4.5	182.4	128.2	310.6	363.3
Chiropractors	29-1011	Line item	57.2	62.6	5.4	9.5	3.0	0.7	3.7	1.8	0.4	2.2	2.8
Dentists	29-1020	Summary	149.3	155.2	5.9	4.0	2.2	0.4	2.6	3.3	0.6	3.9	4.5
Dentists, general	29-1021	Line item	129.8	135.2	5.4	4.1	2.2	0.4	2.6	2.9	0.5	3.4	3.9
Oral and maxillofacial surgeons	29-1022	Line item	6.1	6.4	0.3	4.1	2.2	0.4	2.6	0.1	0.0	0.2	0.2
Orthodontists	29-1023	Line item	5.9	6.2	0.3	4.4	2.2	0.4	2.6	0.1	0.0	0.2	0.2
Prosthodontists	29-1024	Line item	0.9	0.9	0.0	4.5	2.2	0.4	2.6	0.0	0.0	0.0	0.0
Dentists, all other specialists	29-1029	Line item	6.6	6.6	0.0	0.3	2.2	0.4	2.6	0.1	0.0	0.2	0.2
Dietitians and nutritionists	29-1031	Line item	90.9	95.9	5.0	5.5	3.3	2.8	6.1	3.1	2.6	5.7	6.2
Optometrists	29-1041	Line item	47.8	51.6	3.8	8.0	3.6	0.4	4.0	1.8	0.2	2.0	2.4
Pharmacists	29-1051	Line item	335.1	350.5	15.4	4.6	2.4	1.3	3.7	8.1	4.5	12.6	14.2
Physician assistants	29-1071	Line item	162.7	195.8	33.2	20.4	2.0	2.8	4.9	3.6	5.1	8.7	12.0
Podiatrists	29-1081	Line item	9.7	9.9	0.2	1.8	2.3	0.5	2.8	0.2	0.0	0.3	0.3
Therapists	29-1120	Summary	869.4	975.3	106.0	12.2	2.5	2.2	4.6	22.6	20.3	42.9	53.5
Occupational therapists	29-1122	Line item	160.0	182.1	22.1	13.8	2.2	2.4	4.7	3.8	4.2	8.0	10.2
Physical therapists	29-1123	Line item	267.2	296.4	29.3	10.9	2.1	1.5	3.7	6.0	4.3	10.3	13.2
Radiation therapists	29-1124	Line item	19.2	19.6	0.4	1.9	2.3	2.1	4.4	0.4	0.4	0.9	0.9
Recreational therapists	29-1125	Line item	16.1	16.6	0.5	3.3	3.6	4.0	7.6	0.6	0.7	1.2	1.3
Respiratory therapists	29-1126	Line item	139.6	156.4	16.8	12.1	2.7	2.1	4.8	4.0	3.1	7.1	8.8
Speech-language pathologists	29-1127	Line item	187.4	215.5	28.2	15.0	2.6	2.6	5.2	5.2	5.3	10.5	13.3
Exercise physiologists	29-1128	Line item	23.9	26.1	2.3	9.5	3.0	2.8	5.8	0.8	0.7	1.4	1.7
Therapists, all other	29-1129	Line item	56.1	62.5	6.4	11.5	3.0	2.8	5.8	1.8	1.6	3.4	4.1
Veterinarians	29-1131	Line item	86.4	94.7	8.3	9.6	1.5	0.8	2.4	1.4	0.8	2.2	3.0
Registered nurses	29-1141	Line item	3,391.0	3,557.1	166.1	4.9	2.8	2.1	5.0	97.9	74.6	172.4	189.1
Nurse anesthetists	29-1151	Line item	53.8	58.5	4.6	8.6	2.2	1.7	4.0	1.3	1.0	2.2	2.7
Nurse midwives	29-1161	Line item	8.6	9.5	0.9	11.1	2.2	2.1	4.3	0.2	0.2	0.4	0.5
Nurse practitioners	29-1171	Line item	320.4	448.8	128.4	40.1	2.2	2.1	4.3	8.6	8.1	16.6	29.5
Audiologists	29-1181	Line item	15.8	17.3	1.5	9.5	2.4	0.9	3.2	0.4	0.1	0.5	0.7
Physicians	29-1210	Summary	785.6	807.7	22.1	2.8	2.1	0.4	2.5	16.7	3.4	20.1	22.3
Anesthesiologists	29-1211	Line item	45.3	46.7	1.4	3.2	2.1	0.4	2.5	1.0	0.2	1.2	1.3
Cardiologists	29-1212	Line item	19.4	20.2	0.8	4.1	2.1	0.4	2.5	0.4	0.1	0.5	0.6
Dermatologists	29-1213	Line item	10.9	11.6	0.7	6.4	2.1	0.4	2.5	0.2	0.0	0.3	0.4
Emergency medicine physicians	29-1214	Line item	36.1	37.1	1.0	2.7	2.1	0.4	2.5	0.8	0.2	0.9	1.0
Family medicine physicians	29-1215	Line item	116.0	119.1	3.1	2.7	2.1	0.4	2.5	2.5	0.5	3.0	3.3
General internal medicine physicians	29-1216	Line item	73.2	75.6	2.4	3.3	2.1	0.4	2.5	1.6	0.3	1.9	2.1
Neurologists	29-1217	Line item	8.3	8.8	0.5	5.4	2.1	0.4	2.5	0.2	0.0	0.2	0.3
Obstetricians and gynecologists	29-1218	Line item	21.5	21.7	0.3	1.2	2.1	0.4	2.5	0.5	0.1	0.5	0.6
Pediatricians, general	29-1221	Line item	46.4	46.8	0.4	0.8	2.1	0.4	2.5	1.0	0.2	1.2	1.2
Physicians, pathologists	29-1222	Line item	12.6	13.1	0.5	4.2	2.1	0.4	2.5	0.3	0.1	0.3	0.4
Psychiatrists	29-1223	Line item	27.1	28.8	1.7	6.1	2.1	0.4	2.5	0.6	0.1	0.7	0.9
Radiologists	29-1224	Line item	28.2	29.0	0.8	2.7	2.1	0.4	2.5	0.6	0.1	0.7	0.8
Physicians, all other	29-1229	Line item	340.7	349.3	8.6	2.5	2.1	0.4	2.5	7.2	1.5	8.7	9.6
Surgeons	29-1240	Summary	53.4	55.5	2.1	4.0	1.6	0.4	2.0	0.9	0.2	1.1	1.3

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Ophthalmologists, except pediatric	29-1241	Line item	12.5	13.1	0.5	4.3	1.6	0.4	2.0	0.2	0.1	0.3	0.3
Orthopedic surgeons, except pediatric	29-1242	Line item	14.7	15.3	0.6	4.1	1.6	0.4	2.0	0.2	0.1	0.3	0.4
Pediatric surgeons	29-1243	Line item	1.1	1.1	0.0	1.5	1.6	0.4	2.0	0.0	0.0	0.0	0.0
Surgeons, all other	29-1249	Line item	25.1	26.0	1.0	3.9	1.6	0.4	2.0	0.4	0.1	0.5	0.6
Miscellaneous healthcare diagnosing or treating practitioners	29-1290	Summary	278.3	295.7	17.4	6.3	3.7	2.1	5.8	10.6	6.1	16.7	18.5
Acupuncturists	29-1291	Line item	15.3	16.4	1.0	6.8	3.9	1.0	4.9	0.6	0.2	0.8	0.9
Dental hygienists	29-1292	Line item	221.6	237.2	15.5	7.0	3.7	2.2	6.0	8.6	5.1	13.7	15.3
Healthcare diagnosing or treating practitioners, all other	29-1299	Line item	41.3	42.2	0.8	2.0	3.4	2.0	5.4	1.4	0.8	2.3	2.4
Health technologists and technicians	29-2000	Summary	3,205.6	3,393.0	187.4	5.8	3.4	3.9	7.4	112.5	130.1	242.7	261.4
Clinical laboratory technologists and technicians	29-2010	Line item	351.2	357.2	6.0	1.7	3.1	3.1	6.2	11.0	11.0	22.0	22.6
Diagnostic related technologists and technicians	29-2030	Summary	451.5	478.8	27.3	6.1	2.6	2.4	5.0	12.3	11.1	23.4	26.1
Cardiovascular technologists and technicians	29-2031	Line item	64.7	66.6	1.9	3.0	2.8	2.7	5.4	1.8	1.7	3.6	3.8
Diagnostic medical sonographers	29-2032	Line item	90.0	101.7	11.7	13.0	2.5	2.4	4.8	2.4	2.3	4.6	5.8
Nuclear medicine technologists	29-2033	Line item	20.0	20.6	0.6	3.0	2.2	2.1	4.3	0.4	0.4	0.9	0.9
Radiologic technologists and technicians	29-2034	Line item	228.0	237.8	9.8	4.3	2.7	2.4	5.1	6.4	5.5	11.9	12.9
Magnetic resonance imaging technologists	29-2035	Line item	44.1	47.2	3.1	7.1	2.5	2.4	4.9	1.2	1.1	2.2	2.6
Medical dosimetrists	29-2036	Line item	4.8	4.9	0.2	3.5	2.2	2.1	4.3	0.1	0.1	0.2	0.2
Emergency medical technicians and paramedics	29-2040	Summary	282.9	297.2	14.3	5.0	2.1	3.9	6.1	6.2	11.4	17.6	19.0
Emergency medical technicians	29-2042	Line item	181.0	190.2	9.2	5.1	2.4	4.7	7.1	4.4	8.8	13.2	14.1
Paramedics	29-2043	Line item	101.9	107.0	5.1	5.0	1.7	2.5	4.2	1.8	2.6	4.4	4.9
Health practitioner support technologists and technicians	29-2050	Summary	994.3	1,088.4	94.1	9.5	3.7	5.3	9.0	38.5	54.9	93.4	102.8
Dietetic technicians	29-2051	Line item	30.9	31.7	0.8	2.5	5.6	7.1	12.7	1.7	2.2	4.0	4.0
Pharmacy technicians	29-2052	Line item	490.4	521.8	31.5	6.4	3.7	5.3	9.1	18.9	27.0	45.9	49.0
Psychiatric technicians	29-2053	Line item	144.5	173.3	28.9	20.0	3.4	4.8	8.2	5.4	7.6	13.0	15.9
Surgical technologists	29-2055	Line item	115.6	120.8	5.2	4.5	2.7	2.8	5.5	3.2	3.3	6.5	7.0
Veterinary technologists and technicians	29-2056	Line item	134.2	146.4	12.2	9.1	3.2	6.2	9.3	4.4	8.6	13.1	14.3
Ophthalmic medical technicians	29-2057	Line item	78.8	94.4	15.6	19.8	5.6	7.1	12.7	4.8	6.1	11.0	12.5
Licensed practical and licensed vocational nurses	29-2061	Line item	651.4	668.5	17.1	2.6	4.2	3.8	8.0	27.4	25.3	52.7	54.4
Medical records specialists	29-2072	Line item	194.8	208.6	13.8	7.1	3.5	2.9	6.4	7.1	5.8	12.9	14.2
Opticians, dispensing	29-2081	Line item	79.9	82.2	2.3	2.9	4.2	3.9	8.0	3.4	3.1	6.5	6.8
Miscellaneous health technologists and technicians	29-2090	Summary	199.6	212.2	12.6	6.3	3.3	3.6	6.9	6.7	7.5	14.2	15.4
Orthotists and prosthetists	29-2091	Line item	10.1	11.5	1.3	13.3	3.3	3.6	6.9	0.4	0.4	0.7	0.9
Hearing aid specialists	29-2092	Line item	10.7	12.6	2.0	18.4	3.3	3.6	6.9	0.4	0.4	0.8	1.0
Health technologists and technicians, all other	29-2099	Line item	178.8	188.1	9.3	5.2	3.3	3.6	6.9	6.0	6.7	12.6	13.6
Other healthcare practitioners and	29-9000	Summary	146.7	159.8	13.1	8.9	3.0	2.8	5.8	4.5	4.3	8.9	10.2

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
technical occupations													
Health information technologists and medical registrars	29-9021	Line item	41.9	48.1	6.2	14.7	3.0	2.8	5.8	1.3	1.3	2.6	3.2
Miscellaneous health practitioners and technical workers	29-9090	Summary	104.8	111.8	6.9	6.6	3.0	2.8	5.8	3.2	3.1	6.3	7.0
Athletic trainers	29-9091	Line item	33.9	37.6	3.8	11.1	3.0	2.8	5.8	1.1	1.0	2.1	2.4
Genetic counselors	29-9092	Line item	4.0	4.3	0.4	9.3	3.0	2.8	5.8	0.1	0.1	0.2	0.3
Surgical assistants	29-9093	Line item	25.3	26.6	1.3	5.1	3.0	2.8	5.8	0.8	0.7	1.5	1.6
Healthcare practitioners and technical workers, all other	29-9099	Line item	41.7	43.1	1.5	3.6	3.0	2.8	5.8	1.3	1.2	2.5	2.6
Healthcare support occupations	31-0000	Summary	7,982.8	8,971.1	988.3	12.4	7.3	6.7	14.0	618.4	569.4	1,187.9	1,286.7
Home health and personal care aides; and nursing assistants, orderlies, and psychiatric aides	31-1100	Summary	5,881.6	6,655.6	774.1	13.2	8.1	6.4	14.4	505.6	400.0	905.6	983.0
Home health and personal care aides	31-1120	Line item	4,347.7	5,087.5	739.8	17.0	8.6	6.1	14.7	403.9	288.0	691.9	765.8
Nursing assistants, orderlies, and psychiatric aides	31-1130	Summary	1,533.9	1,568.1	34.2	2.2	6.6	7.2	13.8	101.7	112.0	213.7	217.1
Nursing assistants	31-1131	Line item	1,441.5	1,474.0	32.6	2.3	6.6	7.2	13.8	96.3	104.5	200.8	204.1
Orderlies	31-1132	Line item	54.0	55.8	1.8	3.3	5.8	8.0	13.8	3.2	4.4	7.6	7.8
Psychiatric aides	31-1133	Line item	38.5	38.3	-0.1	-0.4	5.8	8.0	13.8	2.2	3.1	5.3	5.3
Occupational therapy and physical therapist assistants and aides	31-2000	Summary	211.5	246.9	35.4	16.7	5.0	8.4	13.4	11.6	19.2	30.8	34.3
Occupational therapy assistants and aides	31-2010	Summary	54.4	64.0	9.6	17.6	4.5	7.1	11.7	2.7	4.2	6.9	7.9
Occupational therapy assistants	31-2011	Line item	49.2	58.7	9.5	19.2	4.5	7.1	11.7	2.4	3.8	6.3	7.2
Occupational therapy aides	31-2012	Line item	5.2	5.3	0.1	2.5	4.5	7.1	11.7	0.2	0.4	0.6	0.6
Physical therapist assistants and aides	31-2020	Summary	157.1	182.9	25.8	16.4	5.2	8.8	14.0	8.9	15.0	23.9	26.4
Physical therapist assistants	31-2021	Line item	111.5	136.0	24.5	22.0	5.2	8.8	14.0	6.5	10.9	17.4	19.8
Physical therapist aides	31-2022	Line item	45.6	46.9	1.3	2.8	5.2	8.8	14.0	2.4	4.1	6.5	6.6
Other healthcare support occupations	31-9000	Summary	1,889.7	2,068.5	178.8	9.5	5.1	7.6	12.7	101.3	150.3	251.6	269.4
Massage therapists	31-9011	Line item	168.0	193.9	25.9	15.4	6.6	5.7	12.2	11.9	10.3	22.2	24.7
Miscellaneous healthcare support occupations	31-9090	Summary	1,721.7	1,874.6	152.9	8.9	5.0	7.8	12.8	89.4	140.0	229.4	244.7
Dental assistants	31-9091	Line item	381.9	406.3	24.4	6.4	5.2	7.6	12.8	20.5	30.0	50.5	52.9
Medical assistants	31-9092	Line item	811.0	912.2	101.2	12.5	4.5	7.4	11.9	38.7	63.5	102.2	112.3
Medical equipment preparers	31-9093	Line item	76.5	84.2	7.6	10.0	5.7	6.9	12.6	4.6	5.6	10.1	10.9
Medical transcriptionists	31-9094	Line item	43.9	41.8	-2.2	-4.9	7.4	10.4	17.8	3.2	4.5	7.6	7.4
Pharmacy aides	31-9095	Line item	41.1	41.1	-0.1	-0.1	5.4	9.4	14.8	2.2	3.9	6.1	6.1
Veterinary assistants and laboratory animal caretakers	31-9096	Line item	117.8	128.1	10.3	8.7	5.5	11.8	17.3	6.7	14.5	21.2	22.2
Phlebotomists	31-9097	Line item	139.7	147.5	7.9	5.6	5.0	7.3	12.3	7.2	10.4	17.6	18.4
Healthcare support workers, all other	31-9099	Line item	109.7	113.5	3.8	3.5	5.7	6.9	12.6	6.3	7.7	14.1	14.4
Protective service occupations	33-0000	Summary	3,787.4	3,816.6	29.1	0.8	4.7	6.4	11.1	177.6	243.0	420.6	423.6
Supervisors of protective service workers	33-1000	Summary	408.4	417.1	8.7	2.1	3.0	4.3	7.3	12.3	17.6	30.0	30.8
First-line supervisors of law enforcement workers	33-1010	Summary	217.9	220.9	3.0	1.4	2.7	4.1	6.8	6.0	8.9	14.9	15.2
First-line supervisors of correctional officers	33-1011	Line item	57.1	55.5	-1.6	-2.8	3.3	4.6	7.9	1.9	2.6	4.5	4.3
First-line supervisors of police and detectives	33-1012	Line item	160.8	165.4	4.6	2.9	2.5	3.9	6.4	4.1	6.3	10.4	10.9

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
First-line supervisors of firefighting and prevention workers	33-1021	Line item	97.2	100.5	3.4	3.4	2.6	3.7	6.3	2.6	3.6	6.2	6.5
Miscellaneous first-line supervisors, protective service workers	33-1090	Summary	93.3	95.6	2.3	2.5	4.0	5.4	9.4	3.8	5.1	8.9	9.1
First-line supervisors of security workers	33-1091	Line item	71.9	73.8	1.9	2.7	4.0	5.4	9.4	2.9	3.9	6.8	7.0
First-line supervisors of protective service workers, all other	33-1099	Line item	21.5	21.8	0.3	1.6	4.0	5.4	9.4	0.9	1.2	2.0	2.1
Firefighting and prevention workers	33-2000	Summary	362.5	375.3	12.8	3.5	2.1	5.4	7.5	7.7	19.9	27.6	28.9
Firefighters	33-2011	Line item	344.9	356.7	11.8	3.4	2.0	5.4	7.4	7.0	18.9	25.9	27.1
Fire inspectors	33-2020	Summary	17.6	18.6	1.0	5.6	3.6	5.9	9.5	0.6	1.1	1.7	1.8
Fire inspectors and investigators	33-2021	Line item	14.7	15.2	0.6	3.8	3.6	5.9	9.5	0.5	0.9	1.4	1.5
Forest fire inspectors and prevention specialists	33-2022	Line item	2.9	3.3	0.4	14.6	3.6	5.9	9.5	0.1	0.2	0.3	0.3
Law enforcement workers	33-3000	Summary	1,241.6	1,232.0	-9.7	-0.8	2.7	5.0	7.7	33.6	62.2	95.8	94.8
Bailiffs, correctional officers, and jailers	33-3010	Summary	406.5	376.0	-30.5	-7.5	3.4	5.5	8.9	13.5	21.4	34.9	31.9
Bailiffs	33-3011	Line item	19.0	18.6	-0.4	-2.2	5.5	4.4	9.9	1.0	0.8	1.9	1.8
Correctional officers and jailers	33-3012	Line item	387.5	357.4	-30.1	-7.8	3.3	5.5	8.9	12.5	20.6	33.1	30.1
Detectives and criminal investigators	33-3021	Line item	117.9	117.1	-0.8	-0.7	2.2	4.5	6.7	2.5	5.3	7.8	7.8
Fish and game wardens	33-3031	Line item	7.0	6.6	-0.4	-6.0	4.3	4.4	8.7	0.3	0.3	0.6	0.5
Parking enforcement workers	33-3041	Line item	8.4	8.2	-0.1	-1.5	4.3	4.4	8.7	0.4	0.4	0.7	0.7
Police officers	33-3050	Summary	701.9	724.0	22.1	3.1	2.4	4.9	7.3	16.9	34.8	51.7	53.9
Police and sheriff's patrol officers	33-3051	Line item	698.8	720.8	22.0	3.1	2.4	4.9	7.3	16.9	34.7	51.5	53.7
Transit and railroad police	33-3052	Line item	3.1	3.2	0.1	3.0	2.4	4.9	7.3	0.1	0.2	0.2	0.2
Other protective service workers	33-9000	Summary	1,774.8	1,792.2	17.4	1.0	7.0	8.0	15.0	124.0	143.2	267.2	269.0
Animal control workers	33-9011	Line item	12.2	12.7	0.5	3.9	4.0	6.2	10.1	0.5	0.8	1.3	1.3
Private detectives and investigators	33-9021	Line item	43.6	46.2	2.6	6.0	3.2	5.0	8.1	1.4	2.2	3.7	3.9
Security guards and gambling surveillance officers	33-9030	Summary	1,272.4	1,277.5	5.1	0.4	5.1	7.6	12.7	64.7	97.1	161.8	162.3
Gambling surveillance officers and gambling investigators	33-9031	Line item	10.3	10.3	0.0	0.3	5.1	7.6	12.7	0.5	0.8	1.3	1.3
Security guards	33-9032	Line item	1,262.1	1,267.1	5.1	0.4	5.1	7.6	12.7	64.2	96.3	160.5	161.0
Miscellaneous protective service workers	33-9090	Summary	446.6	455.8	9.2	2.1	12.7	9.6	22.3	57.4	43.1	100.5	101.4
Crossing guards and flaggers	33-9091	Line item	91.4	94.7	3.3	3.6	13.7	5.3	19.0	12.8	4.9	17.7	18.0
Lifeguards, ski patrol, and other recreational protective service workers	33-9092	Line item	149.7	158.4	8.7	5.8	13.9	13.2	27.2	21.5	20.4	41.9	42.7
Transportation security screeners	33-9093	Line item	50.1	47.1	-3.0	-6.0	5.2	5.2	10.4	2.5	2.5	5.0	4.7
School bus monitors	33-9094	Line item	71.4	69.5	-2.0	-2.7	12.5	5.7	18.2	8.8	4.0	12.8	12.6
Protective service workers, all other	33-9099	Line item	84.0	86.1	2.1	2.5	13.9	13.2	27.2	11.9	11.3	23.1	23.3
Food preparation and serving related occupations	35-0000	Summary	13,805.3	14,295.3	489.9	3.5	8.2	10.2	18.3	1,146.3	1,430.5	2,576.8	2,625.8
Supervisors of food preparation and serving workers	35-1000	Summary	1,412.3	1,499.3	87.0	6.2	4.8	8.9	13.7	69.7	129.9	199.6	208.3
Chefs and head cooks	35-1011	Line item	197.3	211.3	14.0	7.1	3.4	7.8	11.2	7.0	15.9	23.0	24.4

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First-line supervisors of food preparation and serving workers	35-1012	Line item	1,215.0	1,288.0	73.0	6.0	5.0	9.1	14.1	62.6	114.0	176.6	183.9
Cooks and food preparation workers	35-2000	Summary	3,707.8	3,807.5	99.7	2.7	7.1	8.1	15.2	267.6	302.6	570.2	580.2
Cooks	35-2010	Summary	2,805.1	2,935.7	130.6	4.7	6.7	7.9	14.6	193.0	226.1	419.1	432.2
Cooks, fast food	35-2011	Line item	669.5	579.2	-90.3	-13.5	6.7	7.9	14.6	42.0	49.2	91.2	82.1
Cooks, institution and cafeteria	35-2012	Line item	466.1	475.4	9.3	2.0	6.7	7.9	14.6	31.7	37.1	68.7	69.7
Cooks, private household	35-2013	Line item	34.2	36.0	1.7	5.1	6.7	7.9	14.6	2.4	2.8	5.1	5.3
Cooks, restaurant	35-2014	Line item	1,460.2	1,677.2	217.0	14.9	6.7	7.9	14.6	105.5	123.5	229.0	250.7
Cooks, short order	35-2015	Line item	151.1	142.7	-8.4	-5.6	6.7	7.9	14.6	9.9	11.6	21.4	20.6
Cooks, all other	35-2019	Line item	24.0	25.3	1.3	5.5	6.7	7.9	14.6	1.7	1.9	3.6	3.7
Food preparation workers	35-2021	Line item	902.7	871.8	-30.9	-3.4	8.4	8.6	17.0	74.6	76.5	151.1	148.0
Food and beverage serving workers	35-3000	Summary	7,159.6	7,429.5	269.8	3.8	9.0	11.7	20.7	658.1	853.5	1,511.6	1,538.6
Bartenders	35-3011	Line item	756.7	801.5	44.8	5.9	5.2	10.9	16.1	40.3	84.7	125.1	129.6
Fast food and counter workers	35-3023	Line item	3,796.0	4,029.2	233.2	6.1	10.3	12.2	22.5	402.8	478.1	881.0	904.3
Waiters and waitresses	35-3031	Line item	2,329.7	2,313.5	-16.3	-0.7	8.2	11.5	19.7	191.3	267.1	458.4	456.7
Food servers, nonrestaurant	35-3041	Line item	277.2	285.3	8.2	3.0	8.4	8.4	16.8	23.7	23.6	47.2	48.0
Other food preparation and serving related workers	35-9000	Summary	1,525.6	1,559.0	33.4	2.2	9.8	9.4	19.2	150.9	144.5	295.4	298.7
Dining room and cafeteria attendants and bartender helpers	35-9011	Line item	527.4	560.6	33.1	6.3	9.1	8.6	17.7	49.5	46.8	96.3	99.6
Dishwashers	35-9021	Line item	477.7	478.6	0.9	0.2	8.0	8.0	16.0	38.5	38.2	76.7	76.8
Hosts and hostesses, restaurant, lounge, and coffee shop	35-9031	Line item	429.9	423.5	-6.4	-1.5	13.3	12.1	25.4	56.9	51.5	108.4	107.7
Food preparation and serving related workers, all other	35-9099	Line item	90.5	96.3	5.8	6.4	6.4	8.6	15.0	6.0	8.0	14.0	14.6
Building and grounds cleaning and maintenance occupations	37-0000	Summary	5,715.9	5,832.9	117.1	2.0	6.4	7.0	13.5	371.6	405.3	777.0	788.7
Supervisors of building and grounds cleaning and maintenance workers	37-1000	Summary	494.5	506.4	11.9	2.4	4.4	6.6	11.0	22.2	32.8	55.1	56.3
First-line supervisors of housekeeping and janitorial workers	37-1011	Line item	269.8	276.4	6.7	2.5	5.2	6.7	11.9	14.2	18.2	32.4	33.0
First-line supervisors of landscaping, lawn service, and groundskeeping workers	37-1012	Line item	224.7	230.0	5.2	2.3	3.5	6.5	10.0	8.0	14.7	22.7	23.2
Building cleaning and pest control workers	37-2000	Summary	3,924.9	3,984.2	59.3	1.5	7.2	6.9	14.0	283.7	271.2	554.9	560.8
Building cleaning workers	37-2010	Summary	3,822.5	3,876.8	54.2	1.4	7.3	6.8	14.1	280.8	261.1	542.0	547.4
Janitors and cleaners, except maids and housekeeping cleaners	37-2011	Line item	2,447.7	2,495.5	47.8	2.0	7.1	7.0	14.0	174.5	172.1	346.5	351.3
Maids and housekeeping cleaners	37-2012	Line item	1,356.8	1,362.8	6.0	0.4	7.7	6.5	14.2	105.1	87.8	192.9	193.5
Building cleaning workers, all other	37-2019	Line item	18.1	18.5	0.5	2.5	7.1	7.0	14.0	1.3	1.3	2.6	2.6
Pest control workers	37-2021	Line item	102.4	107.5	5.1	4.9	2.8	9.6	12.3	2.9	10.0	12.9	13.4
Grounds maintenance workers	37-3000	Summary	1,296.4	1,342.3	45.9	3.5	5.0	7.7	12.7	65.7	101.3	167.0	171.6
Landscaping and groundskeeping workers	37-3011	Line item	1,192.5	1,235.0	42.4	3.6	5.1	7.6	12.7	62.0	92.0	154.0	158.2
Pesticide handlers, sprayers, and applicators, vegetation	37-3012	Line item	29.6	30.7	1.1	3.8	3.8	9.3	13.1	1.2	2.8	4.0	4.1
Tree trimmers and pruners	37-3013	Line item	60.1	62.1	2.0	3.3	3.2	8.5	11.7	2.0	5.2	7.2	7.4

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Grounds maintenance workers, all other	37-3019	Line item	14.1	14.5	0.3	2.4	3.8	9.3	13.1	0.5	1.3	1.9	1.9
Personal care and service occupations	39-0000	Summary	4,464.1	4,650.6	186.5	4.2	6.8	9.7	16.5	310.1	443.7	753.8	772.4
Supervisors of personal care and service workers	39-1000	Summary	304.9	323.4	18.5	6.1	3.8	6.1	9.9	12.0	19.3	31.3	33.1
First-line supervisors of entertainment and recreation workers	39-1010	Summary	155.8	164.3	8.5	5.4	3.8	6.1	9.9	6.1	9.8	15.9	16.8
First-line supervisors of gambling services workers	39-1013	Line item	32.5	33.1	0.6	2.0	3.8	6.1	9.9	1.3	2.0	3.3	3.3
First-line supervisors of entertainment and recreation workers, except gambling services	39-1014	Line item	123.3	131.1	7.8	6.3	3.8	6.1	9.9	4.9	7.8	12.7	13.4
First-line supervisors of personal service workers	39-1022	Line item	149.1	159.1	10.0	6.7	3.8	6.1	9.9	5.9	9.5	15.3	16.3
Animal care and service workers	39-2000	Summary	439.4	489.4	50.0	11.4	6.0	10.5	16.5	28.0	48.6	76.7	81.7
Animal trainers	39-2011	Line item	47.3	49.8	2.4	5.1	4.9	9.2	14.1	2.4	4.5	6.8	7.1
Animal caretakers	39-2021	Line item	392.1	439.6	47.6	12.1	6.2	10.6	16.8	25.7	44.2	69.8	74.6
Entertainment attendants and related workers	39-3000	Summary	659.8	674.8	15.0	2.3	10.0	13.8	23.7	66.5	91.8	158.3	159.8
Gambling services workers	39-3010	Summary	113.0	111.8	-1.2	-1.0	5.8	10.2	16.0	6.6	11.5	18.0	17.9
Gambling dealers	39-3011	Line item	88.7	88.1	-0.6	-0.6	5.8	10.2	16.0	5.2	9.0	14.2	14.1
Gambling and sports book writers and runners	39-3012	Line item	8.2	7.7	-0.5	-6.1	5.8	10.2	16.0	0.5	0.8	1.3	1.2
Gambling service workers, all other	39-3019	Line item	16.1	16.0	-0.1	-0.6	5.8	10.2	16.0	0.9	1.6	2.6	2.6
Motion picture projectionists	39-3021	Line item	2.0	2.0	-0.1	-3.7	10.6	14.7	25.3	0.2	0.3	0.5	0.5
Ushers, lobby attendants, and ticket takers	39-3031	Line item	121.7	123.1	1.4	1.2	11.4	13.7	25.1	13.9	16.8	30.7	30.8
Miscellaneous entertainment attendants and related workers	39-3090	Summary	423.1	438.0	14.9	3.5	10.6	14.7	25.3	45.8	63.3	109.1	110.6
Amusement and recreation attendants	39-3091	Line item	392.3	405.5	13.2	3.4	10.6	14.7	25.3	42.4	58.6	101.1	102.4
Costume attendants	39-3092	Line item	6.7	7.1	0.4	5.9	10.6	14.7	25.3	0.7	1.0	1.8	1.8
Locker room, coatroom, and dressing room attendants	39-3093	Line item	15.6	16.6	1.0	6.4	10.6	14.7	25.3	1.7	2.4	4.1	4.2
Entertainment attendants and related workers, all other	39-3099	Line item	8.5	8.8	0.3	3.6	10.6	14.7	25.3	0.9	1.3	2.2	2.2
Funeral service workers	39-4000	Summary	66.8	68.8	2.0	3.0	7.2	7.4	14.6	4.9	5.0	9.9	10.1
Embalmers and crematory operators	39-4010	Summary	6.8	6.9	0.2	2.2	9.7	7.3	17.0	0.7	0.5	1.2	1.2
Embalmers	39-4011	Line item	3.6	3.7	0.0	1.3	9.7	7.3	17.0	0.4	0.3	0.6	0.6
Crematory operators	39-4012	Line item	3.1	3.2	0.1	3.3	9.7	7.3	17.0	0.3	0.2	0.5	0.6
Funeral attendants	39-4021	Line item	32.5	33.5	1.0	3.1	9.7	7.3	17.0	3.2	2.4	5.6	5.7
Morticians, undertakers, and funeral arrangers	39-4031	Line item	27.5	28.4	0.8	3.1	3.8	7.5	11.2	1.0	2.1	3.1	3.2
Personal appearance workers	39-5000	Summary	984.2	1,042.4	58.2	5.9	5.2	6.8	12.0	52.5	68.9	121.5	127.3
Barbers, hairdressers, hairstylists and cosmetologists	39-5010	Summary	651.2	686.6	35.3	5.4	5.3	6.7	12.1	35.7	44.9	80.7	84.2
Barbers	39-5011	Line item	76.0	79.2	3.1	4.1	3.7	6.7	10.4	2.9	5.2	8.1	8.4
Hairdressers, hairstylists, and cosmetologists	39-5012	Line item	575.2	607.4	32.2	5.6	5.6	6.7	12.3	32.9	39.7	72.6	75.8

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Miscellaneous personal appearance workers	39-5090	Summary	333.0	355.8	22.8	6.9	4.9	7.0	11.9	16.8	24.0	40.8	43.1
Makeup artists, theatrical and performance	39-5091	Line item	7.0	7.6	0.6	8.1	5.6	8.3	13.9	0.4	0.6	1.0	1.1
Manicurists and pedicurists	39-5092	Line item	210.1	224.8	14.7	7.0	4.8	6.0	10.7	10.4	13.0	23.3	24.8
Shampooers	39-5093	Line item	18.5	19.6	1.0	5.5	5.6	8.3	13.9	1.1	1.6	2.6	2.7
Skincare specialists	39-5094	Line item	97.4	103.9	6.6	6.7	5.0	8.8	13.8	5.0	8.9	13.8	14.5
Baggage porters, bellhops, and concierges	39-6000	Summary	78.1	78.6	0.5	0.7	5.9	8.7	14.6	4.6	6.8	11.4	11.5
Baggage porters and bellhops	39-6011	Line item	32.5	32.0	-0.5	-1.6	5.9	8.7	14.6	1.9	2.8	4.7	4.6
Concierges	39-6012	Line item	45.6	46.7	1.1	2.3	5.9	8.7	14.6	2.7	4.0	6.7	6.8
Tour and travel guides	39-7000	Summary	55.8	60.3	4.5	8.1	9.3	12.2	21.6	5.4	7.1	12.5	13.0
Tour and travel guides	39-7010	Line item	55.8	60.3	4.5	8.1	9.3	12.2	21.6	5.4	7.1	12.5	13.0
Other personal care and service workers	39-9000	Summary	1,875.1	1,912.9	37.8	2.0	7.2	10.4	17.5	136.1	196.1	332.2	336.0
Childcare workers	39-9011	Line item	991.6	962.4	-29.2	-2.9	7.6	9.1	16.7	74.7	88.4	163.1	160.2
Recreation and fitness workers	39-9030	Summary	697.8	755.3	57.5	8.2	6.6	12.2	18.8	47.8	88.6	136.5	142.2
Exercise trainers and group fitness instructors	39-9031	Line item	370.1	414.2	44.1	11.9	6.1	11.7	17.8	23.7	46.0	69.7	74.2
Recreation workers	39-9032	Line item	327.7	341.1	13.4	4.1	7.2	12.8	20.0	24.1	42.6	66.7	68.1
Residential advisors	39-9041	Line item	91.2	94.7	3.5	3.8	7.8	10.6	18.4	7.3	9.8	17.1	17.4
Personal care and service workers, all other	39-9099	Line item	94.4	100.4	6.0	6.4	6.5	9.4	15.9	6.3	9.2	15.5	16.1
Sales and related occupations	41-0000	Summary	14,532.6	14,234.8	-297.8	-2.0	5.8	6.8	12.6	833.2	983.4	1,816.5	1,786.8
Supervisors of sales workers	41-1000	Summary	1,752.6	1,680.3	-72.3	-4.1	3.7	5.5	9.2	63.5	93.6	157.1	149.9
First-line supervisors of retail sales workers	41-1011	Line item	1,432.6	1,360.3	-72.3	-5.0	3.8	5.7	9.5	53.3	79.0	132.3	125.1
First-line supervisors of non-retail sales workers	41-1012	Line item	320.0	320.0	0.0	0.0	3.2	4.6	7.8	10.2	14.6	24.8	24.8
Retail sales workers	41-2000	Summary	7,796.8	7,483.8	-313.0	-4.0	7.7	8.1	15.8	589.3	620.5	1,209.9	1,178.6
Cashiers	41-2010	Summary	3,179.8	2,864.7	-315.1	-9.9	9.8	9.4	19.1	295.6	282.6	578.2	546.7
Cashiers	41-2011	Line item	3,157.2	2,843.6	-313.6	-9.9	9.8	9.4	19.1	293.5	280.6	574.0	542.6
Gambling change persons and booth cashiers	41-2012	Line item	22.6	21.1	-1.5	-6.4	9.8	9.4	19.1	2.1	2.0	4.2	4.0
Counter and rental clerks and parts salespersons	41-2020	Summary	680.3	701.9	21.6	3.2	4.6	6.0	10.7	32.1	41.8	73.9	76.1
Counter and rental clerks	41-2021	Line item	408.2	421.3	13.1	3.2	4.8	5.9	10.7	19.9	24.6	44.6	45.9
Parts salespersons	41-2022	Line item	272.1	280.6	8.5	3.1	4.4	6.2	10.6	12.2	17.2	29.3	30.2
Retail salespersons	41-2031	Line item	3,936.7	3,917.1	-19.6	-0.5	6.7	7.5	14.2	261.6	296.2	557.8	555.8
Sales representatives, services	41-3000	Summary	2,479.4	2,550.3	70.9	2.9	3.1	5.6	8.6	77.7	139.8	217.5	224.6
Advertising sales agents	41-3011	Line item	103.7	97.1	-6.6	-6.4	3.2	6.8	10.0	3.2	6.8	10.0	9.3
Insurance sales agents	41-3021	Line item	568.8	589.8	21.1	3.7	3.6	4.2	7.7	20.7	24.2	44.9	47.0
Securities, commodities, and financial services sales agents	41-3031	Line item	514.5	531.6	17.1	3.3	2.6	4.4	7.0	13.4	23.1	36.4	38.1
Travel agents	41-3041	Line item	65.7	67.2	1.4	2.2	4.7	5.8	10.5	3.1	3.8	7.0	7.1
Sales representatives of services, except advertising, insurance, financial services, and travel	41-3091	Line item	1,226.7	1,264.7	37.9	3.1	3.0	6.6	9.6	37.3	81.9	119.2	123.0
Sales representatives, wholesale and manufacturing	41-4000	Summary	1,613.6	1,623.8	10.1	0.6	3.4	5.3	8.7	55.0	86.0	141.1	142.1
Sales representatives, wholesale and manufacturing, technical and scientific products	41-4011	Line item	303.2	308.9	5.7	1.9	3.4	5.3	8.7	10.4	16.3	26.7	27.2

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Sales representatives, wholesale and manufacturing, except technical and scientific products	41-4012	Line item	1,310.5	1,314.9	4.4	0.3	3.4	5.3	8.7	44.6	69.8	114.4	114.8
Other sales and related workers	41-9000	Summary	890.1	896.6	6.5	0.7	5.3	4.9	10.2	47.5	43.4	90.9	91.6
Models, demonstrators, and product promoters	41-9010	Summary	85.9	85.7	-0.1	-0.2	10.4	7.3	17.7	8.9	6.2	15.2	15.2
Demonstrators and product promoters	41-9011	Line item	79.2	79.1	-0.1	-0.1	10.4	7.3	17.7	8.2	5.8	14.0	14.0
Models	41-9012	Line item	6.7	6.7	0.0	-0.5	10.4	7.3	17.7	0.7	0.5	1.2	1.2
Real estate brokers and sales agents	41-9020	Summary	532.2	548.7	16.5	3.1	4.8	3.5	8.3	25.9	18.7	44.6	46.3
Real estate brokers	41-9021	Line item	111.3	115.0	3.7	3.3	4.8	3.5	8.3	5.4	3.9	9.3	9.7
Real estate sales agents	41-9022	Line item	420.9	433.7	12.8	3.1	4.8	3.5	8.3	20.5	14.8	35.3	36.6
Sales engineers	41-9031	Line item	56.8	59.9	3.1	5.5	2.4	5.6	8.0	1.4	3.3	4.6	5.0
Telemarketers	41-9041	Line item	67.4	52.5	-14.9	-22.1	5.2	8.1	13.3	3.1	4.9	8.0	6.5
Miscellaneous sales and related workers	41-9090	Summary	147.8	149.8	2.0	1.3	5.5	6.9	12.4	8.2	10.3	18.5	18.7
Door-to-door sales workers, news and street vendors, and related workers	41-9091	Line item	25.3	22.8	-2.5	-10.0	6.4	5.8	12.2	1.5	1.4	2.9	2.7
Sales and related workers, all other	41-9099	Line item	122.6	127.1	4.5	3.7	5.3	7.1	12.5	6.6	8.9	15.6	16.0
Office and administrative support occupations	43-0000	Summary	19,325.2	18,563.3	-761.9	-3.9	5.2	5.8	10.9	981.5	1,091.4	2,073.0	1,996.8
Supervisors of office and administrative support workers	43-1000	Summary	1,558.4	1,554.4	-3.9	-0.3	4.0	5.3	9.3	63.0	81.9	144.9	144.5
First-line supervisors of office and administrative support workers	43-1011	Line item	1,558.4	1,554.4	-3.9	-0.3	4.0	5.3	9.3	63.0	81.9	144.9	144.5
Communications equipment operators	43-2000	Summary	42.1	31.4	-10.7	-25.4	5.7	5.9	11.6	2.1	2.2	4.3	3.2
Switchboard operators, including answering service	43-2011	Line item	36.6	27.0	-9.6	-26.3	5.8	5.9	11.7	1.8	1.9	3.7	2.8
Telephone operators	43-2021	Line item	4.0	2.9	-1.1	-27.5	5.8	5.8	11.6	0.2	0.2	0.4	0.3
Communications equipment operators, all other	43-2099	Line item	1.4	1.5	0.0	2.5	4.5	5.3	9.8	0.1	0.1	0.1	0.1
Financial clerks	43-3000	Summary	2,833.6	2,642.5	-191.1	-6.7	5.7	5.2	10.9	155.4	142.4	297.7	278.6
Bill and account collectors	43-3011	Line item	166.9	149.4	-17.5	-10.5	4.5	5.2	9.8	7.1	8.3	15.4	13.7
Billing and posting clerks	43-3021	Line item	429.8	427.9	-1.9	-0.4	4.5	5.4	9.9	19.3	23.0	42.4	42.2
Bookkeeping, accounting, and auditing clerks	43-3031	Line item	1,613.4	1,519.1	-94.3	-5.8	6.4	5.0	11.5	100.7	78.6	179.4	170.0
Gambling cage workers	43-3041	Line item	14.1	13.4	-0.7	-5.0	3.9	6.3	10.2	0.5	0.9	1.4	1.3
Payroll and timekeeping clerks	43-3051	Line item	161.1	134.2	-27.0	-16.7	5.4	5.2	10.7	8.0	7.7	15.7	13.0
Procurement clerks	43-3061	Line item	61.9	56.6	-5.4	-8.7	3.2	5.5	8.7	1.9	3.3	5.2	4.6
Tellers	43-3071	Line item	347.4	302.5	-44.9	-12.9	5.0	5.6	10.6	16.1	18.1	34.3	29.8
Financial clerks, all other	43-3099	Line item	38.9	39.4	0.5	1.4	3.9	6.3	10.2	1.5	2.4	4.0	4.0
Information and record clerks	43-4000	Summary	5,511.6	5,304.2	-207.4	-3.8	5.6	6.9	12.5	300.2	373.5	673.7	653.0
Brokerage clerks	43-4011	Line item	40.8	36.9	-3.9	-9.5	5.8	5.9	11.7	2.2	2.3	4.5	4.1
Correspondence clerks	43-4021	Line item	6.9	6.5	-0.4	-5.6	5.1	6.5	11.6	0.3	0.4	0.8	0.7
Court, municipal, and license clerks	43-4031	Line item	180.4	185.9	5.5	3.0	4.6	5.2	9.8	8.5	9.5	18.0	18.5
Credit authorizers, checkers, and clerks	43-4041	Line item	12.0	11.3	-0.7	-6.2	4.1	4.7	8.8	0.5	0.6	1.0	1.0
Customer service representatives	43-4051	Line item	2,814.0	2,660.3	-153.7	-5.5	5.6	7.4	13.0	154.2	202.9	357.1	341.7
Eligibility interviewers, government programs	43-4061	Line item	166.8	168.5	1.7	1.0	3.8	4.5	8.3	6.3	7.5	13.8	14.0
File clerks	43-4071	Line item	84.3	70.9	-13.4	-15.9	5.5	5.6	11.1	4.3	4.4	8.6	7.3

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2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Hotel, motel, and resort desk clerks	43-4081	Line item	264.2	274.0	9.9	3.7	6.5	9.3	15.8	17.5	25.1	42.7	43.6
Interviewers, except eligibility and loan	43-4111	Line item	164.3	145.1	-19.1	-11.6	5.4	6.0	11.5	8.4	9.3	17.8	15.8
Library assistants, clerical	43-4121	Line item	84.5	78.9	-5.6	-6.7	8.8	7.6	16.4	7.2	6.2	13.4	12.8
Loan interviewers and clerks	43-4131	Line item	177.6	173.5	-4.1	-2.3	3.2	4.6	7.8	5.6	8.2	13.7	13.3
New accounts clerks	43-4141	Line item	38.9	33.8	-5.2	-13.2	2.9	4.9	7.8	1.1	1.8	2.8	2.3
Order clerks	43-4151	Line item	89.5	74.1	-15.4	-17.2	5.1	6.5	11.6	4.2	5.4	9.5	8.0
Human resources assistants, except payroll and timekeeping	43-4161	Line item	95.2	88.4	-6.8	-7.1	4.3	6.2	10.5	4.0	5.7	9.7	9.0
Receptionists and information clerks	43-4171	Line item	1,007.2	1,007.6	0.3	0.0	6.1	6.7	12.8	61.1	67.3	128.4	128.5
Reservation and transportation ticket agents and travel clerks	43-4181	Line item	131.9	135.6	3.7	2.8	4.5	6.0	10.5	6.0	8.0	14.1	14.4
Information and record clerks, all other	43-4199	Line item	153.3	153.0	-0.3	-0.2	5.8	5.9	11.7	8.9	9.0	17.8	17.8
Material recording, scheduling, dispatching, and distributing workers	43-5000	Summary	2,492.6	2,422.1	-70.6	-2.8	3.8	5.1	8.9	93.0	124.5	217.5	210.5
Cargo and freight agents	43-5011	Line item	100.6	109.2	8.6	8.5	2.7	4.9	7.6	2.8	5.1	8.0	8.8
Couriers and messengers	43-5021	Line item	247.2	267.6	20.4	8.2	4.7	5.4	10.1	12.1	13.8	25.9	27.9
Dispatchers	43-5030	Summary	323.9	325.5	1.6	0.5	3.8	5.2	8.9	12.2	16.8	29.0	29.2
Public safety telecommunicators	43-5031	Line item	105.2	108.9	3.6	3.5	4.3	5.3	9.7	4.6	5.7	10.3	10.7
Dispatchers, except police, fire, and ambulance	43-5032	Line item	218.7	216.7	-2.1	-0.9	3.5	5.1	8.6	7.6	11.1	18.7	18.5
Meter readers, utilities	43-5041	Line item	20.1	17.7	-2.4	-12.0	3.9	4.2	8.1	0.7	0.8	1.5	1.3
Postal service workers	43-5050	Summary	500.0	477.1	-22.9	-4.6	3.9	3.7	7.5	19.0	17.8	36.8	34.5
Postal service clerks	43-5051	Line item	74.2	71.6	-2.6	-3.5	5.0	3.7	8.8	3.7	2.7	6.4	6.1
Postal service mail carriers	43-5052	Line item	319.4	308.1	-11.3	-3.5	3.4	3.5	6.9	10.7	11.1	21.8	20.6
Postal service mail sorters, processors, and processing machine operators	43-5053	Line item	106.4	97.5	-8.9	-8.4	4.5	4.0	8.5	4.6	4.1	8.7	7.8
Production, planning, and expediting clerks	43-5061	Line item	388.8	381.7	-7.1	-1.8	3.3	5.7	9.0	12.9	22.0	34.9	34.1
Shipping, receiving, and inventory clerks	43-5071	Line item	862.2	795.8	-66.3	-7.7	3.7	5.4	9.2	30.8	45.1	75.9	69.3
Weighers, measurers, checkers, and samplers, recordkeeping	43-5111	Line item	49.8	47.4	-2.4	-4.8	5.0	6.3	11.3	2.4	3.1	5.5	5.3
Secretaries and administrative assistants	43-6000	Summary	3,453.1	3,440.8	-12.4	-0.4	5.3	5.1	10.4	184.4	175.1	359.5	358.3
Executive secretaries and executive administrative assistants	43-6011	Line item	502.8	494.9	-7.9	-1.6	4.6	5.6	10.2	22.8	28.0	50.8	50.0
Legal secretaries and administrative assistants	43-6012	Line item	156.3	147.3	-9.0	-5.8	8.3	5.2	13.5	12.6	7.9	20.5	19.6
Medical secretaries and administrative assistants	43-6013	Line item	850.0	885.3	35.3	4.2	4.6	4.9	9.5	39.7	42.7	82.4	85.9
Secretaries and administrative assistants, except legal, medical, and executive	43-6014	Line item	1,944.0	1,913.2	-30.8	-1.6	5.7	5.0	10.7	109.3	96.6	205.9	202.8
Other office and administrative support workers	43-9000	Summary	3,433.7	3,167.9	-265.8	-7.7	5.6	5.8	11.4	183.4	191.8	375.2	348.7
Data entry and information processing workers	43-9020	Summary	181.7	130.5	-51.2	-28.2	5.0	5.8	10.8	7.8	9.1	16.9	11.8
Data entry keyers	43-9021	Line item	141.6	104.9	-36.7	-25.9	4.7	6.0	10.7	5.8	7.4	13.2	9.5

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Word processors and typists	43-9022	Line item	40.0	25.6	-14.4	-36.1	6.1	5.1	11.2	2.0	1.7	3.7	2.2
Desktop publishers	43-9031	Line item	5.0	4.4	-0.6	-12.4	4.3	6.0	10.3	0.2	0.3	0.5	0.4
Insurance claims and policy processing clerks	43-9041	Line item	256.7	247.2	-9.5	-3.7	3.8	4.7	8.4	9.5	11.8	21.2	20.3
Mail clerks and mail machine operators, except postal service	43-9051	Line item	67.4	62.9	-4.4	-6.6	5.8	5.6	11.3	3.8	3.6	7.4	6.9
Office clerks, general	43-9061	Line item	2,646.0	2,468.2	-177.8	-6.7	5.9	5.9	11.7	149.7	150.5	300.2	282.4
Office machine operators, except computer	43-9071	Line item	25.5	21.6	-3.9	-15.2	6.2	7.5	13.7	1.5	1.8	3.2	2.8
Proofreaders and copy markers	43-9081	Line item	12.0	11.9	-0.1	-0.6	8.8	7.1	15.8	1.0	0.8	1.9	1.9
Statistical assistants	43-9111	Line item	6.5	6.3	-0.2	-2.5	5.1	7.3	12.4	0.3	0.5	0.8	0.8
Office and administrative support workers, all other	43-9199	Line item	232.9	214.8	-18.1	-7.8	4.3	6.0	10.3	9.7	13.5	23.1	21.3
Farming, fishing, and forestry occupations	45-0000	Summary	1,008.5	983.3	-25.2	-2.5	6.6	8.0	14.6	65.7	79.6	145.3	142.8
Supervisors of farming, fishing, and forestry workers	45-1000	Summary	65.4	67.0	1.6	2.5	5.2	7.4	12.6	3.4	4.9	8.3	8.5
First-line supervisors of farming, fishing, and forestry workers	45-1011	Line item	65.4	67.0	1.6	2.5	5.2	7.4	12.6	3.4	4.9	8.3	8.5
Agricultural workers	45-2000	Summary	866.2	841.8	-24.3	-2.8	6.7	8.0	14.7	57.2	68.7	125.9	123.5
Agricultural inspectors	45-2011	Line item	14.7	14.9	0.2	1.5	5.7	9.3	15.0	0.8	1.4	2.2	2.2
Animal breeders	45-2021	Line item	7.9	8.1	0.2	2.4	6.7	8.0	14.8	0.5	0.6	1.2	1.2
Graders and sorters, agricultural products	45-2041	Line item	38.9	36.8	-2.1	-5.4	6.6	7.4	14.0	2.5	2.8	5.3	5.1
Miscellaneous agricultural workers	45-2090	Summary	804.7	782.1	-22.6	-2.8	6.7	8.0	14.8	53.4	63.9	117.2	115.0
Agricultural equipment operators	45-2091	Line item	65.2	70.3	5.0	7.7	6.7	8.0	14.8	4.6	5.5	10.0	10.5
Farmworkers and laborers, crop, nursery, and greenhouse	45-2092	Line item	504.8	488.1	-16.8	-3.3	6.7	8.0	14.8	33.4	40.0	73.4	71.7
Farmworkers, farm, ranch, and aquacultural animals	45-2093	Line item	224.6	213.4	-11.1	-5.0	6.7	8.0	14.8	14.7	17.6	32.4	31.2
Agricultural workers, all other	45-2099	Line item	10.1	10.3	0.2	2.3	6.7	8.0	14.8	0.7	0.8	1.5	1.5
Fishing and hunting workers	45-3000	Summary	21.9	20.9	-1.0	-4.6	6.3	7.3	13.6	1.3	1.6	2.9	2.8
Fishing and hunting workers	45-3031	Line item	21.9	20.9	-1.0	-4.6	6.3	7.3	13.6	1.3	1.6	2.9	2.8
Forest, conservation, and logging workers	45-4000	Summary	55.0	53.5	-1.5	-2.8	6.7	8.3	15.0	3.7	4.5	8.2	8.0
Forest and conservation workers	45-4011	Line item	10.8	10.3	-0.5	-4.7	6.2	13.5	19.7	0.7	1.4	2.1	2.0
Logging workers	45-4020	Summary	44.3	43.3	-1.0	-2.3	6.9	7.0	13.9	3.0	3.1	6.1	6.0
Fallers	45-4021	Line item	5.6	5.2	-0.4	-7.3	6.9	7.0	13.9	0.4	0.4	0.7	0.7
Logging equipment operators	45-4022	Line item	30.9	30.5	-0.4	-1.4	6.9	7.0	13.9	2.1	2.2	4.3	4.2
Log graders and scalers	45-4023	Line item	4.6	4.6	0.0	-0.7	6.9	7.0	13.9	0.3	0.3	0.6	0.6
Logging workers, all other	45-4029	Line item	3.1	3.0	-0.1	-4.7	6.9	7.0	13.9	0.2	0.2	0.4	0.4
Construction and extraction occupations	47-0000	Summary	7,574.7	7,968.8	394.1	5.2	3.1	4.7	7.8	244.4	365.5	609.9	649.3
Supervisors of construction and extraction workers	47-1000	Summary	921.6	970.6	49.0	5.3	3.2	4.2	7.3	29.9	39.6	69.5	74.4
First-line supervisors of construction trades and extraction workers	47-1011	Line item	921.6	970.6	49.0	5.3	3.2	4.2	7.3	29.9	39.6	69.5	74.4
Construction trades workers	47-2000	Summary	5,752.6	6,084.4	331.9	5.8	3.1	4.7	7.7	182.1	276.0	458.0	491.2
Boilermakers	47-2011	Line item	10.4	10.1	-0.2	-2.4	4.3	4.1	8.5	0.4	0.4	0.9	0.8

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Brickmasons, blockmasons, and stonemasons	47-2020	Summary	86.2	88.2	2.0	2.3	2.8	4.3	7.1	2.5	3.7	6.2	6.4
Brickmasons and blockmasons	47-2021	Line item	74.1	76.4	2.4	3.2	2.8	4.3	7.1	2.1	3.2	5.4	5.6
Stonemasons	47-2022	Line item	12.1	11.8	-0.4	-3.0	2.8	4.3	7.1	0.3	0.5	0.9	0.8
Carpenters	47-2031	Line item	959.0	1,002.1	43.1	4.5	2.8	4.3	7.1	27.8	41.9	69.8	74.1
Carpet, floor, and tile installers and finishers	47-2040	Summary	112.3	119.0	6.7	6.0	2.8	3.9	6.7	3.2	4.5	7.7	8.4
Carpet installers	47-2041	Line item	20.3	18.3	-1.9	-9.6	2.8	3.9	6.7	0.5	0.7	1.3	1.1
Floor layers, except carpet, wood, and hard tiles	47-2042	Line item	33.7	36.9	3.2	9.5	2.8	3.9	6.7	1.0	1.4	2.4	2.7
Floor sanders and finishers	47-2043	Line item	5.6	5.8	0.1	2.6	2.8	3.9	6.7	0.2	0.2	0.4	0.4
Tile and stone setters	47-2044	Line item	52.6	58.0	5.3	10.1	2.8	3.9	6.7	1.5	2.1	3.7	4.2
Cement masons, concrete finishers, and terrazzo workers	47-2050	Summary	208.2	211.8	3.6	1.7	2.5	4.2	6.7	5.2	8.7	14.0	14.3
Cement masons and concrete finishers	47-2051	Line item	206.7	210.4	3.8	1.8	2.5	4.2	6.7	5.2	8.7	13.9	14.3
Terrazzo workers and finishers	47-2053	Line item	1.5	1.3	-0.2	-11.1	2.5	4.2	6.7	0.0	0.1	0.1	0.1
Construction laborers	47-2061	Line item	1,457.0	1,563.4	106.5	7.3	3.2	4.6	7.9	48.5	70.2	118.7	129.4
Construction equipment operators	47-2070	Summary	539.5	559.0	19.5	3.6	3.4	4.7	8.1	18.4	25.8	44.3	46.2
Paving, surfacing, and tamping equipment operators	47-2071	Line item	47.0	48.6	1.5	3.2	3.4	4.7	8.1	1.6	2.2	3.9	4.0
Pile driver operators	47-2072	Line item	3.2	3.3	0.1	4.3	3.4	4.7	8.1	0.1	0.2	0.3	0.3
Operating engineers and other construction equipment operators	47-2073	Line item	489.3	507.1	17.8	3.6	3.4	4.7	8.1	16.7	23.4	40.1	41.9
Drywall installers, ceiling tile installers, and tapers	47-2080	Summary	118.6	123.0	4.4	3.7	2.8	4.2	6.9	3.3	5.0	8.4	8.8
Drywall and ceiling tile installers	47-2081	Line item	103.1	107.4	4.3	4.2	2.8	4.2	6.9	2.9	4.4	7.3	7.7
Tapers	47-2082	Line item	15.6	15.6	0.0	0.1	2.8	4.2	6.9	0.4	0.6	1.1	1.1
Electricians	47-2111	Line item	818.7	896.1	77.4	9.5	3.2	5.4	8.5	27.0	46.2	73.2	81.0
Glaziers	47-2121	Line item	60.5	62.5	2.0	3.3	3.6	4.4	7.9	2.2	2.7	4.9	5.1
Insulation workers	47-2130	Summary	67.4	70.2	2.8	4.2	2.8	5.1	7.9	2.0	3.5	5.5	5.7
Insulation workers, floor, ceiling, and wall	47-2131	Line item	40.2	41.7	1.5	3.8	2.8	5.1	7.9	1.2	2.1	3.2	3.4
Insulation workers, mechanical	47-2132	Line item	27.2	28.5	1.3	4.7	2.8	5.1	7.9	0.8	1.4	2.2	2.3
Painters and paperhangers	47-2140	Summary	344.6	357.7	13.1	3.8	3.6	4.1	7.7	12.5	14.4	27.0	28.3
Painters, construction and maintenance	47-2141	Line item	342.2	355.2	13.0	3.8	3.6	4.1	7.7	12.4	14.3	26.8	28.1
Paperhangers	47-2142	Line item	2.3	2.5	0.1	5.3	3.6	4.1	7.7	0.1	0.1	0.2	0.2
Pipelayers, plumbers, pipefitters, and steamfitters	47-2150	Summary	538.9	560.1	21.3	3.9	3.0	5.0	8.1	16.6	27.7	44.3	46.4
Pipelayers	47-2151	Line item	34.4	32.9	-1.4	-4.1	2.6	4.9	7.6	0.9	1.7	2.6	2.4
Plumbers, pipefitters, and steamfitters	47-2152	Line item	504.5	527.2	22.7	4.5	3.0	5.0	8.1	15.7	26.0	41.7	44.0
Plasterers and stucco masons	47-2161	Line item	24.2	25.2	1.0	4.1	3.6	3.8	7.4	0.9	0.9	1.8	1.9
Reinforcing iron and rebar workers	47-2171	Line item	19.4	20.3	0.9	4.6	2.8	4.3	7.1	0.6	0.9	1.4	1.5
Roofers	47-2181	Line item	166.7	176.5	9.8	5.9	2.4	4.4	6.8	4.1	7.6	11.7	12.7
Sheet metal workers	47-2211	Line item	127.0	130.1	3.1	2.4	3.3	4.7	8.0	4.2	6.1	10.3	10.6
Structural iron and steel workers	47-2221	Line item	65.7	68.6	2.9	4.4	2.7	5.1	7.8	1.8	3.4	5.2	5.5
Solar photovoltaic installers	47-2231	Line item	28.6	40.6	12.0	42.1	2.0	6.3	8.4	0.7	2.2	2.9	4.1
Helpers, construction trades	47-3000	Summary	192.1	195.5	3.4	1.8	3.3	6.9	10.2	6.4	13.3	19.7	20.0

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Helpers--brickmasons, blockmasons, stonemasons, and tile and marble setters	47-3011	Line item	16.1	14.4	-1.7	-10.5	3.3	6.9	10.2	0.5	1.0	1.5	1.4
Helpers--carpenters	47-3012	Line item	25.2	26.4	1.1	4.5	3.3	6.9	10.2	0.8	1.8	2.6	2.7
Helpers--electricians	47-3013	Line item	66.6	66.7	0.1	0.2	3.3	6.9	10.2	2.2	4.6	6.8	6.8
Helpers--painters, paperhangers, plasterers, and stucco masons	47-3014	Line item	7.4	7.6	0.2	2.3	3.3	6.9	10.2	0.2	0.5	0.8	0.8
Helpers--pipelayers, plumbers, pipefitters, and steamfitters	47-3015	Line item	45.3	47.5	2.2	4.9	3.3	6.9	10.2	1.5	3.2	4.7	4.9
Helpers--roofers	47-3016	Line item	5.2	5.5	0.3	5.7	3.3	6.9	10.2	0.2	0.4	0.5	0.6
Helpers, construction trades, all other	47-3019	Line item	26.3	27.4	1.2	4.4	3.3	6.9	10.2	0.9	1.8	2.7	2.8
Other construction and related workers	47-4000	Summary	489.0	499.4	10.4	2.1	4.0	4.6	8.6	19.7	22.8	42.4	43.5
Construction and building inspectors	47-4011	Line item	147.6	146.5	-1.2	-0.8	5.7	4.5	10.2	8.3	6.6	14.9	14.8
Elevator and escalator installers and repairers	47-4021	Line item	24.2	25.4	1.2	5.0	2.7	4.9	7.6	0.7	1.2	1.9	2.0
Fence erectors	47-4031	Line item	26.4	27.6	1.2	4.6	3.4	4.7	8.1	0.9	1.3	2.2	2.3
Hazardous materials removal workers	47-4041	Line item	51.3	51.8	0.5	1.0	4.5	5.1	9.6	2.3	2.6	4.9	5.0
Highway maintenance workers	47-4051	Line item	159.1	163.9	4.8	3.0	3.1	4.2	7.3	5.0	6.8	11.9	12.3
Rail-track laying and maintenance equipment operators	47-4061	Line item	15.0	15.3	0.2	1.6	2.6	4.4	7.0	0.4	0.7	1.1	1.1
Septic tank servicers and sewer pipe cleaners	47-4071	Line item	30.4	32.7	2.3	7.6	3.1	5.3	8.3	1.0	1.7	2.6	2.9
Miscellaneous construction and related workers	47-4090	Line item	35.0	36.2	1.2	3.5	3.1	5.3	8.3	1.1	1.9	3.0	3.1
Extraction workers	47-5000	Summary	219.4	218.9	-0.6	-0.3	2.9	6.4	9.3	6.4	13.9	20.3	20.2
Derrick, rotary drill, and service unit operators, oil and gas	47-5010	Summary	69.9	70.1	0.2	0.3	2.5	6.6	9.0	1.7	4.6	6.3	6.3
Derrick operators, oil and gas	47-5011	Line item	11.3	11.3	0.1	0.5	2.5	6.6	9.0	0.3	0.7	1.0	1.0
Rotary drill operators, oil and gas	47-5012	Line item	13.3	13.4	0.0	0.2	2.5	6.6	9.0	0.3	0.9	1.2	1.2
Service unit operators, oil and gas	47-5013	Line item	45.2	45.4	0.2	0.4	2.5	6.6	9.0	1.1	3.0	4.1	4.1
Surface mining machine operators and earth drillers	47-5020	Summary	54.0	54.4	0.4	0.7	3.2	5.5	8.7	1.8	3.0	4.7	4.7
Excavating and loading machine and dragline operators, surface mining	47-5022	Line item	35.8	35.6	-0.1	-0.4	3.2	5.5	8.7	1.2	1.9	3.1	3.1
Earth drillers, except oil and gas	47-5023	Line item	18.3	18.8	0.5	2.9	3.2	5.5	8.7	0.6	1.0	1.6	1.7
Explosives workers, ordnance handling experts, and blasters	47-5032	Line item	5.8	5.8	-0.1	-0.9	3.1	6.4	9.5	0.2	0.4	0.5	0.5
Underground mining machine operators	47-5040	Summary	27.2	24.9	-2.3	-8.6	3.6	7.1	10.7	0.9	1.9	2.8	2.6
Continuous mining machine operators	47-5041	Line item	14.9	15.0	0.1	0.6	3.6	7.1	10.7	0.5	1.1	1.6	1.6
Roof bolters, mining	47-5043	Line item	2.3	1.5	-0.8	-34.2	3.6	7.1	10.7	0.1	0.1	0.2	0.1
Loading and moving machine operators, underground mining	47-5044	Line item	6.4	5.0	-1.4	-22.3	3.6	7.1	10.7	0.2	0.4	0.6	0.5
Underground mining machine operators, all other	47-5049	Line item	3.6	3.4	-0.2	-6.1	3.6	7.1	10.7	0.1	0.2	0.4	0.4
Rock splitters, quarry	47-5051	Line item	3.2	3.4	0.1	4.4	3.8	6.7	10.5	0.1	0.2	0.3	0.4
Roustabouts, oil and gas	47-5071	Line item	46.0	47.1	1.1	2.5	2.5	6.6	9.0	1.1	3.1	4.2	4.3
Helpers--extraction workers	47-5081	Line item	7.0	6.9	-0.1	-1.7	3.8	6.7	10.5	0.3	0.5	0.7	0.7

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Extraction workers, all other	47-5099	Line item	6.3	6.4	0.1	1.4	3.8	6.7	10.5	0.2	0.4	0.7	0.7
Installation, maintenance, and repair occupations	49-0000	Summary	6,492.9	6,794.3	301.4	4.6	3.8	4.9	8.7	250.6	327.3	577.9	608.1
Supervisors of installation, maintenance, and repair workers	49-1000	Summary	617.5	636.5	19.1	3.1	3.5	4.6	8.1	21.8	28.6	50.5	52.4
First-line supervisors of mechanics, installers, and repairers	49-1011	Line item	617.5	636.5	19.1	3.1	3.5	4.6	8.1	21.8	28.6	50.5	52.4
Electrical and electronic equipment mechanics, installers, and repairers	49-2000	Summary	498.5	504.9	6.4	1.3	3.2	5.7	8.9	16.1	28.6	44.7	45.4
Computer, automated teller, and office machine repairers	49-2011	Line item	79.1	78.4	-0.7	-0.9	3.5	6.2	9.8	2.8	4.9	7.7	7.6
Radio and telecommunications equipment installers and repairers	49-2020	Summary	168.6	163.1	-5.5	-3.3	3.1	5.9	9.0	5.2	9.7	14.9	14.3
Radio, cellular, and tower equipment installers and repairers	49-2021	Line item	11.7	12.7	1.0	8.6	3.1	5.9	9.0	0.4	0.7	1.1	1.2
Telecommunications equipment installers and repairers, except line installers	49-2022	Line item	156.9	150.4	-6.6	-4.2	3.1	5.9	9.0	4.8	9.0	13.8	13.2
Miscellaneous electrical and electronic equipment mechanics, installers, and repairers	49-2090	Summary	250.8	263.5	12.7	5.1	3.2	5.4	8.6	8.2	14.0	22.1	23.4
Avionics technicians	49-2091	Line item	21.4	23.1	1.7	8.2	2.2	5.2	7.3	0.5	1.1	1.6	1.8
Electric motor, power tool, and related repairers	49-2092	Line item	17.1	17.7	0.6	3.4	5.0	4.5	9.5	0.9	0.8	1.6	1.7
Electrical and electronics installers and repairers, transportation equipment	49-2093	Line item	7.0	7.4	0.4	6.1	3.0	4.9	7.8	0.2	0.3	0.6	0.6
Electrical and electronics repairers, commercial and industrial equipment	49-2094	Line item	61.1	60.7	-0.5	-0.8	3.0	4.9	7.8	1.8	3.0	4.8	4.7
Electrical and electronics repairers, powerhouse, substation, and relay	49-2095	Line item	23.4	24.7	1.3	5.5	3.0	4.9	7.8	0.7	1.2	1.9	2.0
Electronic equipment installers and repairers, motor vehicles	49-2096	Line item	10.3	8.9	-1.4	-13.6	3.0	4.9	7.8	0.3	0.5	0.7	0.6
Audiovisual equipment installers and repairers	49-2097	Line item	24.6	26.3	1.6	6.6	3.7	5.9	9.6	0.9	1.5	2.4	2.6
Security and fire alarm systems installers	49-2098	Line item	85.9	94.9	8.9	10.4	3.2	6.2	9.4	2.9	5.6	8.5	9.4
Vehicle and mobile equipment mechanics, installers, and repairers	49-3000	Summary	1,927.6	2,005.5	77.9	4.0	3.4	5.0	8.4	67.5	97.6	165.1	172.9
Aircraft mechanics and service technicians	49-3011	Line item	139.4	145.0	5.6	4.0	2.8	4.8	7.6	4.0	6.8	10.8	11.3
Automotive technicians and repairers	49-3020	Summary	998.6	1,035.7	37.1	3.7	3.3	4.8	8.1	33.4	48.9	82.3	86.0
Automotive body and related repairers	49-3021	Line item	172.6	175.4	2.8	1.6	3.8	4.4	8.2	6.6	7.7	14.3	14.6

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Automotive glass installers and repairers	49-3022	Line item	20.4	21.1	0.7	3.6	2.4	4.1	6.5	0.5	0.9	1.4	1.4
Automotive service technicians and mechanics	49-3023	Line item	805.6	839.2	33.6	4.2	3.2	4.9	8.1	26.3	40.3	66.6	70.0
Bus and truck mechanics and diesel engine specialists	49-3031	Line item	319.9	327.7	7.8	2.4	3.3	4.7	8.0	10.7	15.1	25.8	26.5
Heavy vehicle and mobile equipment service technicians and mechanics	49-3040	Summary	245.6	261.3	15.7	6.4	3.0	5.0	8.0	7.5	12.7	20.2	21.7
Farm equipment mechanics and service technicians	49-3041	Line item	39.0	43.3	4.3	11.0	3.0	5.0	8.0	1.2	2.1	3.3	3.7
Mobile heavy equipment mechanics, except engines	49-3042	Line item	188.7	199.6	10.9	5.8	3.0	5.0	8.0	5.7	9.7	15.5	16.5
Rail car repairers	49-3043	Line item	17.9	18.4	0.5	2.8	3.0	5.0	8.0	0.5	0.9	1.4	1.5
Small engine mechanics	49-3050	Summary	78.0	81.3	3.3	4.2	4.6	4.6	9.2	3.6	3.7	7.3	7.6
Motorboat mechanics and service technicians	49-3051	Line item	26.2	27.8	1.6	6.0	4.6	4.6	9.2	1.2	1.2	2.5	2.6
Motorcycle mechanics	49-3052	Line item	14.9	15.7	0.8	5.3	4.6	4.6	9.2	0.7	0.7	1.4	1.5
Outdoor power equipment and other small engine mechanics	49-3053	Line item	36.9	37.8	0.9	2.5	4.6	4.6	9.2	1.7	1.7	3.4	3.5
Miscellaneous vehicle and mobile equipment mechanics, installers, and repairers	49-3090	Summary	146.2	154.6	8.4	5.8	5.5	7.0	12.5	8.3	10.5	18.8	19.7
Bicycle repairers	49-3091	Line item	13.2	12.9	-0.3	-2.3	5.5	7.0	12.5	0.7	0.9	1.6	1.6
Recreational vehicle service technicians	49-3092	Line item	19.5	21.7	2.2	11.5	5.5	7.0	12.5	1.1	1.4	2.6	2.8
Tire repairers and changers	49-3093	Line item	113.4	119.9	6.5	5.7	5.5	7.0	12.5	6.5	8.2	14.6	15.3
Other installation, maintenance, and repair occupations	49-9000	Summary	3,449.3	3,647.3	198.1	5.7	4.1	4.9	9.0	145.1	172.5	317.6	337.4
Control and valve installers and repairers	49-9010	Summary	76.1	80.0	3.9	5.1	3.4	4.6	8.0	2.6	3.6	6.2	6.6
Mechanical door repairers	49-9011	Line item	28.4	31.7	3.2	11.4	3.4	4.6	8.0	1.0	1.4	2.4	2.7
Control and valve installers and repairers, except mechanical door	49-9012	Line item	47.7	48.3	0.6	1.3	3.4	4.6	8.0	1.6	2.2	3.8	3.9
Heating, air conditioning, and refrigeration mechanics and installers	49-9021	Line item	425.2	459.7	34.5	8.1	2.9	5.4	8.3	12.9	23.8	36.6	40.1
Home appliance repairers	49-9031	Line item	37.3	38.3	1.0	2.6	3.8	4.1	7.9	1.4	1.6	3.0	3.1
Industrial machinery installation, repair, and maintenance workers	49-9040	Summary	539.4	608.4	69.0	12.8	3.9	4.3	8.2	22.5	24.8	47.3	54.2
Industrial machinery mechanics	49-9041	Line item	439.6	510.3	70.7	16.1	3.8	4.3	8.1	18.2	20.5	38.7	45.7
Maintenance workers, machinery	49-9043	Line item	57.5	55.9	-1.6	-2.8	4.5	4.2	8.8	2.6	2.4	5.0	4.8
Millwrights	49-9044	Line item	41.3	41.3	0.0	0.0	4.2	4.6	8.8	1.7	1.9	3.6	3.6
Refractory materials repairers, except brickmasons	49-9045	Line item	1.1	0.9	-0.2	-16.9	3.8	4.3	8.1	0.0	0.0	0.1	0.1
Line installers and repairers	49-9050	Summary	227.3	232.6	5.4	2.4	2.8	5.5	8.3	6.4	12.6	19.0	19.6
Electrical power-line installers and repairers	49-9051	Line item	127.4	135.8	8.4	6.6	2.3	5.2	7.5	3.0	6.8	9.8	10.7

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Telecommunications line installers and repairers	49-9052	Line item	99.9	96.8	-3.1	-3.1	3.5	5.9	9.4	3.4	5.8	9.2	8.9
Precision instrument and equipment repairers	49-9060	Summary	88.7	97.5	8.7	9.8	3.9	4.9	8.9	3.7	4.6	8.3	9.1
Camera and photographic equipment repairers	49-9061	Line item	2.3	1.9	-0.3	-15.1	3.9	4.9	8.9	0.1	0.1	0.2	0.2
Medical equipment repairers	49-9062	Line item	68.0	76.8	8.8	12.9	3.9	4.9	8.9	2.9	3.6	6.4	7.3
Musical instrument repairers and tuners	49-9063	Line item	6.2	6.3	0.1	1.4	3.9	4.9	8.9	0.2	0.3	0.6	0.6
Watch and clock repairers	49-9064	Line item	1.4	1.4	0.0	-1.1	3.9	4.9	8.9	0.1	0.1	0.1	0.1
Precision instrument and equipment repairers, all other	49-9069	Line item	10.8	11.0	0.2	2.0	3.9	4.9	8.9	0.4	0.5	1.0	1.0
Maintenance and repair workers, general	49-9071	Line item	1,629.7	1,692.1	62.4	3.8	4.6	4.6	9.2	76.9	76.7	153.6	159.8
Wind turbine service technicians	49-9081	Line item	13.6	20.5	6.8	49.9	4.1	5.3	9.4	0.7	0.9	1.6	2.3
Miscellaneous installation, maintenance, and repair workers	49-9090	Summary	411.8	418.4	6.6	1.6	4.3	5.8	10.1	18.0	23.9	42.0	42.6
Coin, vending, and amusement machine servicers and repairers	49-9091	Line item	32.5	31.6	-0.9	-2.9	4.7	6.4	11.1	1.5	2.1	3.6	3.5
Commercial divers	49-9092	Line item	4.2	4.5	0.4	8.5	4.1	5.3	9.4	0.2	0.2	0.4	0.4
Locksmiths and safe repairers	49-9094	Line item	18.8	17.2	-1.6	-8.3	5.1	4.9	10.0	0.9	0.9	1.8	1.7
Manufactured building and mobile home installers	49-9095	Line item	3.1	3.3	0.2	5.9	4.1	5.3	9.4	0.1	0.2	0.3	0.3
Riggers	49-9096	Line item	24.6	25.4	0.8	3.2	3.2	6.6	9.8	0.8	1.6	2.5	2.5
Signal and track switch repairers	49-9097	Line item	8.7	8.8	0.1	1.7	4.1	5.3	9.4	0.4	0.5	0.8	0.8
Helpers--installation, maintenance, and repair workers	49-9098	Line item	98.7	101.0	2.2	2.3	4.9	6.7	11.6	4.9	6.7	11.6	11.8
Installation, maintenance, and repair workers, all other	49-9099	Line item	221.2	226.5	5.4	2.4	4.1	5.3	9.4	9.2	11.8	21.0	21.5
Production occupations	51-0000	Summary	9,001.2	8,901.6	-99.6	-1.1	4.4	6.5	10.9	395.5	577.8	973.3	963.4
Supervisors of production workers	51-1000	Summary	698.6	706.9	8.3	1.2	3.6	5.9	9.5	25.1	41.8	66.8	67.7
First-line supervisors of production and operating workers	51-1011	Line item	698.6	706.9	8.3	1.2	3.6	5.9	9.5	25.1	41.8	66.8	67.7
Assemblers and fabricators	51-2000	Summary	1,885.4	1,874.2	-11.2	-0.6	4.4	6.3	10.6	82.1	117.9	200.0	198.8
Aircraft structure, surfaces, rigging, and systems assemblers	51-2011	Line item	33.6	28.7	-4.9	-14.5	4.3	6.3	10.7	1.3	2.0	3.3	2.8
Electrical, electronics, and electromechanical assemblers	51-2020	Summary	273.6	284.7	11.1	4.1	4.8	5.8	10.6	13.5	16.2	29.6	30.7
Coil winders, tapers, and finishers	51-2021	Line item	12.2	11.5	-0.8	-6.3	4.8	5.8	10.6	0.6	0.7	1.3	1.2
Electrical, electronic, and electromechanical assemblers, except coil winders, tapers, and finishers	51-2028	Line item	261.4	273.3	11.9	4.6	4.8	5.8	10.6	12.9	15.5	28.4	29.6
Engine and other machine assemblers	51-2031	Line item	38.4	30.3	-8.1	-21.1	3.4	7.0	10.4	1.2	2.4	3.6	2.8
Structural metal fabricators and fitters	51-2041	Line item	53.8	45.0	-8.8	-16.3	3.9	6.1	10.0	1.9	3.0	4.9	4.1
Fiberglass laminators and fabricators	51-2051	Line item	18.6	19.4	0.8	4.2	4.3	6.3	10.7	0.8	1.2	2.0	2.1
Timing device assemblers and adjusters	51-2061	Line item	0.2	0.2	0.0	-17.5	4.3	6.3	10.7	0.0	0.0	0.0	0.0

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Miscellaneous assemblers and fabricators	51-2090	Line item	1,467.1	1,465.9	-1.3	-0.1	4.3	6.3	10.7	63.4	93.1	156.5	156.3
Food processing workers	51-3000	Summary	891.3	931.6	40.4	4.5	5.4	7.4	12.8	49.3	67.7	117.0	121.0
Bakers	51-3011	Line item	249.1	263.2	14.0	5.6	6.7	8.3	15.0	17.1	21.3	38.5	39.9
Butchers and other meat, poultry, and fish processing workers	51-3020	Summary	359.5	370.5	11.0	3.1	4.6	7.0	11.6	16.8	25.7	42.5	43.6
Butchers and meat cutters	51-3021	Line item	143.1	144.5	1.4	1.0	4.6	7.0	11.6	6.6	10.1	16.7	16.9
Meat, poultry, and fish cutters and trimmers	51-3022	Line item	146.8	154.9	8.1	5.5	4.6	7.0	11.6	7.0	10.6	17.6	18.4
Slaughterers and meat packers	51-3023	Line item	69.6	71.2	1.5	2.2	4.6	7.0	11.6	3.2	5.0	8.2	8.4
Miscellaneous food processing workers	51-3090	Summary	282.6	297.9	15.3	5.4	5.3	7.1	12.4	15.3	20.7	36.0	37.5
Food and tobacco roasting, baking, and drying machine operators and tenders	51-3091	Line item	20.7	20.8	0.1	0.6	3.8	7.8	11.6	0.8	1.6	2.4	2.4
Food batchmakers	51-3092	Line item	173.5	185.4	11.9	6.9	5.6	7.3	12.8	10.0	13.1	23.1	24.2
Food cooking machine operators and tenders	51-3093	Line item	29.7	29.9	0.2	0.6	6.6	8.1	14.7	2.0	2.4	4.4	4.4
Food processing workers, all other	51-3099	Line item	58.7	61.8	3.1	5.3	4.2	6.1	10.2	2.5	3.6	6.2	6.5
Metal workers and plastic workers	51-4000	Summary	1,639.4	1,581.5	-57.9	-3.5	3.8	6.1	9.9	60.6	99.0	159.6	153.8
Forming machine setters, operators, and tenders, metal and plastic	51-4020	Summary	97.3	94.5	-2.7	-2.8	3.6	6.1	9.7	3.4	5.9	9.3	9.0
Extruding and drawing machine setters, operators, and tenders, metal and plastic	51-4021	Line item	66.0	66.8	0.8	1.2	3.6	6.1	9.7	2.4	4.1	6.4	6.5
Forging machine setters, operators, and tenders, metal and plastic	51-4022	Line item	8.8	7.2	-1.7	-18.9	3.6	6.1	9.7	0.3	0.5	0.8	0.6
Rolling machine setters, operators, and tenders, metal and plastic	51-4023	Line item	22.5	20.6	-1.9	-8.3	3.6	6.1	9.7	0.8	1.3	2.1	1.9
Machine tool cutting setters, operators, and tenders, metal and plastic	51-4030	Summary	282.9	247.7	-35.2	-12.4	4.2	5.7	10.0	11.3	15.2	26.4	22.9
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	51-4031	Line item	174.7	153.6	-21.1	-12.1	4.5	5.6	10.1	7.4	9.1	16.5	14.4
Drilling and boring machine tool setters, operators, and tenders, metal and plastic	51-4032	Line item	5.3	4.3	-1.0	-19.6	3.2	6.9	10.1	0.2	0.3	0.5	0.4
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	51-4033	Line item	70.1	61.7	-8.4	-12.0	4.2	5.5	9.6	2.7	3.6	6.3	5.5
Lathe and turning machine tool setters, operators, and tenders, metal and plastic	51-4034	Line item	18.9	16.4	-2.6	-13.6	3.2	6.9	10.1	0.6	1.2	1.8	1.5
Milling and planing machine setters, operators, and tenders, metal and plastic	51-4035	Line item	13.8	11.8	-2.0	-14.4	3.2	6.9	10.1	0.4	0.9	1.3	1.1
Machinists	51-4041	Line item	299.5	299.6	0.0	0.0	4.1	5.7	9.8	12.3	17.2	29.5	29.5

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Metal furnace operators, tenders, pourers, and casters	51-4050	Summary	26.7	26.0	-0.8	-2.8	3.7	6.3	10.0	1.0	1.6	2.6	2.6
Metal-refining furnace operators and tenders	51-4051	Line item	20.8	20.3	-0.5	-2.3	3.7	6.3	10.0	0.8	1.3	2.1	2.0
Pourers and casters, metal	51-4052	Line item	5.9	5.7	-0.3	-4.7	3.7	6.3	10.0	0.2	0.4	0.6	0.6
Model makers and patternmakers, metal and plastic	51-4060	Summary	4.8	3.8	-1.0	-20.3	4.4	6.5	10.9	0.2	0.3	0.5	0.4
Model makers, metal and plastic	51-4061	Line item	3.2	2.6	-0.6	-18.2	4.4	6.5	10.9	0.1	0.2	0.3	0.3
Patternmakers, metal and plastic	51-4062	Line item	1.6	1.2	-0.4	-24.4	4.4	6.5	10.9	0.1	0.1	0.1	0.1
Molders and molding machine setters, operators, and tenders, metal and plastic	51-4070	Summary	167.3	158.2	-9.1	-5.5	4.4	6.5	10.9	7.1	10.6	17.7	16.8
Foundry mold and coremakers	51-4071	Line item	12.7	9.4	-3.3	-25.9	4.4	6.5	10.9	0.5	0.7	1.2	0.9
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	51-4072	Line item	154.6	148.8	-5.8	-3.8	4.4	6.5	10.9	6.6	9.8	16.5	15.9
Multiple machine tool setters, operators, and tenders, metal and plastic	51-4081	Line item	131.0	130.3	-0.7	-0.5	3.8	6.0	9.8	5.0	7.8	12.8	12.8
Tool and die makers	51-4111	Line item	55.2	49.3	-6.0	-10.8	4.6	5.6	10.2	2.4	2.9	5.3	4.7
Welding, soldering, and brazing workers	51-4120	Summary	496.2	502.5	6.4	1.3	3.0	6.6	9.6	15.0	33.1	48.2	48.8
Welders, cutters, solderers, and brazers	51-4121	Line item	457.3	467.2	9.9	2.2	3.0	6.6	9.6	13.9	30.7	44.6	45.6
Welding, soldering, and brazing machine setters, operators, and tenders	51-4122	Line item	38.9	35.4	-3.5	-9.0	3.0	6.6	9.6	1.1	2.5	3.6	3.2
Miscellaneous metal workers and plastic workers	51-4190	Summary	78.4	69.5	-8.9	-11.4	3.8	6.0	9.8	2.8	4.4	7.3	6.4
Heat treating equipment setters, operators, and tenders, metal and plastic	51-4191	Line item	14.8	12.9	-1.9	-12.8	3.8	6.0	9.8	0.5	0.8	1.4	1.2
Layout workers, metal and plastic	51-4192	Line item	5.7	5.4	-0.3	-5.4	3.8	6.0	9.8	0.2	0.3	0.5	0.5
Plating machine setters, operators, and tenders, metal and plastic	51-4193	Line item	31.7	27.4	-4.3	-13.6	3.8	6.0	9.8	1.1	1.8	2.9	2.5
Tool grinders, filers, and sharpeners	51-4194	Line item	5.8	5.4	-0.5	-7.8	3.8	6.0	9.8	0.2	0.3	0.5	0.5
Metal workers and plastic workers, all other	51-4199	Line item	20.4	18.5	-1.9	-9.5	3.8	6.0	9.8	0.7	1.2	1.9	1.7
Printing workers	51-5100	Summary	212.1	190.4	-21.8	-10.3	4.5	6.2	10.7	9.0	12.5	21.5	19.3
Prepress technicians and workers	51-5111	Line item	26.2	22.3	-3.8	-14.6	5.4	7.6	13.0	1.3	1.8	3.1	2.8
Printing press operators	51-5112	Line item	150.2	138.0	-12.2	-8.1	4.3	6.1	10.4	6.2	8.7	14.9	13.7
Print binding and finishing workers	51-5113	Line item	35.8	30.0	-5.8	-16.1	4.6	5.7	10.3	1.5	1.9	3.4	2.8
Textile, apparel, and furnishings workers	51-6000	Summary	520.7	504.2	-16.5	-3.2	7.3	6.0	13.4	37.5	30.9	68.4	66.8
Laundry and dry-cleaning workers	51-6011	Line item	202.6	213.5	10.9	5.4	8.3	6.5	14.8	17.2	13.6	30.8	31.9
Pressers, textile, garment, and related materials	51-6021	Line item	28.4	24.6	-3.8	-13.5	6.7	5.2	11.9	1.8	1.4	3.2	2.8
Sewing machine operators	51-6031	Line item	124.0	110.7	-13.3	-10.8	6.9	5.3	12.2	8.1	6.2	14.3	13.0
Shoe and leather workers	51-6040	Summary	13.6	13.1	-0.5	-3.8	4.6	5.6	10.1	0.6	0.7	1.4	1.3

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Shoe and leather workers and repairers	51-6041	Line item	9.5	9.1	-0.4	-3.8	4.6	5.6	10.1	0.4	0.5	0.9	0.9
Shoe machine operators and tenders	51-6042	Line item	4.1	3.9	-0.2	-3.7	4.6	5.6	10.1	0.2	0.2	0.4	0.4
Tailors, dressmakers, and sewers	51-6050	Summary	44.2	42.1	-2.1	-4.8	8.0	5.5	13.5	3.5	2.4	5.8	5.6
Sewers, hand	51-6051	Line item	5.4	5.0	-0.4	-7.0	8.0	5.5	13.5	0.4	0.3	0.7	0.7
Tailors, dressmakers, and custom sewers	51-6052	Line item	38.8	37.1	-1.7	-4.5	8.0	5.5	13.5	3.0	2.1	5.1	5.0
Textile machine setters, operators, and tenders	51-6060	Summary	52.5	47.1	-5.4	-10.2	5.6	7.3	12.9	2.8	3.6	6.4	5.9
Textile bleaching and dyeing machine operators and tenders	51-6061	Line item	6.2	5.5	-0.6	-10.1	5.6	7.3	12.9	0.3	0.4	0.8	0.7
Textile cutting machine setters, operators, and tenders	51-6062	Line item	9.3	8.2	-1.1	-11.7	5.6	7.3	12.9	0.5	0.6	1.1	1.0
Textile knitting and weaving machine setters, operators, and tenders	51-6063	Line item	15.3	13.6	-1.7	-11.2	5.6	7.3	12.9	0.8	1.1	1.9	1.7
Textile winding, twisting, and drawing out machine setters, operators, and tenders	51-6064	Line item	21.7	19.8	-1.9	-9.0	5.6	7.3	12.9	1.2	1.5	2.7	2.5
Miscellaneous textile, apparel, and furnishings workers	51-6090	Summary	55.4	53.1	-2.2	-4.0	6.5	5.4	12.0	3.5	3.0	6.5	6.3
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	51-6091	Line item	15.2	15.0	-0.2	-1.1	7.2	6.2	13.4	1.1	0.9	2.0	2.0
Fabric and apparel patternmakers	51-6092	Line item	2.8	2.5	-0.3	-10.2	7.2	6.2	13.4	0.2	0.2	0.4	0.3
Upholsterers	51-6093	Line item	22.7	22.3	-0.4	-1.8	5.6	4.3	10.0	1.3	1.0	2.2	2.2
Textile, apparel, and furnishings workers, all other	51-6099	Line item	14.7	13.3	-1.4	-9.4	7.2	6.2	13.4	1.0	0.9	1.9	1.7
Woodworkers	51-7000	Summary	233.5	229.3	-4.3	-1.8	4.2	6.1	10.2	9.6	14.1	23.7	23.3
Cabinetmakers and bench carpenters	51-7011	Line item	86.0	84.7	-1.4	-1.6	4.3	5.4	9.7	3.6	4.6	8.3	8.1
Furniture finishers	51-7021	Line item	20.5	19.8	-0.7	-3.3	5.5	4.7	10.2	1.1	0.9	2.1	2.0
Model makers and patternmakers, wood	51-7030	Summary	1.4	1.3	-0.1	-4.6	4.5	6.2	10.7	0.1	0.1	0.1	0.1
Model makers, wood	51-7031	Line item	0.9	0.9	0.0	-4.5	4.5	6.2	10.7	0.0	0.1	0.1	0.1
Patternmakers, wood	51-7032	Line item	0.5	0.4	0.0	-5.0	4.5	6.2	10.7	0.0	0.0	0.0	0.0
Woodworking machine setters, operators, and tenders	51-7040	Summary	108.0	106.6	-1.4	-1.3	3.7	6.8	10.6	4.0	7.3	11.4	11.2
Sawing machine setters, operators, and tenders, wood	51-7041	Line item	45.0	44.7	-0.3	-0.6	3.9	6.9	10.8	1.7	3.1	4.8	4.8
Woodworking machine setters, operators, and tenders, except sawing	51-7042	Line item	63.1	61.9	-1.1	-1.8	3.7	6.8	10.4	2.3	4.2	6.5	6.4
Woodworkers, all other	51-7099	Line item	17.6	16.8	-0.8	-4.4	4.5	6.2	10.7	0.8	1.1	1.8	1.8
Plant and system operators	51-8000	Summary	297.9	282.0	-15.9	-5.3	3.3	6.2	9.5	9.5	17.9	27.4	25.8
Power plant operators, distributors, and dispatchers	51-8010	Summary	46.6	41.9	-4.7	-10.1	3.7	5.9	9.6	1.6	2.6	4.2	3.8
Nuclear power reactor operators	51-8011	Line item	5.7	4.9	-0.9	-15.3	3.7	5.9	9.6	0.2	0.3	0.5	0.4

Source: Employment Projections program, U.S. Bureau of Labor Statistics

2024 National Employment Matrix title	2024 National Employment Matrix code	Occupation type	Employment, 2024	Employment, 2034	Employment change, numeric, 2024–34	Employment change, percent, 2024–34	Labor force exit rate, 2024–34 annual average	Occupational transfer rate, 2024–34 annual average	Total occupational separations rate, 2024–34 annual average	Labor force exits, 2024–34 annual average	Occupational transfers, 2024–34 annual average	Total occupational separations, 2024–34 annual average	Occupational openings, 2024–34 annual average
Power distributors and dispatchers	51-8012	Line item	9.3	9.0	-0.3	-3.2	3.7	5.9	9.6	0.3	0.5	0.9	0.8
Power plant operators	51-8013	Line item	31.6	28.0	-3.5	-11.2	3.7	5.9	9.6	1.1	1.8	2.8	2.5
Stationary engineers and boiler operators	51-8021	Line item	33.3	34.0	0.7	2.2	4.4	6.6	11.0	1.5	2.2	3.7	3.8
Water and wastewater treatment plant and system operators	51-8031	Line item	132.4	123.8	-8.7	-6.5	3.3	5.7	9.0	4.2	7.3	11.5	10.7
Miscellaneous plant and system operators	51-8090	Summary	85.6	82.3	-3.2	-3.8	2.6	6.9	9.4	2.2	5.8	7.9	7.6
Chemical plant and system operators	51-8091	Line item	18.1	17.0	-1.1	-6.1	2.6	6.9	9.4	0.5	1.2	1.7	1.6
Gas plant operators	51-8092	Line item	16.2	14.8	-1.4	-8.8	2.6	6.9	9.4	0.4	1.1	1.5	1.3
Petroleum pump system operators, refinery operators, and gaugers	51-8093	Line item	34.9	34.0	-1.0	-2.8	2.6	6.9	9.4	0.9	2.4	3.3	3.2
Plant and system operators, all other	51-8099	Line item	16.3	16.6	0.3	1.6	2.6	6.9	9.4	0.4	1.1	1.6	1.6
Other production occupations	51-9000	Summary	2,622.3	2,601.5	-20.8	-0.8	4.3	6.7	11.1	112.9	176.1	289.0	286.9
Chemical processing machine setters, operators, and tenders	51-9010	Summary	183.2	185.2	1.9	1.0	3.1	7.6	10.7	5.7	13.9	19.7	19.8
Chemical equipment operators and tenders	51-9011	Line item	128.9	133.1	4.3	3.3	3.1	7.6	10.7	4.1	9.9	14.0	14.4
Separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders	51-9012	Line item	54.4	52.0	-2.3	-4.3	3.1	7.6	10.7	1.7	4.0	5.7	5.4
Crushing, grinding, polishing, mixing, and blending workers	51-9020	Summary	141.5	131.5	-10.1	-7.1	3.3	6.5	9.8	4.5	8.8	13.3	12.3
Crushing, grinding, and polishing machine setters, operators, and tenders	51-9021	Line item	28.7	27.9	-0.7	-2.5	3.3	6.5	9.8	0.9	1.8	2.8	2.7
Grinding and polishing workers, hand	51-9022	Line item	11.8	9.3	-2.5	-21.2	3.3	6.5	9.8	0.3	0.7	1.0	0.8
Mixing and blending machine setters, operators, and tenders	51-9023	Line item	101.1	94.3	-6.8	-6.8	3.3	6.5	9.8	3.2	6.3	9.5	8.8
Cutting workers	51-9030	Summary	56.0	53.6	-2.4	-4.3	5.3	6.0	11.3	2.9	3.3	6.2	5.9
Cutters and trimmers, hand	51-9031	Line item	7.0	5.7	-1.3	-18.1	5.3	6.0	11.3	0.3	0.4	0.7	0.6
Cutting and slicing machine setters, operators, and tenders	51-9032	Line item	49.0	47.9	-1.1	-2.3	5.3	6.0	11.3	2.6	2.9	5.5	5.3
Extruding, forming, pressing, and compacting machine setters, operators, and tenders	51-9041	Line item	57.3	58.4	1.1	2.0	2.6	6.2	8.8	1.5	3.6	5.1	5.2
Furnace, kiln, oven, drier, and kettle operators and tenders	51-9051	Line item	16.5	17.0	0.5	3.0	4.5	6.5	11.0	0.7	1.1	1.8	1.9
Inspectors, testers, sorters, samplers, and weighers	51-9061	Line item	598.0	598.1	0.1	0.0	4.7	7.0	11.7	27.8	42.1	69.9	69.9
Jewelers and precious stone and metal workers	51-9071	Line item	35.1	33.2	-1.9	-5.5	6.5	5.7	12.2	2.2	1.9	4.2	4.0
Dental and ophthalmic laboratory technicians and medical appliance technicians	51-9080	Summary	66.8	66.0	-0.7	-1.1	5.3	6.5	11.8	3.5	4.3	7.8	7.7
Dental laboratory technicians	51-9081	Line item	35.2	33.6	-1.6	-4.7	5.3	6.5	11.8	1.8	2.2	4.0	3.9
Medical appliance technicians	51-9082	Line item	12.0	12.4	0.4	3.7	5.3	6.5	11.8	0.6	0.8	1.4	1.5

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Ophthalmic laboratory technicians	51-9083	Line item	19.6	20.0	0.5	2.3	5.3	6.5	11.8	1.0	1.3	2.3	2.4
Packaging and filling machine operators and tenders	51-9111	Line item	381.2	398.2	17.0	4.5	4.9	6.3	11.2	19.1	24.5	43.6	45.3
Painting workers	51-9120	Summary	174.3	175.6	1.3	0.7	3.4	6.0	9.5	6.0	10.6	16.6	16.7
Painting, coating, and decorating workers	51-9123	Line item	8.8	8.9	0.1	1.4	3.4	6.0	9.5	0.3	0.5	0.8	0.8
Coating, painting, and spraying machine setters, operators, and tenders	51-9124	Line item	165.5	166.7	1.2	0.7	3.4	6.0	9.5	5.7	10.0	15.7	15.8
Semiconductor processing technicians	51-9141	Line item	31.9	35.4	3.5	10.9	3.9	6.8	10.7	1.3	2.3	3.6	3.9
Photographic process workers and processing machine operators	51-9151	Line item	11.2	10.9	-0.3	-2.6	4.9	9.1	14.0	0.5	1.0	1.6	1.5
Computer numerically controlled tool operators and programmers	51-9160	Summary	205.4	190.0	-15.4	-7.5	2.8	6.3	9.2	5.6	12.5	18.1	16.6
Computer numerically controlled tool operators	51-9161	Line item	177.1	158.1	-19.0	-10.7	2.8	6.3	9.2	4.7	10.6	15.4	13.5
Computer numerically controlled tool programmers	51-9162	Line item	28.3	31.9	3.6	12.8	2.8	6.3	9.2	0.8	1.9	2.8	3.1
Miscellaneous production workers	51-9190	Summary	663.9	648.4	-15.4	-2.3	4.8	7.0	11.8	31.4	46.2	77.6	76.0
Adhesive bonding machine operators and tenders	51-9191	Line item	12.2	12.3	0.1	1.0	4.6	6.1	10.7	0.6	0.7	1.3	1.3
Cleaning, washing, and metal pickling equipment operators and tenders	51-9192	Line item	14.6	15.2	0.5	3.6	3.9	6.8	10.7	0.6	1.0	1.6	1.6
Cooling and freezing equipment operators and tenders	51-9193	Line item	7.1	7.6	0.5	7.2	3.9	6.8	10.7	0.3	0.5	0.8	0.8
Etchers and engravers	51-9194	Line item	8.6	8.6	-0.1	-0.7	4.8	5.5	10.3	0.4	0.5	0.9	0.9
Molders, shapers, and casters, except metal and plastic	51-9195	Line item	41.7	44.3	2.6	6.2	6.2	5.9	12.1	2.7	2.5	5.2	5.5
Paper goods machine setters, operators, and tenders	51-9196	Line item	97.5	91.4	-6.1	-6.3	3.7	5.5	9.2	3.5	5.2	8.7	8.1
Tire builders	51-9197	Line item	20.9	21.4	0.5	2.3	4.5	7.3	11.8	1.0	1.5	2.5	2.5
Helpers--production workers	51-9198	Line item	168.5	153.5	-15.0	-8.9	6.7	8.9	15.6	10.8	14.4	25.1	23.6
Production workers, all other	51-9199	Line item	292.8	294.3	1.5	0.5	3.9	6.8	10.7	11.6	19.8	31.4	31.6
Transportation and material moving occupations	53-0000	Summary	14,204.6	14,784.4	579.9	4.1	5.3	6.9	12.2	768.2	1,003.8	1,772.0	1,830.0
Supervisors of transportation and material moving workers	53-1000	Summary	619.9	643.0	23.1	3.7	3.4	6.2	9.5	21.2	38.9	60.1	62.4
Aircraft cargo handling supervisors	53-1041	Line item	10.3	10.8	0.5	5.2	3.4	6.2	9.5	0.4	0.7	1.0	1.1
First-line supervisors of transportation and material moving workers, except aircraft cargo handling supervisors	53-1047	Line item	609.6	632.2	22.5	3.7	3.4	6.2	9.5	20.8	38.3	59.1	61.3
Air transportation workers	53-2000	Summary	327.3	347.0	19.8	6.0	4.7	7.1	11.8	15.9	23.9	39.8	41.8
Aircraft pilots and flight engineers	53-2010	Summary	155.4	162.2	6.7	4.3	3.8	7.2	11.0	6.1	11.5	17.5	18.2

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Airline pilots, copilots, and flight engineers	53-2011	Line item	100.0	103.9	3.9	3.9	3.8	7.2	11.0	3.9	7.4	11.3	11.7
Commercial pilots	53-2012	Line item	55.4	58.3	2.8	5.1	3.8	7.2	11.0	2.2	4.1	6.3	6.6
Air traffic controllers and airfield operations specialists	53-2020	Summary	41.0	42.0	1.0	2.5	2.4	6.5	8.9	1.0	2.7	3.7	3.8
Air traffic controllers	53-2021	Line item	24.1	24.4	0.3	1.2	2.4	6.5	8.9	0.6	1.6	2.2	2.2
Airfield operations specialists	53-2022	Line item	16.9	17.6	0.7	4.2	2.4	6.5	8.9	0.4	1.1	1.5	1.6
Flight attendants	53-2031	Line item	130.8	142.9	12.1	9.2	6.4	7.1	13.6	8.8	9.8	18.6	19.8
Motor vehicle operators	53-3000	Summary	4,852.0	5,111.1	259.1	5.3	5.3	5.4	10.8	266.1	270.2	536.3	562.2
Ambulance drivers and attendants, except emergency medical technicians	53-3011	Line item	12.3	12.1	-0.2	-1.3	3.8	8.0	11.8	0.5	1.0	1.4	1.4
Driver/sales workers and truck drivers	53-3030	Summary	3,766.5	3,974.4	208.0	5.5	4.4	5.6	10.0	170.4	217.9	388.3	409.1
Driver/sales workers	53-3031	Line item	451.5	491.3	39.8	8.8	4.4	5.6	10.0	20.8	26.5	47.3	51.3
Heavy and tractor-trailer truck drivers	53-3032	Line item	2,235.1	2,324.4	89.3	4.0	4.4	5.6	10.0	100.4	128.3	228.7	237.6
Light truck drivers	53-3033	Line item	1,079.8	1,158.6	78.9	7.3	4.4	5.6	10.0	49.3	63.0	112.3	120.2
Passenger vehicle drivers	53-3050	Summary	994.0	1,040.6	46.6	4.7	8.8	4.6	13.4	89.1	46.9	136.0	140.6
Bus drivers, school	53-3051	Line item	387.3	388.2	0.9	0.2	11.1	4.6	15.7	43.1	17.7	60.9	61.0
Bus drivers, transit and intercity	53-3052	Line item	158.8	165.6	6.8	4.3	8.0	4.5	12.4	12.9	7.3	20.2	20.9
Shuttle drivers and chauffeurs	53-3053	Line item	243.9	260.3	16.4	6.7	9.0	4.7	13.7	22.7	11.9	34.6	36.3
Taxi drivers	53-3054	Line item	204.0	226.6	22.6	11.1	4.8	4.6	9.4	10.4	9.9	20.3	22.6
Motor vehicle operators, all other	53-3099	Line item	79.3	84.0	4.7	6.0	7.5	5.5	13.0	6.1	4.5	10.6	11.1
Rail transportation workers	53-4000	Summary	89.1	90.2	1.1	1.2	2.7	5.7	8.5	2.4	5.1	7.6	7.7
Locomotive engineers and operators	53-4010	Summary	30.1	30.3	0.2	0.7	2.8	5.2	8.0	0.8	1.6	2.4	2.5
Locomotive engineers	53-4011	Line item	27.0	27.2	0.2	0.7	2.8	5.2	8.0	0.8	1.4	2.2	2.2
Rail yard engineers, dinkey operators, and hostlers	53-4013	Line item	3.1	3.1	0.0	0.3	2.8	5.2	8.0	0.1	0.2	0.2	0.2
Railroad brake, signal, and switch operators and locomotive firers	53-4022	Line item	11.0	11.1	0.1	1.0	3.3	6.0	9.2	0.4	0.7	1.0	1.0
Railroad conductors and yardmasters	53-4031	Line item	36.8	37.2	0.4	1.1	2.3	6.0	8.4	0.9	2.2	3.1	3.1
Subway and streetcar operators	53-4041	Line item	9.6	9.9	0.3	3.4	3.3	6.0	9.2	0.3	0.6	0.9	0.9
Rail transportation workers, all other	53-4099	Line item	1.6	1.6	0.1	3.9	3.3	6.0	9.2	0.1	0.1	0.1	0.2
Water transportation workers	53-5000	Summary	84.3	85.4	1.1	1.3	4.5	6.6	11.1	3.8	5.6	9.4	9.5
Sailors and marine oilers	53-5011	Line item	32.1	32.8	0.7	2.3	4.3	7.4	11.7	1.4	2.4	3.8	3.9
Ship and boat captains and operators	53-5020	Summary	43.5	43.7	0.2	0.5	4.6	5.9	10.6	2.0	2.6	4.6	4.6
Captains, mates, and pilots of water vessels	53-5021	Line item	40.7	40.9	0.2	0.5	4.6	5.9	10.6	1.9	2.4	4.3	4.3
Motorboat operators	53-5022	Line item	2.7	2.8	0.0	1.4	4.6	5.9	10.6	0.1	0.2	0.3	0.3
Ship engineers	53-5031	Line item	8.8	9.0	0.1	1.6	4.3	7.4	11.7	0.4	0.7	1.0	1.1
Other transportation workers	53-6000	Summary	337.4	344.1	6.7	2.0	5.5	7.9	13.4	18.7	26.9	45.6	46.2
Bridge and lock tenders	53-6011	Line item	2.9	2.8	-0.1	-3.3	4.2	5.9	10.1	0.1	0.2	0.3	0.3
Parking attendants	53-6021	Line item	135.7	139.8	4.0	3.0	5.2	7.9	13.1	7.1	10.9	18.1	18.5
Transportation service attendants	53-6030	Summary	128.1	128.5	0.4	0.3	5.4	9.2	14.6	6.9	11.8	18.7	18.8
Automotive and watercraft service attendants	53-6031	Line item	100.0	99.0	-1.0	-1.0	5.4	9.2	14.6	5.4	9.2	14.5	14.4
Aircraft service attendants	53-6032	Line item	28.0	29.5	1.4	5.1	5.4	9.2	14.6	1.5	2.7	4.2	4.3

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Traffic technicians	53-6041	Line item	7.9	8.2	0.3	3.7	4.2	5.9	10.1	0.3	0.5	0.8	0.8
Transportation inspectors	53-6051	Line item	25.7	26.1	0.4	1.7	4.3	5.3	9.6	1.1	1.4	2.5	2.5
Passenger attendants	53-6061	Line item	25.6	26.8	1.2	4.7	10.0	5.2	15.2	2.6	1.4	4.0	4.1
Transportation workers, all other	53-6099	Line item	11.5	11.9	0.4	3.8	4.2	5.9	10.1	0.5	0.7	1.2	1.2
Material moving workers	53-7000	Summary	7,894.6	8,163.5	268.9	3.4	5.5	7.9	13.4	440.0	633.2	1,073.2	1,100.1
Conveyor operators and tenders	53-7011	Line item	29.1	28.1	-1.0	-3.4	4.1	5.4	9.5	1.2	1.6	2.7	2.6
Crane and tower operators	53-7021	Line item	42.3	43.5	1.3	3.0	2.9	5.6	8.5	1.2	2.4	3.7	3.8
Dredge operators	53-7031	Line item	1.1	1.2	0.0	1.2	4.1	5.4	9.5	0.0	0.1	0.1	0.1
Hoist and winch operators	53-7041	Line item	2.7	2.7	0.0	-1.1	4.1	5.4	9.5	0.1	0.1	0.3	0.3
Industrial truck and tractor operators	53-7051	Line item	792.5	801.6	9.1	1.1	3.3	6.1	9.5	26.6	48.9	75.5	76.4
Laborers and material movers	53-7060	Summary	6,802.1	7,059.2	257.1	3.8	5.8	8.1	13.9	401.4	564.3	965.7	991.4
Cleaners of vehicles and equipment	53-7061	Line item	410.1	426.2	16.0	3.9	5.6	7.4	13.0	23.6	31.0	54.5	56.2
Laborers and freight, stock, and material movers, hand	53-7062	Line item	2,988.9	3,033.1	44.3	1.5	5.0	7.6	12.6	150.2	229.7	379.9	384.3
Machine feeders and offbearers	53-7063	Line item	46.5	40.4	-6.0	-13.0	5.1	7.0	12.1	2.2	3.0	5.3	4.7
Packers and packagers, hand	53-7064	Line item	591.8	559.7	-32.2	-5.4	5.9	7.5	13.4	33.7	43.5	77.2	74.0
Stockers and order fillers	53-7065	Line item	2,764.8	2,999.8	235.0	8.5	6.7	8.9	15.6	191.7	257.1	448.8	472.3
Pumping station operators	53-7070	Summary	37.3	36.7	-0.6	-1.7	3.8	7.5	11.3	1.4	2.8	4.2	4.1
Gas compressor and gas pumping station operators	53-7071	Line item	5.4	5.3	-0.1	-1.3	3.8	7.5	11.3	0.2	0.4	0.6	0.6
Pump operators, except wellhead pumpers	53-7072	Line item	13.1	13.5	0.3	2.6	3.8	7.5	11.3	0.5	1.0	1.5	1.5
Wellhead pumpers	53-7073	Line item	18.8	17.9	-0.9	-4.7	3.8	7.5	11.3	0.7	1.4	2.1	2.0
Refuse and recyclable material collectors	53-7081	Line item	147.9	149.2	1.3	0.9	4.3	7.0	11.3	6.3	10.4	16.8	16.9
Tank car, truck, and ship loaders	53-7121	Line item	12.0	12.5	0.5	4.3	4.1	6.4	10.5	0.5	0.8	1.3	1.3
Material moving workers, all other	53-7199	Line item	27.7	28.9	1.2	4.3	4.1	6.4	10.5	1.2	1.8	3.0	3.1

Source: Employment Projections program, U.S. Bureau of Labor Statistics

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U.S. BUREAU OF LABOR STATISTICS Occupational Statistics and Employment Projections Office of Employment and Unemployment Statistics Suitland Federal Center Floor 3 4600 Silver Hill Road Washington, DC 20212-0002

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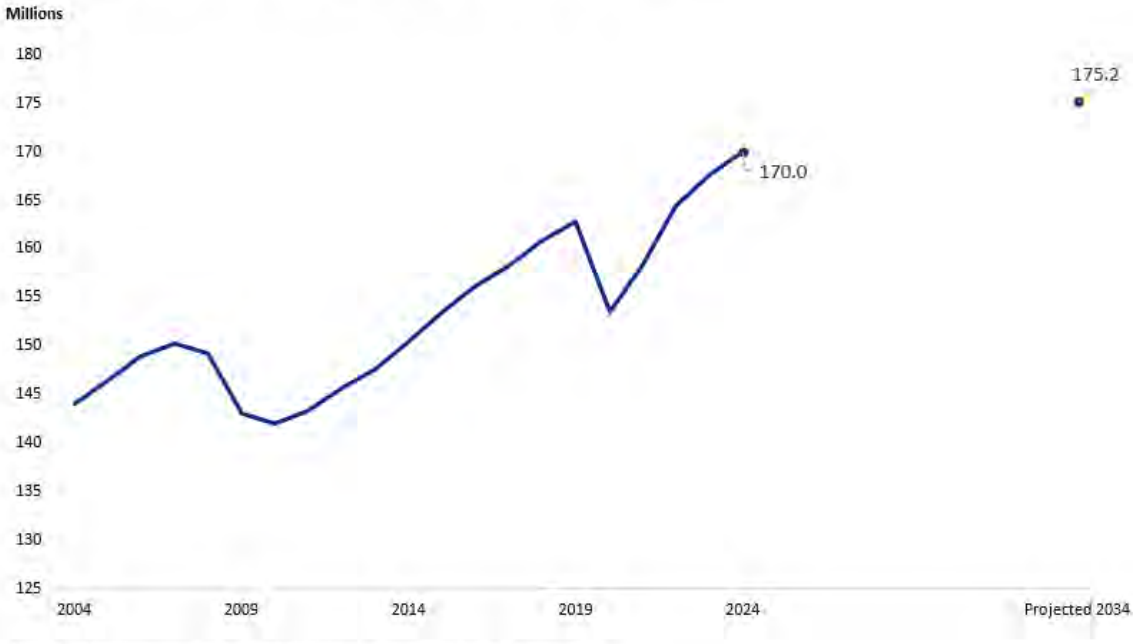
EMPLOYMENT PROJECTIONS — 2024–2034

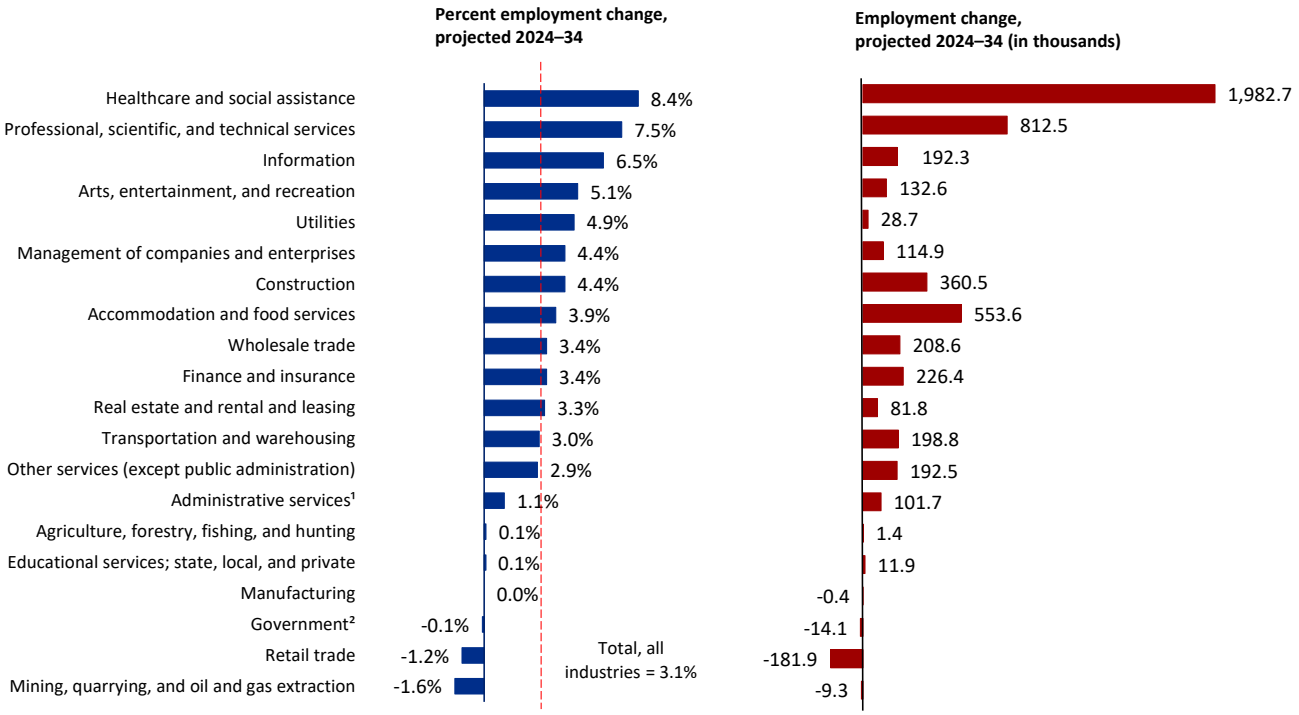
The U.S. economy is projected to add 5.2 million jobs from 2024 to 2034, the U.S. Bureau of Labor Statistics (BLS) reported today. Total employment is projected to increase to 175.2 million and grow 3.1 percent, which is slower than the 13.0-percent growth recorded over the 2014−24 decade. (See chart 1.)

Chart 1. Total employment, 2004–24 and projected 2034



Note: Total employment includes wage and salary employment and self-employment.

Chart 2. Employment change by industry sector, projected 2024–34



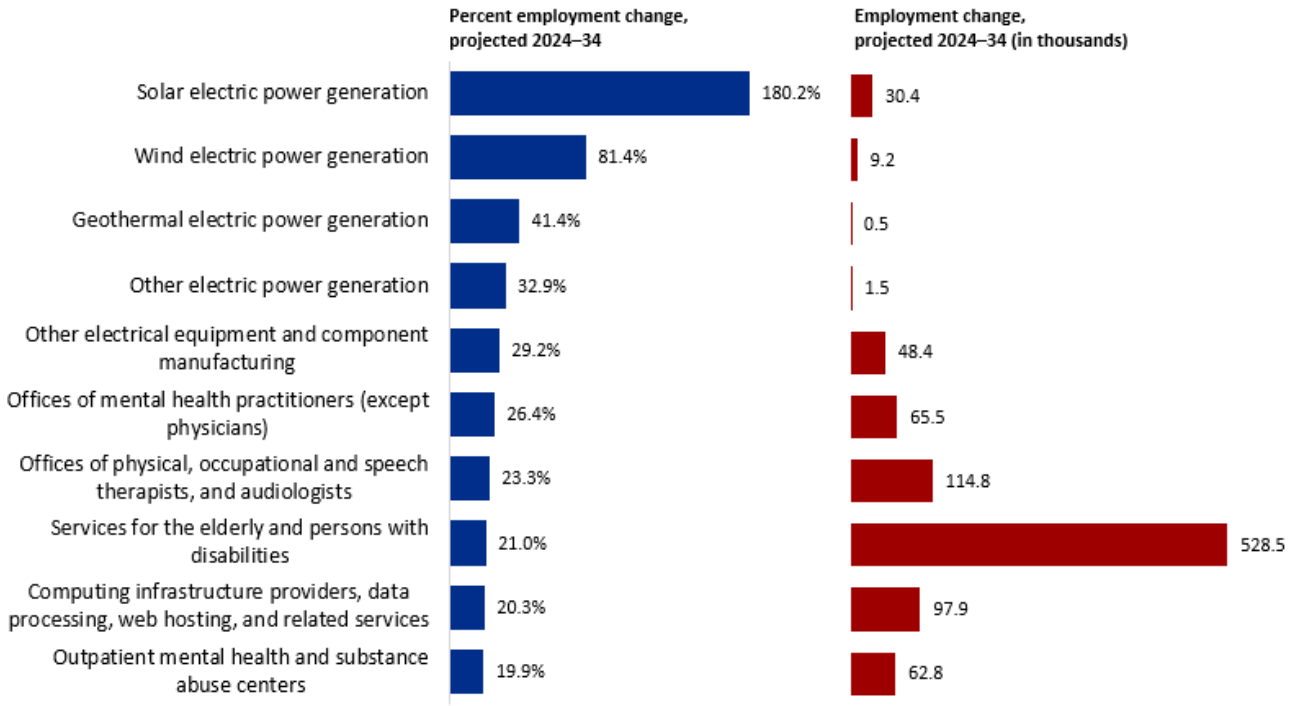
[1]Administrative and support and waste management and remediation services
[2]Excluding state and local education and hospitals
Note: Employment refers to wage and salary employment.

Industry Employment

Healthcare and social assistance is projected to have the largest job growth and be the fastest growing industry sector (+8.4 percent). Employment growth in this sector is expected to be primarily driven by both the aging population and the growing prevalence of chronic conditions, such as heart disease, cancer, and diabetes.

Demand for artificial intelligence (AI)-based systems, data processing, software development, research services, and associated consulting services are expected to drive the need for workers in both the professional, scientific, and technical services sector (+7.5 percent) and the information sector (+6.5 percent). (See chart 2.)

Chart 3. Ten fastest growing industries, projected 2024–34



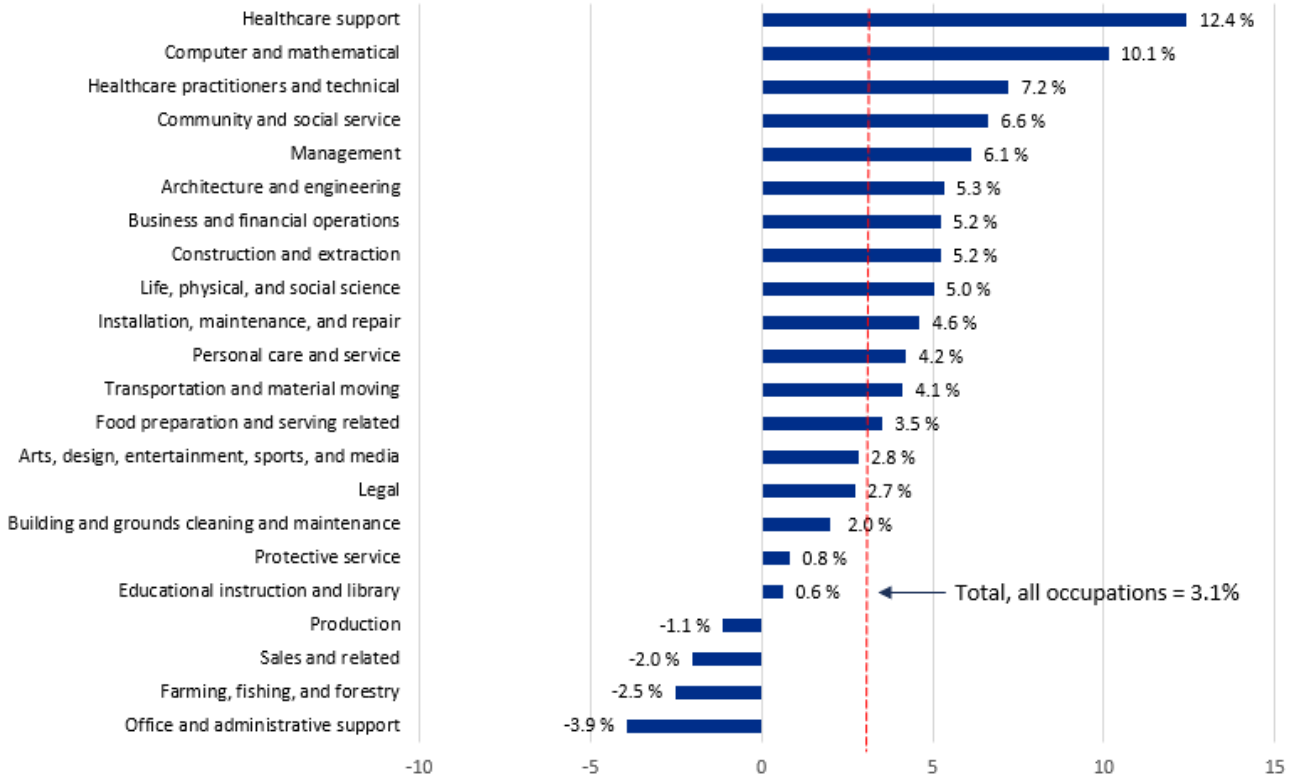
Note: Employment refers to wage and salary employment.

Mining, quarrying, and oil and gas extraction declines (-1.6 percent) are expected to be driven in part by productivity gains through the adoption of emerging technologies, such as robotics and drones, used in extraction. Though not the fastest decline, retail trade (-1.2 percent) is projected to lose the most jobs of any sector as automation, consolidation, and e-commerce are likely to continue to have a negative employment effect on sales occupations at retail outlets. However, the growing volume of online purchases is expected to support employment growth in transportation and warehousing (+3.0 percent), primarily due to an increasing volume of parcel shipments and deliveries.

Increased demand for electricity, primarily related to AI integration, electric vehicles (EVs), and new data centers, is expected over the next decade. As a result, the four top fastest growing industries are related to energy generation. Solar, wind, geothermal, and other electric power generation, which includes tidal power, are projected to be the fastest growing industries over the projections period. (See chart 3.) The four fastest growing industries combined are projected to add 41,600 jobs. The projected fifth-fastest growing industry, other electrical equipment and component manufacturing, includes battery production used for storage and in EVs, is projected to add 48,400 jobs.

Among the ten fastest growing industries, the services for the elderly and persons with disabilities industry (+21.0 percent) is projected to add 528,500 new jobs, the most of any detailed industries. Demand for in-home care will contribute to this growth.

Chart 4. Projected percent change in employment, by occupational group, 2024–34



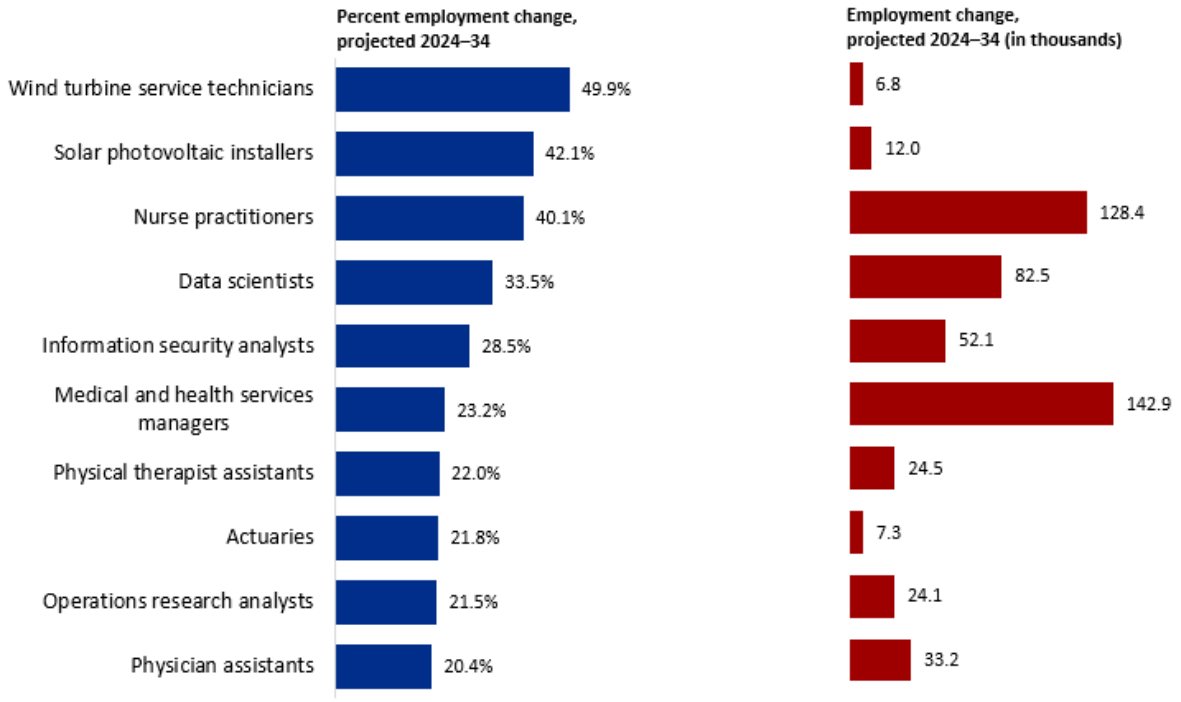
Occupational Employment

Just as fast growth is expected in the healthcare and social assistance sector, healthcare support occupations and healthcare practitioners and technical occupations are projected to be among the fastest growing occupational groups, growing 12.4 percent and 7.2 percent, respectively, from 2024 to 2034. (See chart 4.) The growing elderly population, which typically has greater healthcare needs compared to younger groups, will increase demand for long-term care and therapy services. The healthcare occupations with the fastest projected employment growth—such as nurse practitioners, physical therapist assistants, and physician assistants—assist in meeting this growing demand for care. (See chart 5.) These occupations are key members of care teams, delivering many healthcare services.

Similarly, the projected fast growth for community and social service occupations (+6.6 percent) will stem from more individuals seeking assistance for a variety of challenges, such as marriage and family counseling as well as substance abuse counseling and support.

Technological advancements may also lead to improved productivity for some occupations. The use of automated systems, including AI, is expected to contribute to declining employment of office and administrative support workers. Similarly, the growth of e-commerce as well as the integration of AI systems in sales activities, such as in routine calls, chats, and analysis of sales, are expected to limit demand for many sales workers, leading to employment declines. Advancements in automation will also continue to reduce demand for production occupations.

Chart 5. Ten fastest growing occupations, projected 2024–34



Computer and mathematical occupations are projected to grow the second fastest of any occupational group (+10.1 percent), which is more than three times the average rate of growth projected for the total economy (+3.1 percent). The fast growth of these occupations is expected to stem in part from demand for continued development of AI solutions and an increasing amount of data available for analysis. The growing demand to build AI models, conduct data analysis, and integrate applications into business practices is expected to drive employment of data scientists, the fourth fastest growing occupation in the economy. In addition, the frequency and severity of cyberattacks and data breaches on U.S. businesses is expected to lead to greater demand for information security analysts.

The projected fastest growing occupations over the 2024−34 decade are wind turbine service technicians and solar photovoltaic installers. Although fast growing, the two occupations combined will add fewer than 20,000 new jobs. The repair and maintenance of wind turbines is expected to drive demand for wind turbine service technicians, while installation of new solar panels will lead to the need for more solar photovoltaic installers.

Interpreting the Employment Projections

The Employment Projections (EP) program estimates specific values for projected employment levels and growth rates. However, this precision in the data does not account for the inherent uncertainty of predicting long-term changes in the labor market. Focusing on the direction and relative size of projected changes, rather than on the precise value estimates, may yield similar insights into employment trends and themes across occupations and industries.

The EP program also conducts research on factors that are expected to affect employment, which may not be reflected in historical data, such as emerging technologies and new legislation. Adjustments based on this research are generally applied conservatively such as when there is convincing evidence for a long-term structural change.

More Information

- Detailed information on the 2024–34 industry and occupational employment projections will appear in a separate *Monthly Labor Review* article, to be published later in 2025.
- The *Occupational Outlook Handbook* (*OOH*) includes information on about 600 detailed occupations in over 300 occupational profiles, covering about 4 out of 5 jobs in the economy. Each profile features the 2024–34 projections, along with assessments of the job outlook, work activities, wages, education and training requirements, and more.
- The *OOH* is available online at www.bls.gov/ooh.
- Field of degree pages are available online at www.bls.gov/ooh/field-of-degree/home.htm.
- Information about the importance of various skills by occupation can be found at www.bls.gov/emp/data/skills-data.htm.
- Descriptions of the classification systems and projections methods used can be found on the Employments Projections Methodology Overview page at www.bls.gov/emp/methods-overview.htm.
- Tables with detailed, comprehensive projections data are available online at www.bls.gov/emp/tables.htm.
- Definitions for terms used in this news release are available in the BLS Glossary at www.bls.gov/bls/glossary.htm.

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Technical Note

BLS publishes projections for the labor force, the macroeconomy, industry output and employment, and occupational employment. More information is available online:

- Labor force: https://www.bls.gov/emp/data/labor-force.htm
- Aggregate economy: https://www.bls.gov/emp/data/aggregate-economy.htm
- Industry output and employment: https://www.bls.gov/emp/data/industry-out-and-emp.htm
- Occupational employment: https://www.bls.gov/emp/data/occupational-data.htm

The projections data provide a potential scenario for changes in the economy over a decade. The projections focus on long-term structural trends of the economy and do not try to anticipate future business cycle activity. To meet this objective, specific assumptions are made about the labor force, macroeconomy, industry output and employment, and occupational employment. The projections are not intended to be a forecast of what the future will be but instead are a description of what would be expected to happen under these specific assumptions and circumstances. When these assumptions are not realized, actual values will differ from projections.

Labor supply and demand assumptions

BLS projects the labor force (labor supply) as an input into the macroeconomic projections. BLS also assumes that the economy will be at full employment in the projected year, with the labor market at equilibrium. That is, employment in the projected year will be roughly equivalent to the projected labor force minus a level of frictional unemployment (the relationship is not exact because labor force is a count of people, while employment is a count of jobs, and individual people can hold more than one job). BLS does not project an overall labor shortage or surplus because in the BLS projections data framework, labor supply (the labor force) and labor demand (employment) are linked – a projected increase in labor supply necessarily results in an increase in employment.

Technological progress assumptions

As with many variables, BLS assumes that labor productivity and technological progress will be in line with the historical experience. That is, productivity will increase and technology will progress, but because the BLS method involves analyzing historical relationships in the data and projecting them forward, the future is assumed to behave comparably to the past. (Previous sets of projections data may be accessed via the Projections Archive: https://www.bls.gov/emp/data/projections-archive.htm.) In a future state where technology advances much more rapidly than it has historically, it is unlikely that historical relationships would hold, and therefore BLS projection methods are unlikely to yield reasonable results.

Recent developments in artificial intelligence (AI) have raised the prospect that the future rate of technological progress could be higher than in the past. BLS projection methods could reflect this in a faster rate of labor productivity growth. This would in turn result in a higher level of gross domestic product (GDP) growth (maintaining the BLS full employment

assumption). If this higher rate of productivity growth is uniform across all industries, there is no impact on BLS employment projections – output is higher, productivity is higher, and employment is the same. However, a higher aggregate level of productivity growth could also be reflected differentially in industry productivity. BLS methods could capture this, but BLS has no data on which to base these differential productivity impacts. BLS therefore chooses to present a scenario with technological progress in line with historical patterns, which allows the projections to be grounded by historical data relationships rather than introducing adjustments that would be highly speculative.

BLS does conduct research on factors that are expected to impact employment, particularly those which may not be reflected in historical data, such as new technologies. However, BLS generally applies adjustments based on this research conservatively, where there is convincing evidence for a change. Developments in AI are proceeding rapidly, and the uncertainty about potential impacts remains very high. Projections are always uncertain, and the exact impact of developments such as new technologies on the labor market ten years out is impossible to predict with precision. As a result, BLS releases new projections annually to incorporate new data, research, and analysis. For more details on how BLS assesses and incorporates AI's potential labor market impacts on its employment projections, illustrated via case studies from the 2023–33 projections cycle, see Christine Machovec, Michael J. Rieley, and Emily Rolen, "Incorporating AI impacts in BLS employment projections: occupational case studies," *Monthly Labor Review*, U.S. Bureau of Labor Statistics, February 2025.

The historical record does show that technology impacts occupations, but that these changes tend to be gradual, not sudden. Occupations involve complex combinations of tasks, and even when technology advances rapidly, it can take time for employers and workers to figure out how to incorporate new technology into business practices. New technologies may change the composition or weighting of tasks performed by an occupation even if they do not impact overall demand for an occupation. For more details on the historical record, see Michael J. Handel, "Growth trends for selected occupations considered at risk from automation," *Monthly Labor Review*, U.S. Bureau of Labor Statistics, July 2022.

For more information, visit the Employment Projections Handbook of Methods page online at https://www.bls.gov/opub/hom/emp/home.htm.

Frequently asked questions about the employment projections are online at https://www.bls.gov/emp/frequently-asked-questions.htm.

Users and Uses

The BLS projections are used by high school and college students, their teachers and parents, jobseekers, career counselors, and guidance specialists to determine jobs in demand. The projections also are used by state workforce agencies to prepare state and area projections that, together with the national projections, are widely used by policymakers to make decisions about education and training, funding allocations, and program offerings. These projections of jobs in demand help improve the alignment between education and training and the

hiring needs of employers. In addition, other federal agencies, researchers, and academics use the projections to understand trends in the economy and labor market.

Projections of industry and occupational employment are prepared by each state, using input from the BLS national projections. State projections data are available at Projections Central https://www.projectionscentral.org.

KAUFFMAN INDICATORS OF ENTREPRENEURSHIP

The Kauffman Indicators of Entrepreneurship offers in-depth measures, reports, and accompanying interactive data visualizations that present entrepreneurial trends in the United States.

FEATURED INDICATOR

Entrepreneurial Jobs Indicators

CREATION 2020

Number of net new jobs created at firms aged 0-1 year old per 1,000 people

Creation, measured as net new job change per 1,000 people, reflects the increase or decrease in the number of jobs created in a specific geography by a particular firm age group. Here, a positive value for creation indicates that more jobs are created than lost at firms 0-1 year old in the specific geographic area while a negative value indicates more job losses than job gains.

Compare all states →

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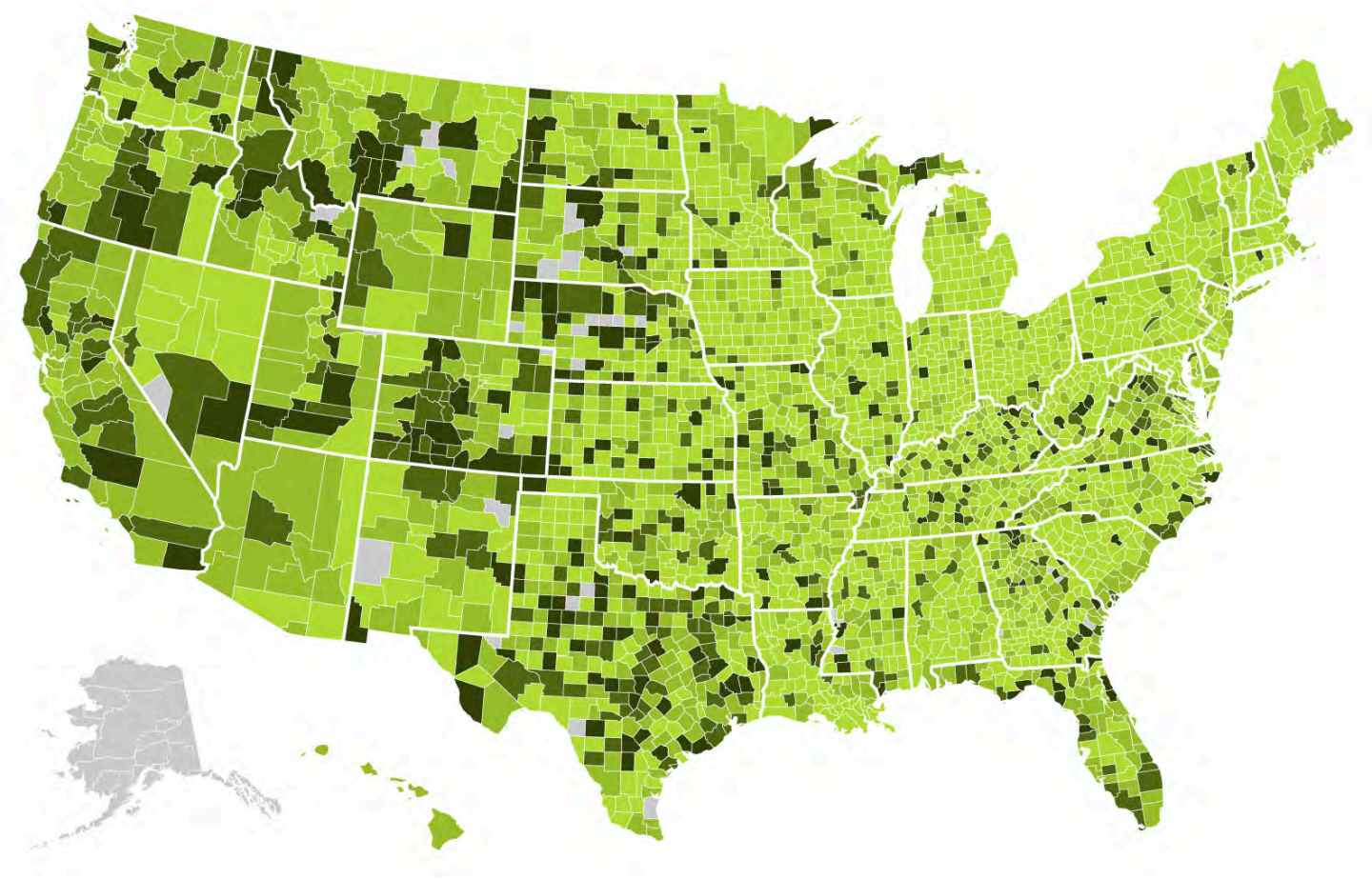
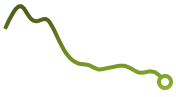


Entrepreneurial Jobs Indicators

VIEW SERIES

The Entrepreneurial Jobs Indicators series captures dimensions related to the quantity and quality of private sector jobs, allowing for comparisons by firm age group (source of jobs) and geography (location of jobs).

CONTRIBUTION



3.15%

NATIONAL RATE 2020

The share of private sector jobs held at firms aged 0-1 year old

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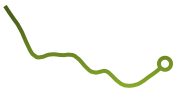
COMPENSATION



66.40%

NATIONAL RATE 2020

Relative earnings of private sector jobs at firms aged 0-1 year old in a specific geography compared to the average earnings at firms of all ages across the U.S.

CREATION

3.99

NATIONAL RATE 2020

Number of net new jobs created at firms aged 0-1 year old per 1,000 people

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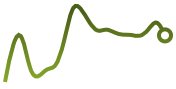
CONSTANCY



53.48%

NATIONAL RATE 2020

Share of jobs held at firms aged 0-1 year old that are stable (lasting three or more quarters)

FEATURED REPORTS

VIEW ALL REPORTS

NATIONAL REPORT

2022 Job Creation by Firm Age: Recent Trends in the United States

This series provides four measures that are relevant to understanding jobs created by new businesses in the United States.

Full Report

NATIONAL REPORT

2021 Early-Stage Entrepreneurship in the United States

This report presents national trends in early-stage entrepreneurship in the United States in 2021, as well as trends for specific demographic groups as available.

Full Report

NATIONAL AND STATE TRENDS REPORT

2021 New Employer Business Report

This report presents national and state trends in new employer businesses in the United States.

Full Report

New Employer Business

VIEW SERIES

The New Employer Business series provides information on new employer businesses, a subset of all entrepreneurial activity. This series includes measures which capture trends in the emergence of these businesses, their representation in the population and among all firms, and the time it takes these businesses to make a first payroll.

RATE OF NEW EMPLOYER BUSINESS ACTUALIZATION

9.16%

NATIONAL RATE 2021

Percent of all new businesses that make a first payroll within eight quarters of business application

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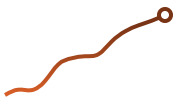
RATE OF NEW EMPLOYER BUSINESSES

0.15

NATIONAL RATE 2021

Number of new employer businesses per 100 people

NEW EMPLOYER BUSINESS VELOCITY



2.06

NATIONAL RATE 2017

Average time to become an employer business, in quarters, within an eight quarter window

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EMPLOYER BUSINESS NEWNESS

6.98%

NATIONAL RATE 2019

New employers as a share of all employer firms

Early-Stage Entrepreneurship

VIEW SERIES

The Early-Stage Entrepreneurship series is a set of measures that represents new business creation in the United States, integrating several high-quality, timely sources of information on early-stage entrepreneurship.

RATE OF NEW ENTREPRENEURS

0.36%

NATIONAL RATE 2021

Percent of population that starts a new business

OPPORTUNITY SHARE OF NEW ENTREPRENEURS

80.87%

NATIONAL RATE 2021

Percent of new entrepreneurs who created a business by choice instead of necessity

STARTUP EARLY JOB CREATION

4.74

NATIONAL RATE 2021

Average number of jobs created by startups in their first year (normalized by population)

STARTUP EARLY SURVIVAL RATE

81.70%

NATIONAL RATE 2021

Percent of startups that are still active after one year

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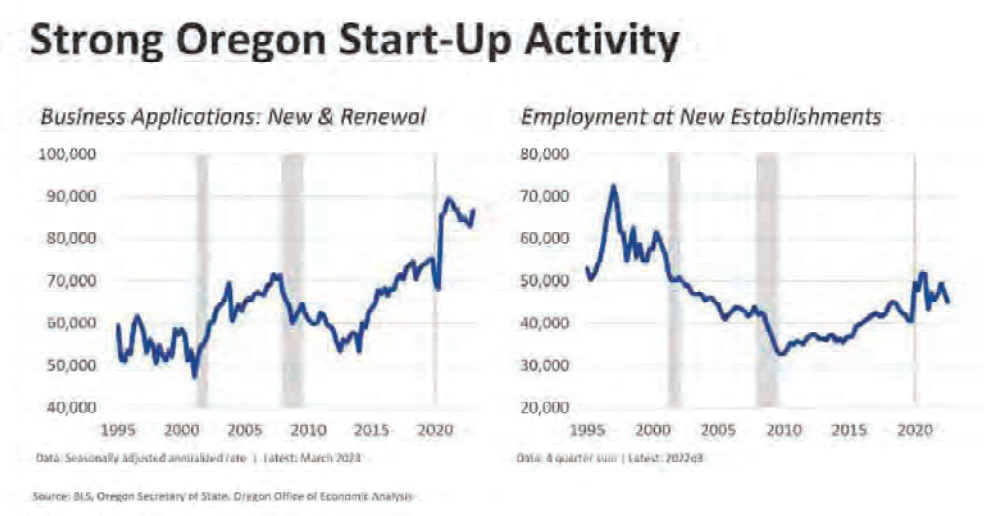
Oregon Office of Economic Analysis

Oregon Economic News, Analysis and Outlook

Strong Start-Up Activity Continues

Posted by: **Josh Lehner** | May 3, 2023

Last week we talked a bit about the labor force outlook and how Oregon appears to be at or near its potential given the strong cyclical economy and aging demographics. Besides labor, the other major driver of economic growth is productivity, which requires business investment and gains in the various types of capital: financial, human, natural, physical, and social. Historically a key source of these gains comes from new businesses. Generally new firms bring new ideas, and/or improved processes that are more efficient to the marketplace. Older or more rigid businesses get left behind as part of the creative destruction process. Start-up activity had clearly been trending down for decades leading up to the pandemic. Since then, new business formation has increased noticeably and appears to be sticking, at least so far as seen in the latest edition of the Graph of the Week.



Running a business is hard. Many firms do not make it beyond their first year or two. Only a couple eventually grow to become a huge, successful firm. As such, one way our office thinks about this is not at the individual firm level, but for Oregon's economy overall. Even if the probability that any given business will be successful remains the same, if you have more ping pong balls in the hopper, your overall probability that one of them will be successful is higher. And while simply having more businesses does not

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necessarily lead to increased business investment and productivity gains, it sure is an encouraging signal about those possibilities in the years ahead.

In terms of the outlook for start-up activity there are some crosscurrents. Personal savings and home equity are the most common funding source for new businesses. While those are higher today, and can continue to support and drive this ongoing strength in start-up activity, the impacts of high inflation, rising interest rates, and recession risks likely weighs on new activity a bit. Additionally, we know venture capital and banking lending is tighter today than earlier in the pandemic, which will likely slow new business formation as well.

Now, on the upside two items stand out. One is the potential for a general shift in the economy, especially related to working-from-home type jobs and businesses, which allows more people to test out their ideas if they so choose. Two is demographics. While young college dropouts may be the stereotype of who are entrepreneurs, most are actually middle-aged. Research from the Census Bureau finds the average age of the entrepreneur at founding is 42 and the average age of the most successful of the new businesses is 45. Obviously, there is a range of ages and outcomes, but on a demographically-adjusted basis entrepreneurship rates peak in the late 30s and early 40s. The fact that the large Millennial generation is now in their 30s and increasingly in their 40s, that is a big demographic tailwind to new business formation. A key here is that entrepreneurs tend to get a bit of work experience and in doing so they identify a need or a new way to do things that is more efficient, and then go out and try to improve that thing they have identified, and hopefully make money along the way.

Finally, as noted at the top, if we think about the capital and labor as the nuts and bolts of growth, there are a few implications given we have a pretty good idea where labor stands today. It means attracting and retaining talent is even more important (and getting the expected rebound in migration is huge for the long-run outlook). It also means capital takes on extra importance, and in terms of the range of possible outcomes, it is more of a wildcard at the moment.

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- January 2011
- December 2010
- November 2010
- October 2010
- September 2010
- August 2010
- July 2010
- June 2010
- May 2010
- April 2010
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Josh Lehner

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TUESDAY, FEBRUARY 20, 2024, AT 10:00 A.M. EST

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QUARTERLY RETAIL E-COMMERCE SALES
4th QUARTER 2023

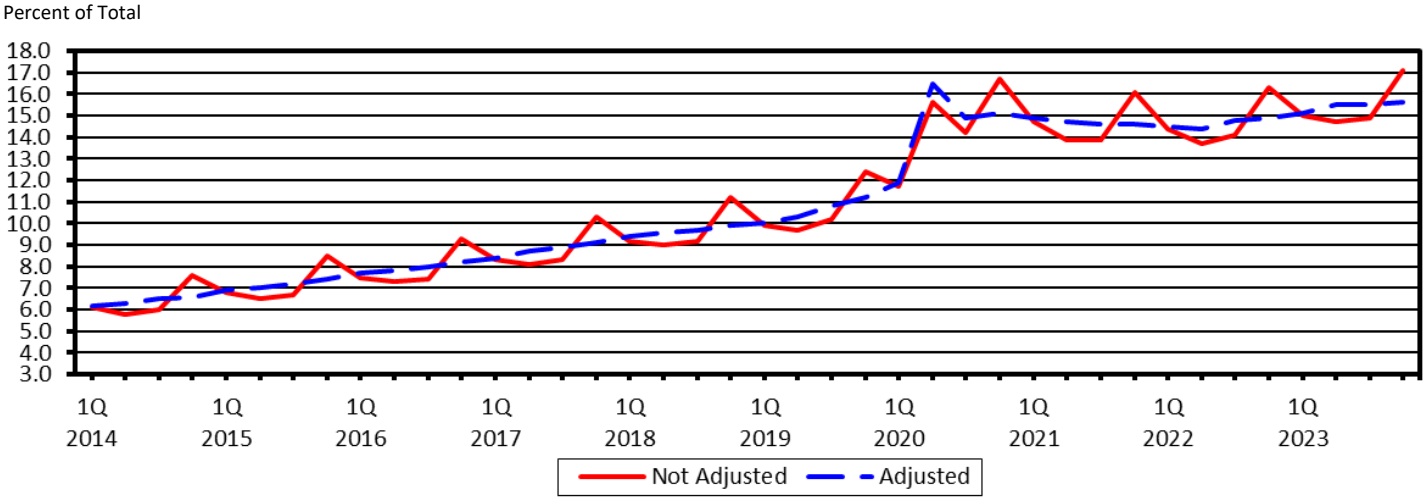
Intention to Revise E-commerce Estimates: Quarterly retail e-commerce estimates will be revised based on the results of the 2022 Annual Retail Trade Survey. Revised not adjusted estimates and corresponding adjusted estimates are scheduled for release on May 17, 2024 at 10:00 a.m. EDT.

The Census Bureau of the Department of Commerce announced today that the estimate of U.S. retail e-commerce sales for the fourth quarter of 2023, adjusted for seasonal variation, but not for price changes, was $285.2 billion, an increase of 0.8 percent (±1.1%)* from the third quarter of 2023. Total retail sales for the fourth quarter of 2023 were estimated at $1,831.4 billion, an increase of 0.4 percent (±0.4%)* from the third quarter of 2023. The fourth quarter 2023 e-commerce estimate increased 7.5 percent (±1.2%) from the fourth quarter of 2022 while total retail sales increased 2.8 percent (±0.4%) in the same period. E-commerce sales in the fourth quarter of 2023 accounted for 15.6 percent of total sales.

On a not adjusted basis, the estimate of U.S. retail e-commerce sales for the fourth quarter of 2023 totaled $324.8 billion, an increase of 19.5 percent (±1.1%) from the third quarter of 2023. The fourth quarter 2023 e-commerce estimate increased 7.2 percent (±1.2%) from the fourth quarter of 2022 while total retail sales increased 2.4 percent (±0.4%) in the same period. E-commerce sales in the fourth quarter of 2023 accounted for 17.1 percent of total sales.

Total e-commerce sales for 2023 were estimated at $1,118.7 billion, an increase of 7.6 percent (±1.2%) from 2022. Total retail sales in 2023 increased 2.1 percent (±0.4%) from 2022. E-commerce sales in 2023 accounted for 15.4 percent of total sales. E-commerce sales in 2022 accounted for 14.7 percent of total sales.

Estimated Quarterly U.S. Retail E-commerce Sales as a Percent of Total Quarterly Retail Sales:
1st Quarter 2014 – 4th Quarter 2023



The Quarterly Retail E-Commerce sales estimate for the first quarter of 2024 is scheduled for release on May 17, 2024 at 10:00 A.M. EDT.

For information, including estimates from 4th quarter 1999 forward, visit the Census Bureau's Web site at <http://www.census.gov/retail>. For additional information about Census Bureau e-business measurement programs and plans visit <https://www.census.gov/programs-surveys/e-stats.html>.

** The 90% confidence interval includes zero. The Census Bureau does not have sufficient statistical evidence to conclude that the actual change is different from zero.*

Table 1. Estimated Quarterly U.S. Retail Sales: Total and E-commerce[1]

(Estimates are based on data from the Monthly Retail Trade Survey and administrative records.)

Quarter	Retail Sales (millions of dollars)		E-commerce as a Percent of Total	Percent Change From Prior Quarter		Percent Change From Same Quarter A Year Ago	
	Total	E-commerce		Total	E-commerce	Total	E-commerce
Adjusted[2]							
4th quarter 2023(p)	1,831,393	285,224	15.6	0.4	0.8	2.8	7.5
3rd quarter 2023(r)	1,824,811	282,922	15.5	1.5	1.8	2.2	7.1
2nd quarter 2023	1,797,503	277,841	15.5	-0.2	2.2	0.6	7.6
1st quarter 2023	1,801,241	271,867	15.1	1.1	2.5	3.5	7.5
4th quarter 2022(r)	1,782,161	265,314	14.9	-0.2	0.5	6.0	7.7
Not Adjusted							
4th quarter 2023(p)	1,902,695	324,816	17.1	4.1	19.5	2.4	7.2
3rd quarter 2023(r)	1,827,290	271,797	14.9	-0.3	0.9	2.0	7.8
2nd quarter 2023	1,831,959	269,287	14.7	9.0	6.5	0.5	7.6
1st quarter 2023	1,680,614	252,773	15.0	-9.5	-16.6	3.5	7.8
4th quarter 2022	1,857,200	303,120	16.3	3.7	20.2	5.8	6.9

(p) Preliminary estimate. (r) Revised estimate.

[1] E-commerce sales are sales of goods and services where the buyer places an order, or the price and terms of the sale are negotiated over an Internet, mobile device (M-commerce), extranet, Electronic Data Interchange (EDI) network, electronic mail, or other comparable online system. Payment may or may not be made online.
[2] Estimates are adjusted for seasonal variation, but not for price changes. Total sales estimates are also adjusted for trading-day differences and moving holidays.

Note: Table 2 provides estimated measures of sampling variability. For information on confidentiality protection, sampling error, nonsampling error, sample design, and definitions, see http://www.census.gov/retail/mrts/how_surveys_are_collected.html.

Table 2. Estimated Measures of Sampling Variability for Quarterly U.S. Retail Sales Estimates: Total and E-commerce

(Estimates are shown as percents and are based on data from the Monthly Retail Trade Survey.)

Quarter	Coefficient of Variation (CV)		Standard Error (SE) for E-commerce as a Percent of Total	SE for Percent Change From Prior Quarter		SE for Percent Change From Same Quarter A Year Ago	
	Total	E-commerce		Total	E-commerce	Total	E-commerce
4th quarter 2023(p)	0.7	1.8	0.2	0.2	0.6	0.2	0.7
3rd quarter 2023(r)	0.8	1.8	0.2	0.1	0.2	0.2	0.7
2nd quarter 2023	0.8	1.8	0.2	0.1	0.4	0.2	0.9
1st quarter 2023	0.7	1.7	0.2	0.2	0.4	0.2	0.9
4th quarter 2022	0.6	1.5	0.2	0.2	0.5	0.1	0.6

(p) Preliminary estimate. (r) Revised estimate. (Z) Estimate is less than 0.05%.

Note: Estimated measures of sampling variability are based on data not adjusted for seasonal variation, trading-day differences, or moving holidays, and are used to make confidence statements about both adjusted and not adjusted estimates. For information on confidentiality protection, sampling error, nonsampling error, sample design, and definitions, see http://www.census.gov/retail/mrts/how_surveys_are_collected.html.

Survey Description

Retail e-commerce sales are estimated from the same sample used for the Monthly Retail Trade Survey (MRTS) to estimate preliminary and final U.S. retail sales. Advance U.S. retail sales are estimated from a subsample of the MRTS sample that is not of adequate size to measure changes in retail e-commerce sales.

A stratified simple random sampling method is used to select approximately 10,800 retail firms excluding food services whose sales are then weighted and benchmarked to represent the complete universe of over two million retail firms. The MRTS sample is probability based and represents all employer firms engaged in retail activities as defined by the North American Industry Classification System (NAICS). Coverage includes all retailers whether or not they are engaged in e-commerce. Online travel services, financial brokers and dealers, and ticket sales agencies are **not** classified as retail and are **not** included in either the total retail or retail e-commerce sales estimates. Nonemployers are represented in the estimates through benchmarking to prior annual survey estimates that include nonemployer sales based on administrative records. E-commerce sales are included in the total monthly sales estimates.

The MRTS sample is updated on an ongoing basis to account for new retail employer businesses (including those selling via the Internet), business deaths, and other changes to the retail business universe. Firms are asked each month to report e-commerce sales separately. For each month of the quarter, data for nonresponding sampling units are imputed from responding sampling units falling within the same kind of business and sales size category or based on historical performance of that company. Responding firms account for approximately 70 percent of the e-commerce sales estimate and about 68 percent of the estimate of U.S. retail sales for any quarter.

For each month of the quarter, estimates are obtained by summing weighted sales (either reported or imputed). The monthly estimates are benchmarked to prior annual survey estimates. Estimates for the quarter are obtained by summing the monthly benchmarked estimates. The estimate for the most recent quarter is a preliminary estimate. Therefore, the estimate is subject to revision. Data users who create their own estimates using data from this report should cite the Census Bureau as the source of the input data only.

Adjusted Estimates

This report publishes estimates that have been adjusted for seasonal variation and holiday and trading-day differences, but not for price changes. We used quarterly e-commerce sales estimates for 4th quarter 1999 to the current quarter as input to the X-13ARIMA-SEATS program to derive the adjusted estimates. For sales, we derived quarterly adjusted estimates by summing adjusted monthly sales estimates for each respective quarter. Seasonal adjustment of estimates is an approximation based on current and past experiences.

The X-13ARIMA-SEATS software improves upon the X-12 ARIMA seasonal adjustment software by providing enhanced diagnostics as well as incorporating an enhanced version of the Bank of Spain's SEATS (Signal Extraction in ARIMA Time Series) software, which uses an ARIMA model-based procedure instead of the X-11 filter-based approach to estimate seasonal factors. The X-13ARIMA-SEATS and X-12 ARIMA software produce identical results when using X-13ARIMA-SEATS with the X-11 filter-based adjustments. The X-13ARIMA-SEATS software and additional information on the X-13ARIMA-SEATS program may be found at https://www.census.gov/data/software/x13as.html.

Note that the retail estimates continue to be adjusted using the X-11 filter-based adjustment procedure.

Reliability of Estimates

Because the estimates in this report are based on a sample survey, they contain sampling error and nonsampling error.

Sampling error is the difference between the estimate and the result that would be obtained from a complete enumeration of the population conducted under the same survey conditions. This error occurs because only a subset of the entire population is measured in a sample survey. Standard errors and coefficients of variation, as given in Table 2 of this report, are estimated measures of sampling variation.

The margin of error, as used on page 1, gives a range about the estimate which is a 90 percent confidence interval. If, for example, the estimated percent change is -11.4% and its estimated standard error is 1.2%, then the margin of error is ±1.753 x 1.2% or 2.1%, and the 90 percent confidence interval is -13.5% to -9.3%. Confidence intervals are computed based on the particular sample selected and canvassed. If one repeats the process of drawing all possible samples and forming all corresponding confidence intervals, approximately 90 percent of these individual confidence intervals would contain the estimate computed from a complete enumeration of all units on the sampling frame. If the confidence interval contains 0%, then one does not have sufficient evidence to conclude at the 90 percent confidence level that the change is different from zero.

Nonsampling error encompasses all other factors that contribute to the total error of a sample survey estimate. This type of error can occur because of nonresponse, insufficient coverage of the universe of retail businesses with e-commerce sales, mistakes in the recording and coding of data, and other errors of collection, response, coverage, or processing. Although not directly measured, precautionary steps are taken to minimize the effects of nonsampling error.

ECONOMY, MARKET & TRENDS

More Retailers Are Rolling out Small-Format Stores

By Holly Dutton
January 8, 2024

Even before the pandemic, the retail sector was experiencing the rise of e-commerce and changing preferences in how people shop, as retailers began exploring pop-ups and other kinds of experiential strategies. At the same time, traditional malls were continuing to struggle, especially older, lower-tier properties. Now, three years after COVID-19 upended retail and led to closings and companies rethinking how best to attract shoppers, the latest trend taking hold revolves around a more curated approach. Companies including Macy's, Nordstrom, Kohl's, and IKEA are rolling out small-format stores around the country, often in suburban areas, as they try other ways to connect with their customers.

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An IKEA Plan and Order store in Prague. (Wikimedia Commons)

Era of experimentation

Big-name retailers may have made headlines recently in announcing plans for more of these small concept stores, but the idea is ...ething the industry has been exploring for more than a decade. Wal-Mart experimented with smaller-format stores in 2011, with ...d-down Wal-Mart Express locations that ranged between 12,000 and 15,000 square feet (between 1,115 and 1,395 sq m) in size.

By 2016, the idea garnered even more attention when Amazon unveiled its Amazon Go store. The concept was announced as a "new kind of corner store" where shoppers could grab a coffee, snacks, a quick lunch, or return an Amazon package.

Amazon executives envisioned the smaller stores—ranging in size from 450 square feet (42 sq m) to 2,700 square feet (250 sq m)—opening in office lobbies and in hospitals. What set these stores apart, aside from their diminutive size, was that they required no waiting in line and no exchange of money. As shoppers entered the store, they scanned their Amazon Go app at a gate, and whatever they left with would be charged to their account.

Although the Amazon stores opened in several markets around the country—including New York, Seattle, and San Francisco—company leaders announced earlier this year that they were closing many of the locations, as they looked to cut costs and shrink their real estate footprint.

Other early adopters of the small-store concept included IKEA, which opened a small concept store in San Francisco in August 2023 to long lines, and Best Buy, which opened its first small-format store in Monroe, North Carolina, a town in the Charlotte metropolitan area, last year. Every retailer has its own particular vision and reasons behind the decision to build a smaller-sized store, but on its face, small concept stores offer a lot of positives.

"A smaller concept store may be easier to gear toward local tastes and culture, which can help create stronger connections with new and existing customers," says Stephanie Cegielski, vice president of research and public relations at the International Council of Shopping Centers.

Compared with a large retail format, small-format stores typically require smaller buildouts and operating costs. Smaller layouts also more flexibility for a retailer that allows placement of more stores in growing secondary and tertiary markets.

Amid efforts to reach their customer base, many retailers are choosing to open these small-format stores in suburban areas, given the higher percentage of Americans working from home since the pandemic. Another driver of the push for more suburban locations is more dense, urban areas' often having zoning laws that prevent a retailer from opening up a more traditionally sized store. "A smaller format store may offer an accessible point of entry," Cegielski says.

In this post-pandemic time, when the industry is still experiencing a normalization of shopping behaviors exacerbated by inflation, retailers must think differently about the rules of retail. "Scale still matters, but it's about being much more specific about building to local scale and geographic density, and understanding what customers are looking for," says Nate Shenck, managing director and senior partner at Boston Consulting Group, who leads the company's North American retail team. "Almost all retailers are trying to find the next levers for growth, and format experimentation is one of those."

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ing the customer experience

Nordstrom's small-format strategy, "Closer to You," first launched in 2020, in five major U.S. markets. It focuses on bringing Nordstrom Rack stores closer to its customers and having a more curated selection of products. The stores offer order pick-up, returns, and other services, such as tailors at every location and personal stylists. The rollout of these stores has continued to expand. This summer, Nordstrom executives announced plans to open 23 Nordstrom Rack stores, in mostly suburban markets, across the country, between fall 2023 and spring 2025. The locations will range in size from 23,000 square feet (2,100 sq m) to 36,000 square feet (3,344 sq m).

When Macy's announced its small-format store openings last fall, company leaders said the push toward expanding its small-format stores—and its Bloomingdale's brand, especially—focused on how customers experience a retail setting. "It's all about curation of product and the delivery of a better experience for the customer," incoming Macy's CEO Tony Spring told CNBC's Jim Cramer.

The company is targeting locations in off-mall shopping centers for these new concept stores, which also include Bloomie's, a small-format offshoot of Bloomingdale's. Those stores are about one-fifth the size of the traditional, large-format department store brand and put a high priority on customer service. Bloomie's fitting rooms, for instance, were designed with comfort in mind. The spaces are larger and more inviting, with designated lounge areas where customers are encouraged to take selfies.

"Our small-format stores are efficient to operate, provide the customer with a shopping alternative within our omnichannel ecosystem, and present a unique opportunity to target high-traffic shopping centers," says Macy's COO & CFO Adrian Mitchell in the company's announcement.

IKEA has also made a foray into small-format stores. The company stated last fall that it had opened more than 70 new IKEA locations by late 2023, most of which were small-format stores and the company's Plan and Order locations. In 2021, IKEA opened a small-format store in the Queens borough of New York City that was about half the size of an average IKEA outpost.

Before that store opening, IKEA opened a 17,350-square-foot (1,612 sq m) planning studio in Manhattan's Upper East Side. Both the Queens and the Manhattan locations closed in 2022, but IKEA has focused on opening more of these kinds of stores in markets around the world, including its latest small-format store in Copenhagen, which company leaders touted as being more accessible for the many cyclists who call that city home. IKEA also opened a new small-format store in San Francisco in August 2023.

Downsizing stores can also be a boon to retailers' sustainability efforts. By opening a smaller store, they're already on the right track to decarbonization. A smaller square-footage footprint means a smaller carbon footprint. Plus, whereas a typical store format might include several escalators and elevators running for more than 12 hours a day, a small-format store could avoid them altogether.

Heating and cooling a space with more than 100,000 square feet (9,290 sq m) uses considerably more energy than a store about a third or less that size. Additionally, smaller retail footprints potentially have local environmental benefits on such things as stormwater runoff.

Retailers are increasingly looking at small-format stores to stay competitive and better connect to their customer base, but the shift is also being driven by the ongoing labor shortage that has affected industries across the spectrum. Not only are many retailers finding it hard to staff stores, even when they are able to fill positions, but the cost of labor and operating costs has gotten very high, due to inflation.

"I think it's a combination of a lot of things … driving up costs," says Richard Lake, founding partner of the Washington, D.C.–based firm Roadside Development. Lake points to how many employees it takes to run large-format stores with 150,000 square feet (14,000 sq m) or more, the amount of merchandise that is needed to stock such a store, and public safety considerations including the number of exits and entrances. "The marketplace has gotten to be very fraught," Lake says. "Retailers, just like in the office sector, are looking to shrink their footprint and cut costs."

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Holly Dutton

Holly Dutton is a Brooklyn-based journalist who has reported on real estate for more than 10 years. A Texas native, she spent her early years in journalism covering local politics and photographing professional basketball for publications including the *Houston Chronicle.*

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Economic News Release

American Time Use Survey Summary

For release 10:00 a.m. (ET) Thursday, June 26, 2025 USDL-25-1060

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AMERICAN TIME USE SURVEY -- 2024 RESULTS

In 2024, 87 percent of full-time employed people worked on an average weekday, compared with 29 percent on an average weekend day, the U.S. Bureau of Labor Statistics reported today. Full-time employed people averaged 8.4 hours of work on weekdays they worked, and 5.6 hours on weekend days they worked.

These and other results from the American Time Use Survey (ATUS) were released today. They include the average amount of time per day in 2024 that individuals worked, did household activities, and engaged in leisure and sports activities. Additionally, measures of the average time per day spent providing childcare--both as a primary (or main) activity and while doing other things are provided. For a detailed description of ATUS data and methodology, see the Technical Note.

Working (by Employed People) in 2024

--On days they worked, full-time employed people worked an average of 8.1 hours. They worked 8.4 hours on an average weekday and 5.6 hours on an average weekend day. (See table 4.)

--Many more people worked on weekdays than on weekend days: 80 percent of employed people worked on an average weekday, compared with 30 percent on an average weekend day. Multiple jobholders were more likely than single jobholders to work on an average weekend day--50 percent, compared to 29 percent. (See table 4.)

--Among those who worked on an average weekend day, those with lower levels of education worked more hours than those with higher levels of education. On weekend days they worked, high school graduates with no college spent 6.4 hours working, compared with 4.2 hours for those with a bachelor's degree or higher. (See table 4.)

--The share of employed people who spent time working at home on days worked was about the same in 2024 (33 percent) as in 2023 (35 percent). However, the share of men who spent some time working at home decreased from 34 percent in 2023 to 29 percent in 2024, while the share of women who did so remained the same (36 percent). (See table 6.)

--Among workers age 25 and over, there was little difference in the likelihood to work on an average day for those with a bachelor's degree or higher (68 percent) and those with a high school diploma and no college (66 percent). However, workers with higher levels of education were more likely to work at home than were those who had less education. Fifty percent of employed people with a bachelor's degree or higher performed some work at home on days worked, compared with 18 percent of those with a high school diploma and no college. (See table 6.)

--On days they worked, employed men worked 33 minutes more than employed women. This difference partly reflects women's greater likelihood of working part time. However, even among full-time workers (those usually working 35 hours or more per week), men worked more per day than women--8.2 hours, compared with 7.9 hours. (See table 4.)

Household Activities in 2024

--On an average day, 80 percent of people engaged in household activities--such as housework, cooking, lawn care, or household management--spending about two hours on these activities. (See table 1.)

--Eighty-seven percent of women and 74 percent of men spent some time doing household activities on an average day. On the days they did household activities, women spent an average of 2.7 hours on these activities, while men spent 2.3 hours doing so. (See table 1.)

--Among adults living with children under age 18, those who were not employed spent about an hour more than those who were employed doing household activities on an average day--2.9 hours compared to 1.8 hours. (See tables 8B and 8C.)

--More people engaged in housework on weekend days than on weekdays, on average--41 percent, compared with 36 percent. However, people were slightly more likely to do food preparation and cleanup on weekdays than weekend days--64 percent, compared to 62 percent. (See table 2.)

Leisure and Sports Activities in 2024

--Nearly everyone age 15 and over (94 percent) engaged in some sort of leisure and sport activity, such as watching TV, socializing, or exercising on an average day. While men and women were equally likely to engage in leisure and sports activities, men spent more time

in these activities than did women (5.5 hours, compared with 4.7 hours). (See table 1.)

--On average, adults age 75 and over spent 7.6 hours engaged in leisure and sports activities per day--more than any other age group. Those ages 35 to 44 averaged 3.8 hours doing leisure and sports activities per day--less than all other age groups. (See table 11A.)

--Watching TV was the leisure and sports activity that occupied the most time (2.6 hours per day), accounting for over half of all leisure time, on average (5.1 hours per day). (See tables 1 and 11A.)

--Socializing and communicating, along with playing games and computer use for leisure, occupied the most amount of time spent in leisure and sports activities after watching TV. On an average day, individuals spent 35 minutes socializing and communicating and 34 minutes playing games and using a computer for leisure. They spent twice as much time socializing and communicating on weekend days (56 minutes) than on weekdays (26 minutes). (See tables 1, 11A, and 11B.)

--People were less likely to engage in socializing and communicating on an average day in 2024 than in 2014--30 percent compared with 38 percent. They also spent less time in these activities in 2024 than in 2014--35 minutes compared with 43 minutes. (See table 1.)

--Time spent reading for personal interest and playing games or using a computer for leisure varied greatly by age. On an average day, individuals age 75 and over spent 46 minutes reading while those ages 15 to 19 read for 9 minutes. Conversely, individuals ages 15 to 19 spent 1.3 hours playing games or using a computer for leisure on an average day, while those ages 75 and over spent 26 minutes doing so. (See table 11A.)

--Employed adults living in households with no children under age 18 engaged in leisure and sports activities for 4.5 hours per day, an hour and a half more than did employed adults living with a child under age 6 (3.0 hours). (See table 8B.)

Care of Household Children in 2024

--Adults living in households with children under age 6 spent an average of 2.5 hours per day providing primary childcare to household children. Adults living in households where the youngest child was between the ages of 6 and 17 spent one-third as much time providing primary childcare to household children--50 minutes per day. Primary childcare is childcare that is done as a main activity, such as providing physical care or reading to children. (See table 9.)

--On an average day, among adults living in households with children under age 6, women spent an hour more than men providing primary childcare to household children--3.0 hours compared to 2.0 hours. This includes providing physical care, such as bathing or feeding a child (1.3 hours compared to 42 minutes) and travel related to care of household children (19 minutes compared to 9 minutes), among other activities. (See table 9.)

--On average, among adults living with children under age 6, those who were not employed spent over an hour more per day caring for and helping household children than did employed adults --3.2 hours versus 2.0 hours. (See tables 8B and 8C.)

--Adults living in households with at least one child under age 13 spent an average of 5.2 hours per day providing secondary childcare--that is, they had at least one child in their care while doing activities other than primary childcare. Secondary childcare provided by adults living in households with children under age 13 was most commonly provided while doing leisure activities (1.8 hours) or household activities (1.2 hours). (See table 10.)

--Adults living in households with children under age 6 spent about the same amount of time providing primary childcare on an average weekday and weekend day (2.6 hours and 2.4 hours). However, they spent less time providing secondary childcare on weekdays (4.5 hours) than on weekend days (7.5 hours). (See tables 9 and 10.)

Additional Data

ATUS 2024 data files are available for users to do their own tabulations and analyses. In accordance with BLS and Census Bureau policies that protect the privacy of survey respondents, personally identifying information does not appear on the data files. The 2024 data files are available on the BLS website at www.bls.gov/tus/data.htm.

- American Time Use Survey Technical Note
- Table 1. Time spent in primary activities and percent of the civilian population engaging in each activity, averages per day by sex, 2024 annual averages
- Table 2. Time spent in primary activities and percent of the civilian population engaging in each activity, averages per day on weekdays and weekends, 2024 annual averages
- Table 3. Time spent in primary activities for the civilian population by age, sex, race, Hispanic or Latino ethnicity, marital status, and educational attainment, 2024 annual averages
- Table 4. Employed persons working and time spent working on days worked by full- and part-time status and sex, jobholding status, educational attainment, and day of week, 2024 annual averages
- Table 5. Employed persons working on main job and time spent working on days worked by class of worker, occupation, earnings, and day of week, 2024 annual averages
- Table 6. Employed persons working at home, workplace, and time spent working at each location by full- and part-time status and sex, jobholding status, and educational attainment, 2024 annual averages
- Table 7. Employed persons working on main job at home, workplace, and time spent working at each location by class of worker, occupation, and earnings, 2024 annual averages
- Table 8A. Time spent in primary activities for the civilian population 18 years and over by presence and age of youngest household child and sex, 2024 annual averages, total
- Table 8B. Time spent in primary activities for the civilian population 18 years and over by presence and age of youngest household child and sex, 2024 annual averages, employed

- Table 8C. Time spent in primary activities for the civilian population 18 years and over by presence and age of youngest household child and sex, 2024 annual averages, not employed
- Table 9. Time adults spent caring for household children as a primary activity by sex, age, and day of week, 2024 annual averages
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Last Modified Date: June 26, 2025

U.S. BUREAU OF LABOR STATISTICS American Time Use Survey Office of Employment and Unemployment Statistics Suitland Federal Center Floor 3 4600 Silver Hill Road Washington, DC 20212-0002

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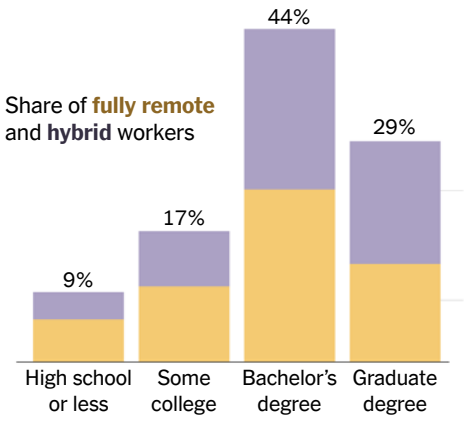


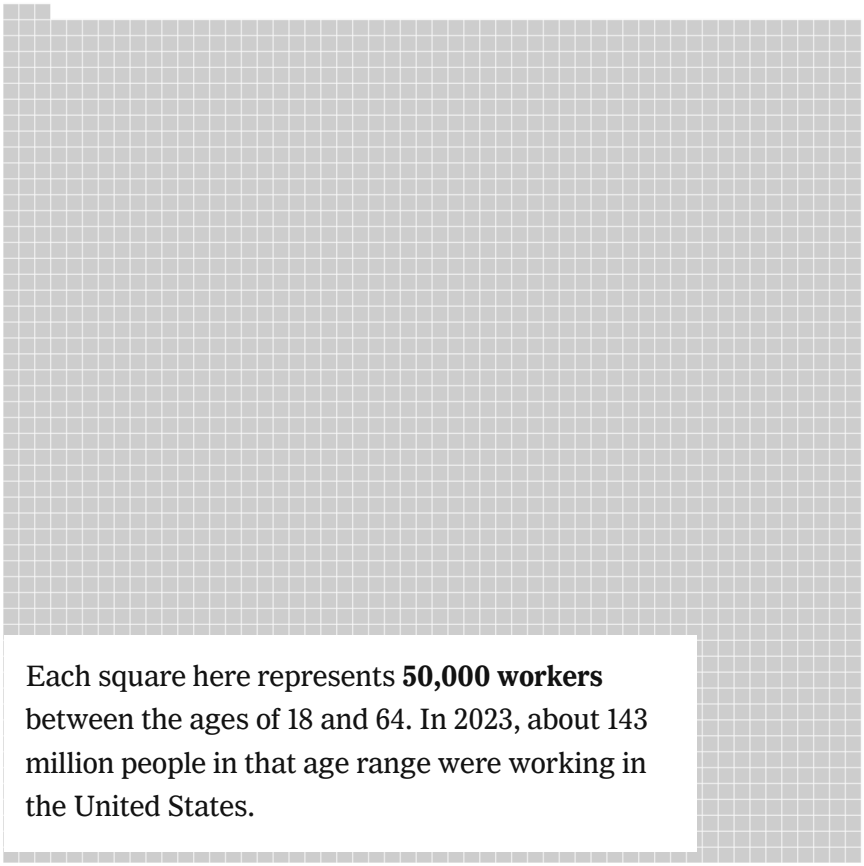
Who Still Works From Home?

By Ben Casselman, Emma Goldberg and Ella Koeze March 8, 2024

The American workplace's experiment with remote work happened, effectively, overnight: With the onset of the pandemic in March 2020, more than half of workers began working from home at least part of the time, according to Gallup. But the shift to a permanent hybrid-work reality has been gradual, with periods of tension as workers across white-collar industries pushed against executives' return-to-office orders.

Those battles have largely come to an end, and workplaces have reached a new hybrid-work status quo. Roughly one-tenth of workers are cobbling together a combination of work in the office and from home, and a similar portion are working entirely remotely.

This population of hybrid and remote workers in the United States doesn't quite mirror the larger population of workers: Government data shows they tend to have more education and are more often white and Asian.



Each square here represents **50,000 workers** between the ages of 18 and 64. In 2023, about 143 million people in that age range were working in the United States.

Roughly 80 percent of those work **fully in person**.
The remaining work either a **hybrid** schedule or **fully remote**.

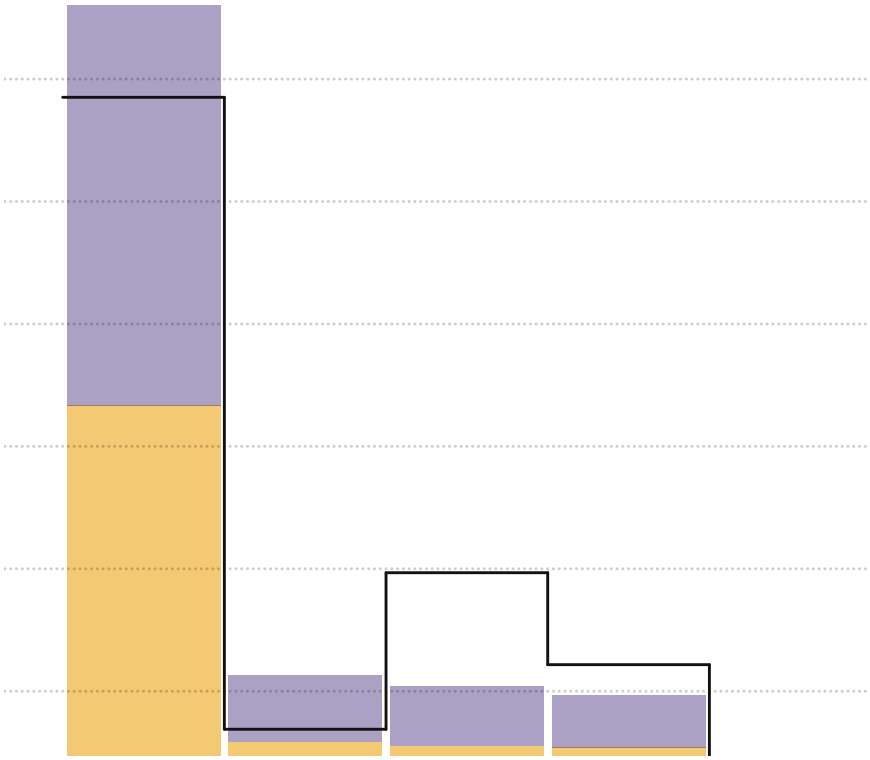
If we look at all workers by their level of education, the biggest group of workers have no college education.

But if we focus on just those who work at home all or some of the time, college educated workers become the most prominent. Working from home is, for the most part, a luxury for the highly educated.

The pandemic laid bare inequalities in the American economy. White-collar workers were in many cases able to do their jobs safely at home, but lower-income workers often had to continue to work in person, even when health risks were highest. And now that the public health emergency is over, that workplace divide — who gets the benefits of remote flexibility and who does not — has become entrenched.

White and Asian workers are more likely to work from home

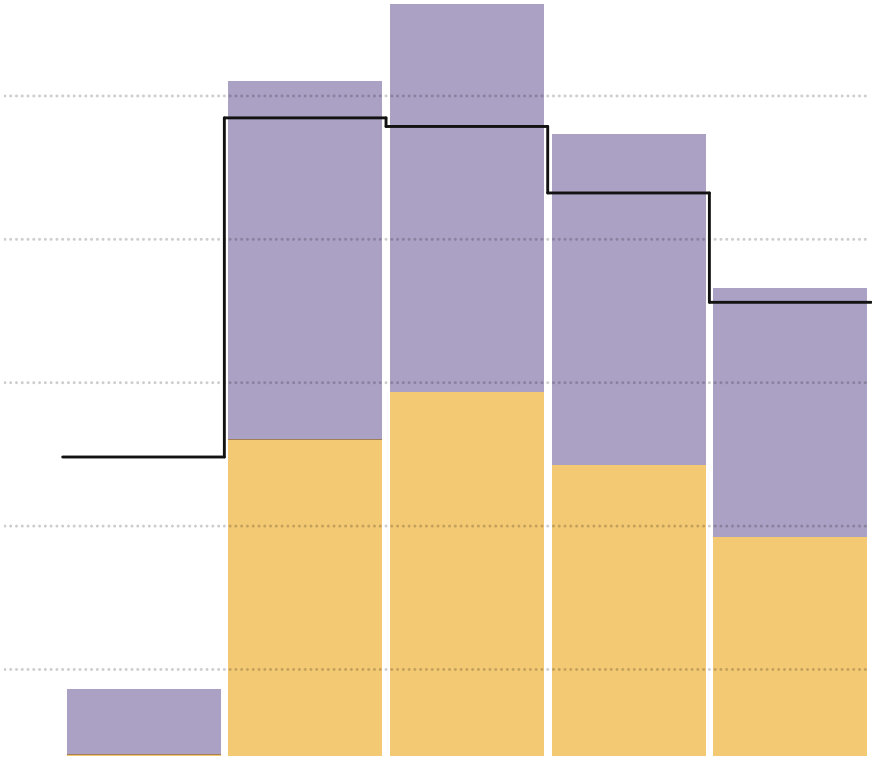
Share of **fully remote** and **hybrid** workers who identify as a given race or ethnicity vs. the same group's share of the entire work force



The divide in who gets the flexibility to work remotely also reflects the country's racial inequalities. Because white and Asian workers are more likely to hold office jobs, they are more likely to have the opportunity to work remotely part or all of the time. Black and Hispanic workers, meanwhile, more frequently hold jobs in food service, construction, retail, health care and other fields that require them to be in person.

The youngest workers are working from home less often

Share of **fully remote** and **hybrid** workers who fall in each age group vs. the same group's share of the entire work force



When employers were first mounting their return-to-office battles, many assumed that their youngest employees would be the toughest to persuade to come back. But today, young people make up a greater share of those working in person than their share of the total work force.

That is partly because a smaller share of Americans under 25 have completed college degrees. Many work in jobs like food service that cannot be done remotely. But that is not the whole story: Even among college graduates, workers in their 20s are more likely to be in the office full time than their older colleagues. That suggests that young workers are embracing the benefits of in-person work: socialization, mentorship and face time with the boss. The potential downsides of fixed office schedules may also matter less to them: Relatively fewer young workers might have children (or aging parents) at home, making remote flexibility less of a priority.

More women work remotely, but it's complicated.

Remote work also breaks down along gender lines — though it does not lend itself to a simple narrative.

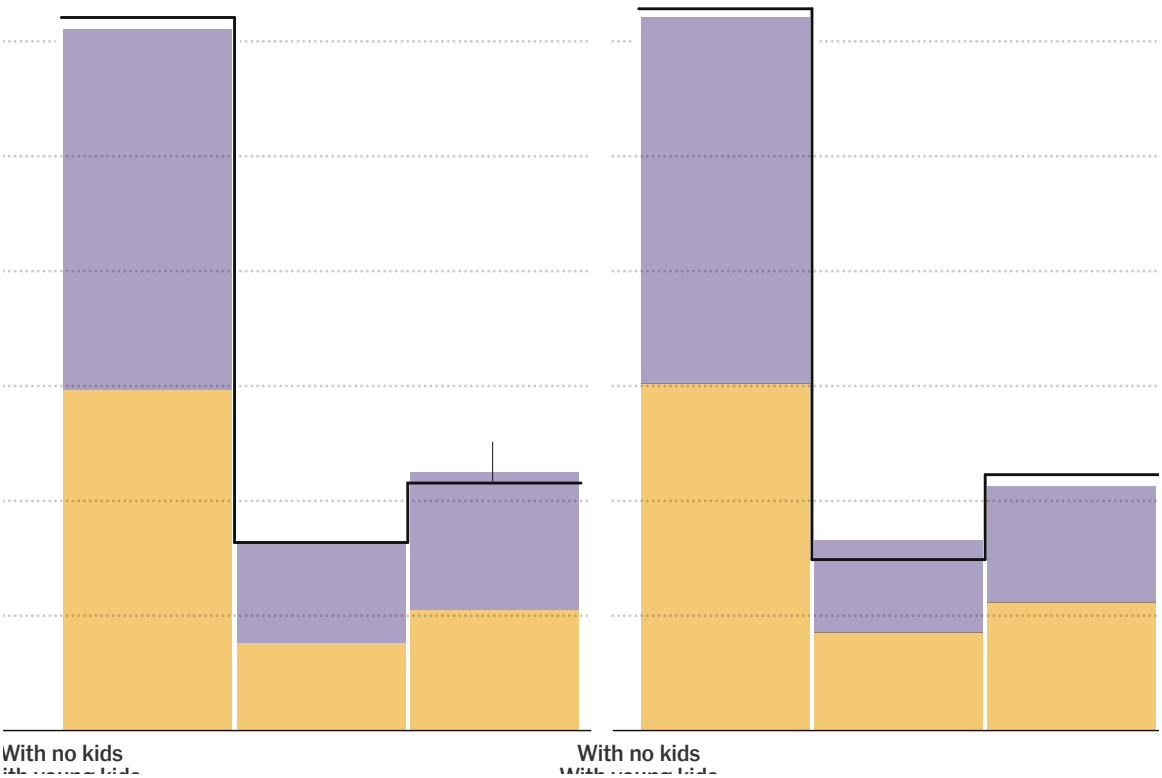
Overall, women are more likely than men to work remotely. That's partly because more women have college degrees, so more of them are in the kind of professional jobs in which flexible arrangements have become the norm. Even among those without college degrees, women are more likely to work at a desk in an administrative or

customer support role, while men more often work in construction, manufacturing and other jobs that can only be done in person.

Looking narrowly at just college graduates, remote work patterns for women and men look more evenly distributed, with men slightly more likely to work remotely than women. But there's one place where the pattern looks different: among parents with young children.

Parents have been some of the biggest winners in the flexible-work era. Remote flexibility made more feasible the constant juggling of professional and caretaking obligations. But it is mothers, not fathers, who appear to be taking the most advantage of workplace flexibility, whether out of choice or necessity.

Share of **fully remote** and **hybrid** **college-educated** workers who have children or not, by gender



Note: Young kids are those 5 years old or younger.

Among college-educated men, having children does not make much difference to whether they work at home or in person. Among women, it's a different story. Mothers of young children are much more likely to work remotely than women without children or mothers of older children.

When possible, disabled workers often choose to go fully remote

Fully remote and hybrid work often get talked about in the same breath. But in some cases, the implications are different.

For many workers with disabilities, the normalization of remote work has offered an opportunity to avoid energy-draining commutes and offices that are not designed to accommodate their needs. For others, it has opened up pathways into industries that were previously difficult to break into.

But those gains come primarily from fully remote work, not the hybrid model that has come to dominate some industries. Workers with disabilities are 22 percent more likely to work fully remotely than otherwise similar workers without disabilities, but only slightly more likely to work a hybrid schedule, according to research from the Economic Innovation Group. Workers with disabilities that limit mobility, such as those who use wheelchairs, were particularly likely to benefit from the opportunity to work entirely from home.

Employers should "understand the significant difference between full-remote and hybrid-remote," the researchers wrote. "A labor market that includes a greater number of full-remote jobs will open the door for far more otherwise qualified workers."

Methodology

The data in this article comes from the Current Population Survey, a monthly survey of 60,000 U.S. households conducted by the Census Bureau. Respondents are asked how many hours they worked the previous week, and how many of those hours they teleworked or worked from home. "Fully remote" workers are those who worked all of their hours remotely; "hybrid" workers are those who worked some but not all of their hours remotely. Respondents who were not employed, or who did not work at all in the previous week, are excluded. Data shown is for calendar year 2023. Figures are rounded throughout.

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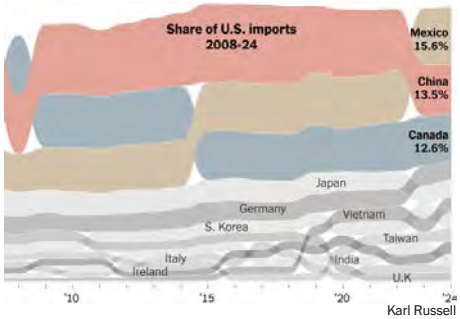

Karl Russell

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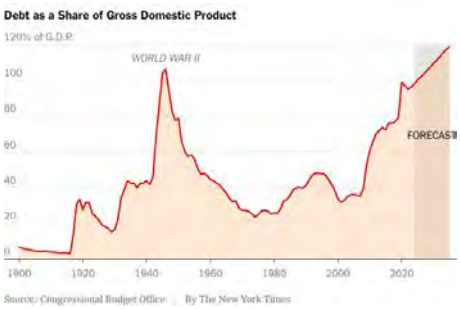

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Alejandro Cegarra for The New York Times

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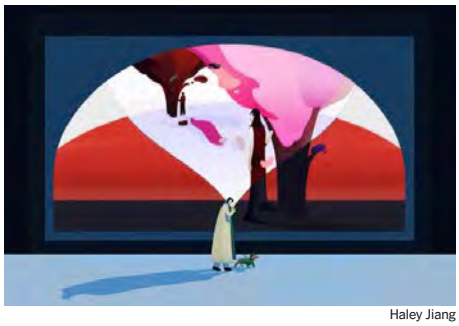

Haley Jiang

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- She Cooked Dinner for 30. Then She Danced With a Lion.
- 50 Things We Say Now, Thanks to 'S.N.L.'
- Why Are Investigators Focused on Night-Vision Goggles in the Deadly Midair Crash?
- The University of California Increased Diversity. Now It's Being Sued.
- A Magazine With a Taste for Provocation (and a Cult Following)
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OPINION

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Downtown Recoveries, 2023 Update

Posted by: **Josh Lehner** | July 18, 2023

We know there have been structural changes as a result of the pandemic. Chief among them is working-from-home is much more common, which impacts urban cores in terms of daily activity and property valuations. Even so, downtowns are not obsolete even if smaller commercial developments in suburban markets do take on more importance today than just a few years ago.

Of course none of this is new information. We have been processing and experiencing these changes in recent years. And by nearly all accounts, the downtown recovery in Portland is lagging some other big cities nationwide, even as the Portland *metro* area is in the middle of the pack when it comes to jobs and income.

All of that said, I wanted to focus for a moment on the downtown recovery data that is most commonly used when discussing these patterns. It comes from researchers out of the University of Toronto and can be found at www.downtownrecovery.com. It is a great resource that tracks cell phone data on the number of people in downtown areas across the U.S. and Canada. It is the data source where the talking point that Portland has the third weakest downtown recovery comes from. Given the information below on different geographic definitions for different downtowns, this talking point needs to be retired, even if downtown issues do need to be addressed.

New data through May just came out and I wanted to highlight a few things. Consider this an addition to the downtown discussion, and not some magnum opus.

#1: Definitions of downtown matter

The researchers use zip codes to define downtown areas. In some cases, particularly in places like San Francisco and Portland, these are narrowly defined areas related to the office towers in the urban core. Downtown Portland in this data is just 97204, which is basically the area south of West Burnside, and East of SW Broadway to the river. Fair enough. That is the *downtown* downtown part of Portland, but does exclude other major parts of the urban core when it comes to the Pearl, Old Town, the areas in and around Portland State University and so on.

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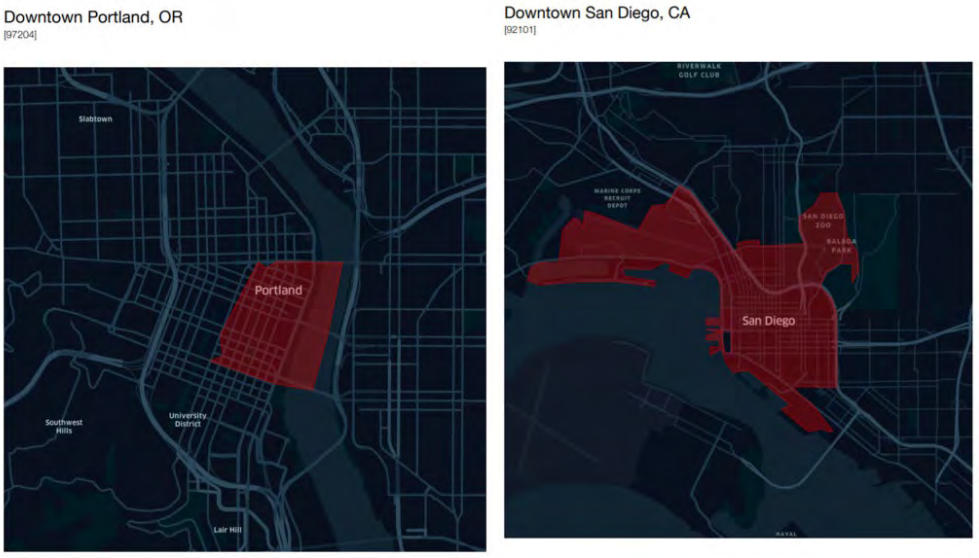

In other cities, zip codes include office towers in addition to other things that could impact the “downtown” recovery. In particular the zip code definition of downtown San Diego also includes the airport and the San Diego Zoo. So as tourism has rebounded it could show a stronger “downtown” even if office and central city activities do not show the same strength. I do not know that is the case in San Diego, but it is worth mentioning these definitions matter. Similarly, some downtown zip code definitions include a lot of residential areas, and not in the tall, urban apartment complex sense, but in also in low-density, single-family neighborhoods. Others include other important institutions like universities or religious sites and so on.

This is just how zip codes work sometimes, and I do not fault the researchers. But these different definitions for each city are important to highlight and these comparisons are not purely apples to apples. As such, I will no longer use “third worst downtown recovery” as a talking point, while also acknowledging downtowns need to continue to evolve and societal issues do need to be addressed.

Quick note. Even as these definitions vary by city, I do not think the data is not useful. In fact, I think the variation allows for a more nuanced look at relative patterns. In a sense it’s a bit of a randomized experiment given not all zip codes are created equal, nor are all downtowns. To me the biggest benefit below is the relative patterns seen in comparison to various other economic and societal measures. I do think those findings hold up.

#2: Downtowns are distinct areas, and recoveries are not driven by regional changes

Downtowns are distinct areas, and downtown recoveries are not driven by the broader regional economy. We know the Portland metro area’s economic recovery in terms of jobs and income is right in the middle of the pack among all large metros nationwide. However, Portland’s downtown recovery is weaker. This lack of a clear pattern between regional and downtown strength is seen elsewhere in the country. These first two scatterplots compare the downtown recovery on the vertical axis with regional employment and population changes during the pandemic. Note the relationships here are very weak at best with an R^2 of around 0.03. Some metros, like Austin, Texas have boomed from a regional look during the pandemic, but even their urban core recovery has not been strong. Conversely, somewhere like Honolulu has lagged economically overall, but their downtown recovery has been comparatively strong.

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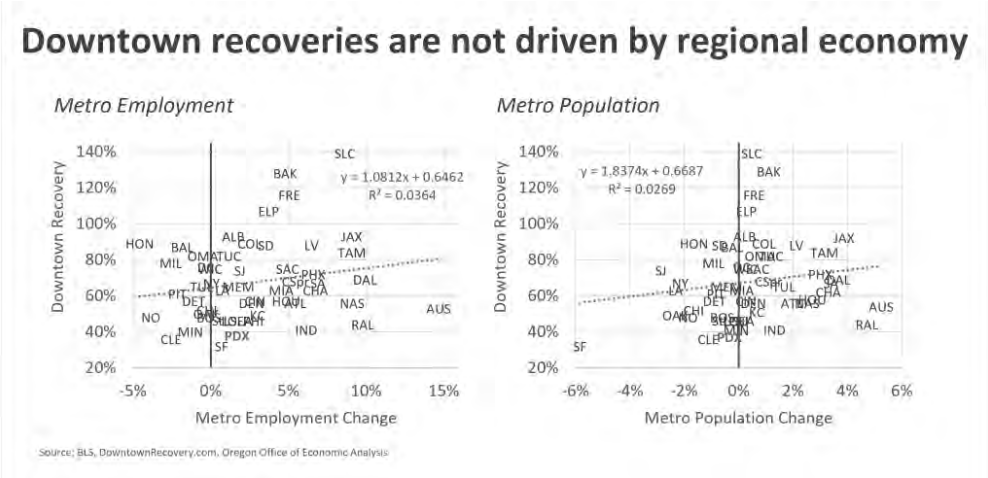
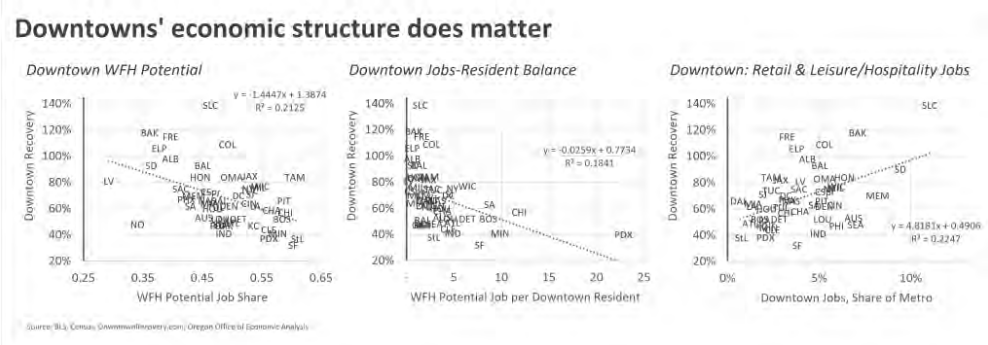


#3: Downtown's economic structure does matter

There are three main sources of demand in downtown: commuters, neighborhood residents, and then people coming to eat, shop, and visit. How any city's downtown was structured ahead of the pandemic does matter for the recovery. Let's take each source of demand in turn.

The scatterplot on the left compares the downtown recovery with the share of downtown jobs that can potentially be done remotely. The more work-from-home type jobs in your downtown, the weaker your downtown recovery likely is. The r^2 here, or goodness of fit, is not exceptionally strong either given there is a lot of variation nationally, but it still is basically 7 times as strong as the regional changes above.



The middle scatterplot gets at the local, neighborhood resident demand piece. If you are going to lose commuters — and you have in a 2 or 3 day WFH world — you need to replace the demand with something. So this chart compares the number of WFH jobs to the number of people living in the downtown. Here Portland is a clear national outlier. The 2020 Census shows there are only about 1,000 people living in 97204 in Portland. Of course that tight definition of downtown Portland matters. There are tens of thousands of Portlanders living in the Pearl, Goose Hollow, by PSU, to say nothing of the NW 21st and NW 23rd areas, the West Hills, parts of the close-in eastside and so on. But this data also speaks to the very distinct parts within the central city. In that sense, downtown Portland predominantly is just office, which are then surrounded by some urban neighborhoods.

Finally, the chart on the right gets at the other source of demand, and the ability and importance of drawing people downtown to eat, shop, and visit. What the chart actually shows is the regional share of retail and leisure and hospitality jobs that are located downtown. If there are more stores, restaurants, theaters, hotels, and the like downtown, people are more likely to go downtown for entertainment and shopping. Certainly Salt Lake — which has the strongest downtown recovery in North America — stands out here. 11% of the metro jobs in retail and leisure and hospitality can be found in their downtown zip codes. This indicates the downtown cluster of entertainment, food, and shopping is very important to the region. (Plus, Temple Square, which is not

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technically in the downtown Salt Lake zip codes but is literally across the street, with their renovations and construction projects in recent years could play a factor as well.)

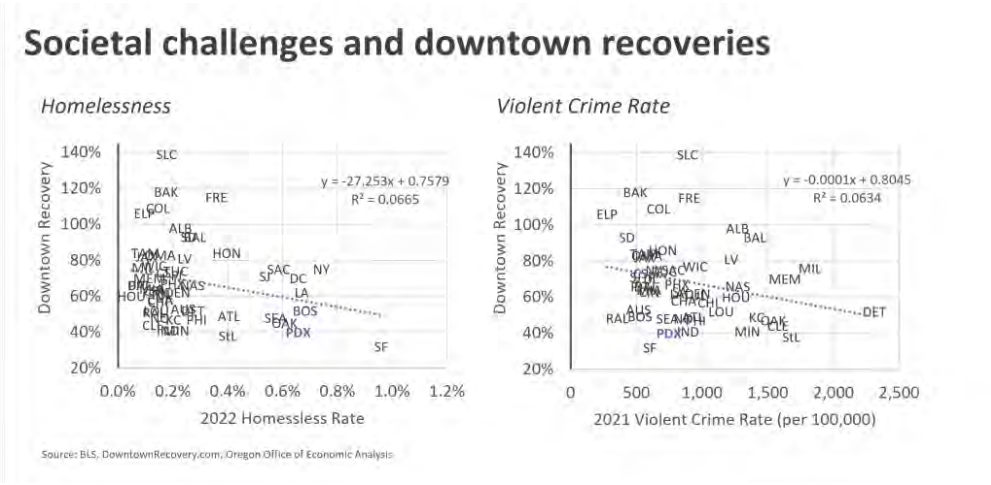
On the other end, places like Portland have a very low concentration of these industries downtown. What that means is there are dining and shopping opportunities spread more broadly throughout the metro area. Portlanders do not have to go downtown unless they want to.

#4: Patterns of crime and homelessness do not match downtown recovery strength

Lastly, one potential issue for downtowns is concerns about public safety. It is important to note that the geographic definitions here do not perfectly align. Downtown recoveries are measured at the zip code level. Homelessness data is counted at the CoC level, which is usually by county in large metro areas. Crime statistics are reported at the department or city level.

Even so, there is a lot of variation in the strength of the downtown recoveries nationwide with the available data on homelessness and crime. Just look at the range of downtown recoveries even among cities with similar type homeless numbers to Portland in the chart on the left, or the wide range of crime rates for cities with similar downtown recovery strengths to Portland in the chart on the right. Overall the r^2 is about 0.06 or 0.07, indicating no statistical relationship.

Note that these charts use the *level* data and not the *change* in these measures. The reason is simple. If you look at the percent change in homelessness or the percent change in crime rates, there is literally zero relationship nationwide (see the slides).



Now, this last finding is a bit more speculative given the different geographic definitions in the available data. And to the extent that public perceptions, if not the actual data, feed into household behaviors in where they decide to eat, shop or visit, that is worth monitoring and discussing.

Bottom Line: Overall, downtowns are distinct areas that do not appear to be impacted by broader, regional changes. Even so, downtowns today are evolving, and will recover. That path may be long, and winding in some cases, but ultimately the demand has to come from somewhere. It can be workers, local residents, and/or visitors. But they must be given the opportunity and reason to be there. Each downton had a slightly different structure pre-pandemic that either helps or impedes recovery in a post-pandemic world. To the extent your downtown is missing one key component, you must rely on the others for growth, or work to improve that missing piece.

The full set of slides are below:

downtown-recoveries-july-2023-1 Download

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Portland's Lagging In-Person Recovery
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Checking in on Portland
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In "Employment"

What's Wrong with Portland?
December 7, 2021
In "Employment"

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117th Congress

An Act

Aug. 16, 2022
[H.R. 5376]

To provide for reconciliation pursuant to title II of S. Con. Res. 14.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Appropriations authorizations.

TITLE I—COMMITTEE ON FINANCE

Subtitle A—Deficit Reduction

SECTION 10001. AMENDMENT OF 1986 CODE.

Except as otherwise expressly provided, whenever in this subtitle an amendment or repeal is expressed in terms of an amendment to, or repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of the Internal Revenue Code of 1986.

PART 1—CORPORATE TAX REFORM

SEC. 10101. CORPORATE ALTERNATIVE MINIMUM TAX.

(a) IMPOSITION OF TAX.—

26 USC 55.

(1) IN GENERAL.—Paragraph (2) of section 55(b) is amended to read as follows:

"(2) CORPORATIONS.—

"(A) APPLICABLE CORPORATIONS.—In the case of an applicable corporation, the tentative minimum tax for the taxable year shall be the excess of—

"(i) 15 percent of the adjusted financial statement income for the taxable year (as determined under section 56A), over

"(ii) the corporate AMT foreign tax credit for the taxable year.

"(B) OTHER CORPORATIONS.—In the case of any corporation which is not an applicable corporation, the tentative minimum tax for the taxable year shall be zero.".

(2) APPLICABLE CORPORATION.—Section 59 is amended by adding at the end the following new subsection:

Determinations.

"(k) APPLICABLE CORPORATION.—For purposes of this part—

"(1) APPLICABLE CORPORATION DEFINED.—

"(A) IN GENERAL.—The term 'applicable corporation' means, with respect to any taxable year, any corporation (other than an S corporation, a regulated investment company, or a real estate investment trust) which meets the

average annual adjusted financial statement income test of subparagraph (B) for one or more taxable years which—

"(i) are prior to such taxable year, and

"(ii) end after December 31, 2021.

Effective date.

"(B) AVERAGE ANNUAL ADJUSTED FINANCIAL STATEMENT INCOME TEST.—For purposes of this subsection— Time period.

"(i) a corporation meets the average annual adjusted financial statement income test for a taxable year if the average annual adjusted financial statement income of such corporation (determined without regard to section 56A(d)) for the 3-taxable-year period ending with such taxable year exceeds $1,000,000,000, and

"(ii) in the case of a corporation described in paragraph (2), such corporation meets the average annual adjusted financial statement income test for a taxable year if—

"(I) the corporation meets the requirements of clause (i) for such taxable year (determined after the application of paragraph (2)), and

"(II) the average annual adjusted financial statement income of such corporation (determined without regard to the application of paragraph (2) and without regard to section 56A(d)) for the 3-taxable-year-period ending with such taxable year is $100,000,000 or more.

"(C) EXCEPTION.—Notwithstanding subparagraph (A), the term 'applicable corporation' shall not include any corporation which otherwise meets the requirements of subparagraph (A) if—

"(i) such corporation—

"(I) has a change in ownership, or

"(II) has a specified number (to be determined by the Secretary and which shall, as appropriate, take into account the facts and circumstances of the taxpayer) of consecutive taxable years, including the most recent taxable year, in which the corporation does not meet the average annual adjusted financial statement income test of subparagraph (B), and

"(ii) the Secretary determines that it would not be appropriate to continue to treat such corporation as an applicable corporation.

The preceding sentence shall not apply to any corporation if, after the Secretary makes the determination described in clause (ii), such corporation meets the average annual adjusted financial statement income test of subparagraph (B) for any taxable year beginning after the first taxable year for which such determination applies.

"(D) SPECIAL RULES FOR DETERMINING APPLICABLE CORPORATION STATUS.— Definition.

"(i) IN GENERAL.—Solely for purposes of determining whether a corporation is an applicable corporation under this paragraph, all adjusted financial statement income of persons treated as a single employer with such corporation under subsection (a) or (b) of section 52 (determined with the modifications described in clause (ii)) shall be treated as adjusted financial

statement income of such corporation, and adjusted financial statement income of such corporation shall be determined without regard to paragraphs (2)(D)(i) and (11) of section 56A(c).

"(ii) MODIFICATIONS.—For purposes of this subparagraph—

Applicability.

"(I) section 52(a) shall be applied by substituting 'component members' for 'members', and

"(II) for purposes of applying section 52(b), the term 'trade or business' shall include any activity treated as a trade or business under paragraph (5) or (6) of section 469(c) (determined without regard to the phrase 'To the extent provided in regulations' in such paragraph (6)).

"(iii) COMPONENT MEMBER.—For purposes of this subparagraph, the term 'component member' has the meaning given such term by section 1563(b), except that the determination shall be made without regard to section 1563(b)(2).

"(E) OTHER SPECIAL RULES.—

Applicability.

"(i) CORPORATIONS IN EXISTENCE FOR LESS THAN 3 YEARS.—If the corporation was in existence for less than 3-taxable years, subparagraph (B) shall be applied on the basis of the period during which such corporation was in existence.

Time period.

"(ii) SHORT TAXABLE YEARS.—Adjusted financial statement income for any taxable year of less than 12 months shall be annualized by multiplying the adjusted financial statement income for the short period by 12 and dividing the result by the number of months in the short period.

"(iii) TREATMENT OF PREDECESSORS.—Any reference in this subparagraph to a corporation shall include a reference to any predecessor of such corporation.

"(2) SPECIAL RULE FOR FOREIGN-PARENTED MULTINATIONAL GROUPS.—

"(A) IN GENERAL.—If a corporation is a member of a foreign-parented multinational group for any taxable year, then, solely for purposes of determining whether such corporation meets the average annual adjusted financial statement income test under paragraph (1)(B)(ii)(I) for such taxable year, the adjusted financial statement income of such corporation for such taxable year shall include the adjusted financial statement income of all members of such group. Solely for purposes of this subparagraph, adjusted financial statement income shall be determined without regard to paragraphs (2)(D)(i), (3), (4), and (11) of section 56A(c).

Definition.

"(B) FOREIGN-PARENTED MULTINATIONAL GROUP.—For purposes of subparagraph (A), the term 'foreign-parented multinational group' means, with respect to any taxable year, two or more entities if—

"(i) at least one entity is a domestic corporation and another entity is a foreign corporation,

"(ii) such entities are included in the same applicable financial statement with respect to such year, and

"(iii) either—

"(I) the common parent of such entities is a foreign corporation, or

"(II) if there is no common parent, the entities are treated as having a common parent which is a foreign corporation under subparagraph (D).

"(C) FOREIGN CORPORATIONS ENGAGED IN A TRADE OR BUSINESS WITHIN THE UNITED STATES.—For purposes of this paragraph, if a foreign corporation is engaged in a trade or business within the United States, such trade or business shall be treated as a separate domestic corporation that is wholly owned by the foreign corporation.

"(D) OTHER RULES.—The Secretary shall, applying the principles of this section, prescribe rules for the application of this paragraph, including rules for the determination of— Applicability.

"(i) the entities (if any) which are to be to be treated under subparagraph (B)(iii)(II) as having a common parent which is a foreign corporation,

"(ii) the entities to be included in a foreign-parented multinational group, and

"(iii) the common parent of a foreign-parented multinational group.

"(3) REGULATIONS OR OTHER GUIDANCE.—The Secretary shall provide regulations or other guidance for the purposes of carrying out this subsection, including regulations or other guidance—

"(A) providing a simplified method for determining whether a corporation meets the requirements of paragraph (1), and

"'(B) addressing the application of this subsection to a corporation that experiences a change in ownership.".

(3) REDUCTION FOR BASE EROSION AND ANTI-ABUSE TAX.—Section 55(a)(2) is amended by inserting "plus, in the case of an applicable corporation, the tax imposed by section 59A" before the period at the end. 26 USC 55.

(4) CONFORMING AMENDMENTS.—

(A) Section 55(a) is amended by striking "In the case of a taxpayer other than a corporation, there" and inserting "There".

(B)(i) Section 55(b)(1) is amended—

(I) by striking so much as precedes subparagraph (A) and inserting the following:

"(1) NONCORPORATE TAXPAYERS.—In the case of a taxpayer other than a corporation—", and

(II) by adding at the end the following new subparagraph:

"(D) ALTERNATIVE MINIMUM TAXABLE INCOME.—The term 'alternative minimum taxable income' means the taxable income of the taxpayer for the taxable year— Definition.

"(i) determined with the adjustments provided in section 56 and section 58, and

"(ii) increased by the amount of the items of tax preference described in section 57.

If a taxpayer is subject to the regular tax, such taxpayer shall be subject to the tax imposed by this section (and, if the regular tax is determined by reference to an amount other than taxable income, such amount shall be treated as the taxable income of such taxpayer for purposes of the preceding sentence).".

26 USC 860E.

(ii) Section 860E(a)(4) is amended by striking "55(b)(2)" and inserting "55(b)(1)(D)".

(iii) Section 897(a)(2)(A)(i) is amended by striking "55(b)(2)" and inserting "55(b)(1)(D)".

(C) Section 11(d) is amended by striking "the tax imposed by subsection (a)" and inserting "the taxes imposed by subsection (a) and section 55".

(D) Section 12 is amended by adding at the end the following new paragraph:

"(5) For alternative minimum tax, see section 55.".

(E) Section 882(a)(1) is amended by inserting ", 55," after "section 11".

(F) Section 6425(c)(1)(A) is amended to read as follows:

"(A) the sum of—

"(i) the tax imposed by section 11 or subchapter L of chapter 1, whichever is applicable, plus

"(ii) the tax imposed by section 55, plus

"(iii) the tax imposed by section 59A, over".

(G) Section 6655(e)(2) is amended by inserting ", adjusted financial statement income (as defined in section 56A)," before "and modified taxable income" each place it appears in subparagraphs (A)(i) and (B)(i).

(H) Section 6655(g)(1)(A) is amended by redesignating clauses (ii) and (iii) as clauses (iii) and (iv), respectively, and by inserting after clause (i) the following new clause:

"(ii) the tax imposed by section 55,".

(b) ADJUSTED FINANCIAL STATEMENT INCOME.—

(1) IN GENERAL.—Part VI of subchapter A of chapter 1 is amended by inserting after section 56 the following new section:

26 USC 56A.

"SEC. 56A. ADJUSTED FINANCIAL STATEMENT INCOME.

Definition.

"(a) IN GENERAL.—For purposes of this part, the term 'adjusted financial statement income' means, with respect to any corporation for any taxable year, the net income or loss of the taxpayer set forth on the taxpayer's applicable financial statement for such taxable year, adjusted as provided in this section.

Definition.

"(b) APPLICABLE FINANCIAL STATEMENT.—For purposes of this section, the term 'applicable financial statement' means, with respect to any taxable year, an applicable financial statement (as defined in section 451(b)(3) or as specified by the Secretary in regulations or other guidance) which covers such taxable year.

"(c) GENERAL ADJUSTMENTS.—

"(1) STATEMENTS COVERING DIFFERENT TAXABLE YEARS.—Appropriate adjustments shall be made in adjusted financial statement income in any case in which an applicable financial statement covers a period other than the taxable year.

"(2) SPECIAL RULES FOR RELATED ENTITIES.—

Applicability.

"(A) CONSOLIDATED FINANCIAL STATEMENTS.—If the financial results of a taxpayer are reported on the

applicable financial statement for a group of entities, rules similar to the rules of section 451(b)(5) shall apply.

"(B) CONSOLIDATED RETURNS.—Except as provided in regulations prescribed by the Secretary, if the taxpayer is part of an affiliated group of corporations filing a consolidated return for any taxable year, adjusted financial statement income for such group for such taxable year shall take into account items on the group's applicable financial statement which are properly allocable to members of such group.

"(C) TREATMENT OF DIVIDENDS AND OTHER AMOUNTS.—In the case of any corporation which is not included on a consolidated return with the taxpayer, adjusted financial statement income of the taxpayer with respect to such other corporation shall be determined by only taking into account the dividends received from such other corporation (reduced to the extent provided by the Secretary in regulations or other guidance) and other amounts which are includible in gross income or deductible as a loss under this chapter (other than amounts required to be included under sections 951 and 951A or such other amounts as provided by the Secretary) with respect to such other corporation. Determination.

"(D) TREATMENT OF PARTNERSHIPS.—

"(i) IN GENERAL.—Except as provided by the Secretary, if the taxpayer is a partner in a partnership, adjusted financial statement income of the taxpayer with respect to such partnership shall be adjusted to only take into account the taxpayer's distributive share of adjusted financial statement income of such partnership.

"(ii) ADJUSTED FINANCIAL STATEMENT INCOME OF PARTNERSHIPS.—For the purposes of this part, the adjusted financial statement income of a partnership shall be the partnership's net income or loss set forth on such partnership's applicable financial statement (adjusted under rules similar to the rules of this section).

"(3) ADJUSTMENTS TO TAKE INTO ACCOUNT CERTAIN ITEMS OF FOREIGN INCOME.—

"(A) IN GENERAL.—If, for any taxable year, a taxpayer is a United States shareholder of one or more controlled foreign corporations, the adjusted financial statement income of such taxpayer with respect to such controlled foreign corporation (as determined under paragraph (2)(C)) shall be adjusted to also take into account such taxpayer's pro rata share (determined under rules similar to the rules under section 951(a)(2)) of items taken into account in computing the net income or loss set forth on the applicable financial statement (as adjusted under rules similar to those that apply in determining adjusted financial statement income) of each such controlled foreign corporation with respect to which such taxpayer is a United States shareholder.

"(B) NEGATIVE ADJUSTMENTS.—In any case in which the adjustment determined under subparagraph (A) would result in a negative adjustment for such taxable year—

"(i) no adjustment shall be made under this paragraph for such taxable year, and

"(ii) the amount of the adjustment determined under this paragraph for the succeeding taxable year (determined without regard to this paragraph) shall be reduced by an amount equal to the negative adjustment for such taxable year.

Determination. Applicability.

"(4) EFFECTIVELY CONNECTED INCOME.—In the case of a foreign corporation, to determine adjusted financial statement income, the principles of section 882 shall apply.

"(5) ADJUSTMENTS FOR CERTAIN TAXES.—Adjusted financial statement income shall be appropriately adjusted to disregard any Federal income taxes, or income, war profits, or excess profits taxes (within the meaning of section 901) with respect to a foreign country or possession of the United States, which are taken into account on the taxpayer's applicable financial statement. To the extent provided by the Secretary, the preceding sentence shall not apply to income, war profits, or excess profits taxes (within the meaning of section 901) that are imposed by a foreign country or possession of the United States and taken into account on the taxpayer's applicable financial statement if the taxpayer does not choose to have the benefits of subpart A of part III of subchapter N for the taxable year. The Secretary shall prescribe such regulations or other guidance as may be necessary and appropriate to provide for the proper treatment of current and deferred taxes for purposes of this paragraph, including the time at which such taxes are properly taken into account.

Regulations. Guidelines.

"(6) ADJUSTMENT WITH RESPECT TO DISREGARDED ENTITIES.—Adjusted financial statement income shall be adjusted to take into account any adjusted financial statement income of a disregarded entity owned by the taxpayer.

Applicability.

"(7) SPECIAL RULE FOR COOPERATIVES.—In the case of a cooperative to which section 1381 applies, the adjusted financial statement income (determined without regard to this paragraph) shall be reduced by the amounts referred to in section 1382(b) (relating to patronage dividends and per-unit retain allocations) to the extent such amounts were not otherwise taken into account in determining adjusted financial statement income.

"(8) RULES FOR ALASKA NATIVE CORPORATIONS.—Adjusted financial statement income shall be appropriately adjusted to allow—

"(A) cost recovery and depletion attributable to property the basis of which is determined under section 21(c) of the Alaska Native Claims Settlement Act (43 U.S.C. 1620(c)), and

"(B) deductions for amounts payable made pursuant to section 7(i) or section 7(j) of such Act (43 U.S.C. 1606(i) and 1606(j)) only at such time as the deductions are allowed for tax purposes.

"(9) AMOUNTS ATTRIBUTABLE TO ELECTIONS FOR DIRECT PAYMENT OF CERTAIN CREDITS.—Adjusted financial statement income shall be appropriately adjusted to disregard any amount treated as a payment against the tax imposed by subtitle A pursuant to an election under section 48D(d) or 6417, to the

extent such amount was not otherwise taken into account under paragraph (5).

"(10) CONSISTENT TREATMENT OF MORTGAGE SERVICING INCOME OF TAXPAYER OTHER THAN A REGULATED INVESTMENT COMPANY.—

"(A) IN GENERAL.—Adjusted financial statement income shall be adjusted so as not to include any item of income in connection with a mortgage servicing contract any earlier than when such income is included in gross income under any other provision of this chapter.

"(B) RULES FOR AMOUNTS NOT REPRESENTING REASONABLE COMPENSATION.—The Secretary shall provide regulations to prevent the avoidance of taxes imposed by this chapter with respect to amounts not representing reasonable compensation (as determined by the Secretary) with respect to a mortgage servicing contract. Determination.

"(11) ADJUSTMENT WITH RESPECT TO DEFINED BENEFIT PENSIONS.—

"(A) IN GENERAL.—Except as otherwise provided in rules prescribed by the Secretary in regulations or other guidance, adjusted financial statement income shall be— Regulations. Guidelines.

"(i) adjusted to disregard any amount of income, cost, or expense that would otherwise be included on the applicable financial statement in connection with any covered benefit plan,

"(ii) increased by any amount of income in connection with any such covered benefit plan that is included in the gross income of the corporation under any other provision of this chapter, and

"(iii) reduced by deductions allowed under any other provision of this chapter with respect to any such covered benefit plan.

"(B) COVERED BENEFIT PLAN.—For purposes of this paragraph, the term 'covered benefit plan' means— Definition.

"(i) a defined benefit plan (other than a multiemployer plan described in section 414(f)) if the trust which is part of such plan is an employees' trust described in section 401(a) which is exempt from tax under section 501(a),

"(ii) any qualified foreign plan (as defined in section 404A(e)), or

"(iii) any other defined benefit plan which provides post-employment benefits other than pension benefits.

"(12) TAX-EXEMPT ENTITIES.—In the case of an organization subject to tax under section 511, adjusted financial statement income shall be appropriately adjusted to only take into account any adjusted financial statement income—

"(A) of an unrelated trade or business (as defined in section 513) of such organization, or

"(B) derived from debt-financed property (as defined in section 514) to the extent that income from such property is treated as unrelated business taxable income.

"(13) DEPRECIATION.—Adjusted financial statement income shall be—

"(A) reduced by depreciation deductions allowed under section 167 with respect to property to which section 168 Applicability.

applies to the extent of the amount allowed as deductions in computing taxable income for the taxable year, and

"(B) appropriately adjusted—

"(i) to disregard any amount of depreciation expense that is taken into account on the taxpayer's applicable financial statement with respect to such property, and

"(ii) to take into account any other item specified by the Secretary in order to provide that such property is accounted for in the same manner as it is accounted for under this chapter.

"(14) QUALIFIED WIRELESS SPECTRUM.—

"(A) IN GENERAL.—Adjusted financial statement income shall be—

"(i) reduced by amortization deductions allowed under section 197 with respect to qualified wireless spectrum to the extent of the amount allowed as deductions in computing taxable income for the taxable year, and

"(ii) appropriately adjusted—

"(I) to disregard any amount of amortization expense that is taken into account on the taxpayer's applicable financial statement with respect to such qualified wireless spectrum, and

"(II) to take into account any other item specified by the Secretary in order to provide that such qualified wireless spectrum is accounted for in the same manner as it is accounted for under this chapter.

Definition.

"(B) QUALIFIED WIRELESS SPECTRUM.—For purposes of this paragraph, the term 'qualified wireless spectrum' means wireless spectrum which—

"(i) is used in the trade or business of a wireless telecommunications carrier, and

Effective date.

"(ii) was acquired after December 31, 2007, and before the date of enactment of this section.

Regulations.
Guidelines.
Determination.

"(15) SECRETARIAL AUTHORITY TO ADJUST ITEMS.—The Secretary shall issue regulations or other guidance to provide for such adjustments to adjusted financial statement income as the Secretary determines necessary to carry out the purposes of this section, including adjustments—

"(A) to prevent the omission or duplication of any item, and

"(B) to carry out the principles of part II of subchapter C of this chapter (relating to corporate liquidations), part III of subchapter C of this chapter (relating to corporate organizations and reorganizations), and part II of subchapter K of this chapter (relating to partnership contributions and distributions).

Determinations.

"(d) DEDUCTION FOR FINANCIAL STATEMENT NET OPERATING LOSS.—

"(1) IN GENERAL.—Adjusted financial statement income (determined after application of subsection (c) and without regard to this subsection) shall be reduced by an amount equal to the lesser of—

"(A) the aggregate amount of financial statement net operating loss carryovers to the taxable year, or

"(B) 80 percent of adjusted financial statement income computed without regard to the deduction allowable under this subsection.

"(2) FINANCIAL STATEMENT NET OPERATING LOSS CARRYOVER.—A financial statement net operating loss for any taxable year shall be a financial statement net operating loss carryover to each taxable year following the taxable year of the loss. The portion of such loss which shall be carried to subsequent taxable years shall be the amount of such loss remaining (if any) after the application of paragraph (1).

"(3) FINANCIAL STATEMENT NET OPERATING LOSS DEFINED.— Effective date.
For purposes of this subsection, the term 'financial statement net operating loss' means the amount of the net loss (if any) set forth on the corporation's applicable financial statement (determined after application of subsection (c) and without regard to this subsection) for taxable years ending after December 31, 2019.

"(e) REGULATIONS AND OTHER GUIDANCE.—The Secretary shall provide for such regulations and other guidance as necessary to carry out the purposes of this section, including regulations and other guidance relating to the effect of the rules of this section on partnerships with income taken into account by an applicable corporation.".

(2) CLERICAL AMENDMENT.—The table of sections for part VI of subchapter A of chapter 1 is amended by inserting after the item relating to section 56 the following new item: 26 USC 55 prec.

"Sec. 56A. Adjusted financial statement income.".

(c) CORPORATE AMT FOREIGN TAX CREDIT.—Section 59, as amended by this section, is amended by adding at the end the following new subsection: 26 USC 59.

"(l) CORPORATE AMT FOREIGN TAX CREDIT.—

"(1) IN GENERAL.—For purposes of this part, if an applicable corporation chooses to have the benefits of subpart A of part III of subchapter N for any taxable year, the corporate AMT foreign tax credit for the taxable year of the applicable corporation is an amount equal to sum of—

"(A) the lesser of—

"(i) the aggregate of the applicable corporation's Determination.
pro rata share (as determined under section 56A(c)(3)) of the amount of income, war profits, and excess profits taxes (within the meaning of section 901) imposed by any foreign country or possession of the United States which are—

"(I) taken into account on the applicable financial statement of each controlled foreign corporation with respect to which the applicable corporation is a United States shareholder, and

"(II) paid or accrued (for Federal income tax purposes) by each such controlled foreign corporation, or

"(ii) the product of the amount of the adjustment under section 56A(c)(3) and the percentage specified in section 55(b)(2)(A)(i), and

"(B) in the case of an applicable corporation that is a domestic corporation, the amount of income, war profits, and excess profits taxes (within the meaning of section

901) imposed by any foreign country or possession of the United States to the extent such taxes are—

"(i) taken into account on the applicable corporation's applicable financial statement, and

"(ii) paid or accrued (for Federal income tax purposes) by the applicable corporation.

Time period.

"(2) CARRYOVER OF EXCESS TAX PAID.—For any taxable year for which an applicable corporation chooses to have the benefits of subpart A of part III of subchapter N, the excess of the amount described in paragraph (1)(A)(i) over the amount described in paragraph (1)(A)(ii) shall increase the amount described in paragraph (1)(A)(i) in any of the first 5 succeeding taxable years to the extent not taken into account in a prior taxable year.

"(3) REGULATIONS OR OTHER GUIDANCE.—The Secretary shall provide for such regulations or other guidance as is necessary to carry out the purposes of this subsection.".

(d) TREATMENT OF GENERAL BUSINESS CREDIT.—Section 38(c)(6)(E) is amended to read as follows:

26 USC 38.

Applicability.

"(E) CORPORATIONS.—In the case of a corporation—

"(i) the first sentence of paragraph (1) shall be applied by substituting '25 percent of the taxpayer's net income tax as exceeds $25,000' for 'the greater of' and all that follows,

"(ii) paragraph (2)(A) shall be applied without regard to clause (ii)(I) thereof, and

"(iii) paragraph (4)(A) shall be applied without regard to clause (ii)(I) thereof.".

(e) CREDIT FOR PRIOR YEAR MINIMUM TAX LIABILITY.—

(1) IN GENERAL.—Section 53(e) is amended to read as follows:

"(e) APPLICATION TO APPLICABLE CORPORATIONS.—In the case of a corporation—

"(1) subsection (b)(1) shall be applied by substituting 'the net minimum tax for all prior taxable years beginning after 2022' for 'the adjusted net minimum tax imposed for all prior taxable years beginning after 1986', and

"(2) the amount determined under subsection (c)(1) shall be increased by the amount of tax imposed under section 59A for the taxable year.".

(2) CONFORMING AMENDMENTS.—Section 53(d) is amended—

(A) in paragraph (2), by striking ", except that in the case" and all that follows through "treated as zero", and

(B) by striking paragraph (3).

26 USC 11 note.

(f) EFFECTIVE DATE.—The amendments made by this section shall apply to taxable years beginning after December 31, 2022.

PART 2—EXCISE TAX ON REPURCHASE OF CORPORATE STOCK

SEC. 10201. EXCISE TAX ON REPURCHASE OF CORPORATE STOCK.

(a) IN GENERAL.—Subtitle D is amended by inserting after chapter 36 the following new chapter:

"CHAPTER 37—REPURCHASE OF CORPORATE STOCK

26 USC 4501 prec.

"Sec. 4501. Repurchase of corporate stock.

"SEC. 4501. REPURCHASE OF CORPORATE STOCK.

26 USC 4501.

"(a) GENERAL RULE.—There is hereby imposed on each covered corporation a tax equal to 1 percent of the fair market value of any stock of the corporation which is repurchased by such corporation during the taxable year.

"(b) COVERED CORPORATION.—For purposes of this section, the term 'covered corporation' means any domestic corporation the stock of which is traded on an established securities market (within the meaning of section 7704(b)(1)). Definition.

"(c) REPURCHASE.—For purposes of this section— Definitions.

"(1) IN GENERAL.—The term 'repurchase' means—

"(A) a redemption within the meaning of section 317(b) with regard to the stock of a covered corporation, and

"(B) any transaction determined by the Secretary to be economically similar to a transaction described in subparagraph (A). Determination.

"(2) TREATMENT OF PURCHASES BY SPECIFIED AFFILIATES.—

"(A) IN GENERAL.—The acquisition of stock of a covered corporation by a specified affiliate of such covered corporation, from a person who is not the covered corporation or a specified affiliate of such covered corporation, shall be treated as a repurchase of the stock of the covered corporation by such covered corporation.

"(B) SPECIFIED AFFILIATE.—For purposes of this section, the term 'specified affiliate' means, with respect to any corporation—

"(i) any corporation more than 50 percent of the stock of which is owned (by vote or by value), directly or indirectly, by such corporation, and

"(ii) any partnership more than 50 percent of the capital interests or profits interests of which is held, directly or indirectly, by such corporation.

"(3) ADJUSTMENT.—The amount taken into account under subsection (a) with respect to any stock repurchased by a covered corporation shall be reduced by the fair market value of any stock issued by the covered corporation during the taxable year, including the fair market value of any stock issued or provided to employees of such covered corporation or employees of a specified affiliate of such covered corporation during the taxable year, whether or not such stock is issued or provided in response to the exercise of an option to purchase such stock.

"(d) SPECIAL RULES FOR ACQUISITION OF STOCK OF CERTAIN FOREIGN CORPORATIONS.— Determinations.

"(1) IN GENERAL.—In the case of an acquisition of stock of an applicable foreign corporation by a specified affiliate of such corporation (other than a foreign corporation or a foreign partnership (unless such partnership has a domestic entity as a direct or indirect partner)) from a person who is not the applicable foreign corporation or a specified affiliate of such applicable foreign corporation, for purposes of this section—

"(A) such specified affiliate shall be treated as a covered corporation with respect to such acquisition,

"(B) such acquisition shall be treated as a repurchase of stock of a covered corporation by such covered corporation, and

"(C) the adjustment under subsection (c)(3) shall be determined only with respect to stock issued or provided by such specified affiliate to employees of the specified affiliate.

"(2) SURROGATE FOREIGN CORPORATIONS.—In the case of a repurchase of stock of a covered surrogate foreign corporation by such covered surrogate foreign corporation, or an acquisition of stock of a covered surrogate foreign corporation by a specified affiliate of such corporation, for purposes of this section—

"(A) the expatriated entity with respect to such covered surrogate foreign corporation shall be treated as a covered corporation with respect to such repurchase or acquisition,

"(B) such repurchase or acquisition shall be treated as a repurchase of stock of a covered corporation by such covered corporation, and

"(C) the adjustment under subsection (c)(3) shall be determined only with respect to stock issued or provided by such expatriated entity to employees of the expatriated entity.

"(3) DEFINITIONS.—For purposes of this subsection—

"(A) APPLICABLE FOREIGN CORPORATION.—The term 'applicable foreign corporation' means any foreign corporation the stock of which is traded on an established securities market (within the meaning of section 7704(b)(1)).

"(B) COVERED SURROGATE FOREIGN CORPORATION.—The term 'covered surrogate foreign corporation' means any surrogate foreign corporation (as determined under section 7874(a)(2)(B) by substituting 'September 20, 2021' for 'March 4, 2003' each place it appears) the stock of which is traded on an established securities market (within the meaning of section 7704(b)(1)), but only with respect to taxable years which include any portion of the applicable period with respect to such corporation under section 7874(d)(1).

"(C) EXPATRIATED ENTITY.—The term 'expatriated entity' has the meaning given such term by section 7874(a)(2)(A).

"(e) EXCEPTIONS.—Subsection (a) shall not apply—

"(1) to the extent that the repurchase is part of a reorganization (within the meaning of section 368(a)) and no gain or loss is recognized on such repurchase by the shareholder under chapter 1 by reason of such reorganization,

"(2) in any case in which the stock repurchased is, or an amount of stock equal to the value of the stock repurchased is, contributed to an employer-sponsored retirement plan, employee stock ownership plan, or similar plan,

"(3) in any case in which the total value of the stock repurchased during the taxable year does not exceed $1,000,000,

"(4) under regulations prescribed by the Secretary, in cases in which the repurchase is by a dealer in securities in the ordinary course of business,

"(5) to repurchases by a regulated investment company (as defined in section 851) or a real estate investment trust, or

"(6) to the extent that the repurchase is treated as a dividend for purposes of this title.

"(f) REGULATIONS AND GUIDANCE.—The Secretary shall prescribe such regulations and other guidance as are necessary or appropriate to carry out, and to prevent the avoidance of, the purposes of this section, including regulations and other guidance—

"(1) to prevent the abuse of the exceptions provided by subsection (e),

"(2) to address special classes of stock and preferred stock, and

"(3) for the application of the rules under subsection (d).".

(b) TAX NOT DEDUCTIBLE.—Paragraph (6) of section 275(a) is amended by inserting "37," before "41". 26 USC 275.

(c) CLERICAL AMENDMENT.—The table of chapters for subtitle D is amended by inserting after the item relating to chapter 36 the following new item: 26 USC 4001 prec.

"CHAPTER 37—REPURCHASE OF CORPORATE STOCK".

(d) EFFECTIVE DATE.—The amendments made by this section shall apply to repurchases (within the meaning of section 4501(c) of the Internal Revenue Code of 1986, as added by this section) of stock after December 31, 2022. 26 USC 4501 note.

PART 3—FUNDING THE INTERNAL REVENUE SERVICE AND IMPROVING TAXPAYER COMPLIANCE

SEC. 10301. ENHANCEMENT OF INTERNAL REVENUE SERVICE RESOURCES.

IN GENERAL.—The following sums are appropriated, out of any money in the Treasury not otherwise appropriated, for the fiscal year ending September 30, 2022:

(1) INTERNAL REVENUE SERVICE.—

(A) IN GENERAL.—

(i) TAXPAYER SERVICES.—For necessary expenses of the Internal Revenue Service to provide taxpayer services, including pre-filing assistance and education, filing and account services, taxpayer advocacy services, and other services as authorized by 5 U.S.C. 3109, at such rates as may be determined by the Commissioner, $3,181,500,000, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(ii) ENFORCEMENT.—For necessary expenses for tax enforcement activities of the Internal Revenue Service to determine and collect owed taxes, to provide legal and litigation support, to conduct criminal investigations (including investigative technology), to provide digital asset monitoring and compliance activities, to enforce criminal statutes related to violations of internal revenue laws and other financial crimes, to purchase and hire passenger motor vehicles (31 U.S.C.

1343(b)), and to provide other services as authorized by 5 U.S.C. 3109, at such rates as may be determined by the Commissioner, $45,637,400,000, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(iii) OPERATIONS SUPPORT.—For necessary expenses of the Internal Revenue Service to support taxpayer services and enforcement programs, including rent payments; facilities services; printing; postage; physical security; headquarters and other IRS-wide administration activities; research and statistics of income; telecommunications; information technology development, enhancement, operations, maintenance, and security; the hire of passenger motor vehicles (31 U.S.C. 1343(b)); the operations of the Internal Revenue Service Oversight Board; and other services as authorized by 5 U.S.C. 3109, at such rates as may be determined by the Commissioner, $25,326,400,000, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(iv) BUSINESS SYSTEMS MODERNIZATION.—For necessary expenses of the Internal Revenue Service's business systems modernization program, including development of callback technology and other technology to provide a more personalized customer service but not including the operation and maintenance of legacy systems, $4,750,700,000, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(B) TASK FORCE TO DESIGN AN IRS-RUN FREE "DIRECT EFILE" TAX RETURN SYSTEM.—For necessary expenses of the Internal Revenue Service to deliver to Congress, within nine months following the date of the enactment of this Act, a report on (I) the cost (including options for differential coverage based on taxpayer adjusted gross income and return complexity) of developing and running a free direct efile tax return system, including costs to build and administer each release, with a focus on multi-lingual and mobile-friendly features and safeguards for taxpayer data; (II) taxpayer opinions, expectations, and level of trust, based on surveys, for such a free direct efile system; and (III) the opinions of an independent third-party on the overall feasibility, approach, schedule, cost, organizational design, and Internal Revenue Service capacity to deliver such a direct efile tax return system, $15,000,000, to remain available until September 30, 2023: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(2) TREASURY INSPECTOR GENERAL FOR TAX ADMINISTRATION.—For necessary expenses of the Treasury Inspector General for Tax Administration in carrying out the Inspector General Act of 1978, as amended, including purchase and hire of passenger motor vehicles (31 U.S.C. 1343(b)); and services

authorized by 5 U.S.C. 3109, at such rates as may be determined by the Inspector General for Tax Administration, $403,000,000, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(3) OFFICE OF TAX POLICY.—For necessary expenses of the Office of Tax Policy of the Department of the Treasury to carry out functions related to promulgating regulations under the Internal Revenue Code of 1986, $104,533,803, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(4) UNITED STATES TAX COURT.—For necessary expenses of the United States Tax Court, including contract reporting and other services as authorized by 5 U.S.C. 3109; $153,000,000, to remain available until September 30, 2031: *Provided,* That these amounts shall be in addition to amounts otherwise available for such purposes.

(5) TREASURY DEPARTMENTAL OFFICES.—For necessary expenses of the Departmental Offices of the Department of the Treasury to provide for oversight and implementation support for actions by the Internal Revenue Service to implement this Act and the amendments made by this Act, $50,000,000, to remain available until September 30, 2031: *Provided*, That these amounts shall be in addition to amounts otherwise available for such purposes.

Subtitle B—Prescription Drug Pricing Reform

PART 1—LOWERING PRICES THROUGH DRUG PRICE NEGOTIATION

SEC. 11001. PROVIDING FOR LOWER PRICES FOR CERTAIN HIGH-PRICED SINGLE SOURCE DRUGS.

(a) PROGRAM TO LOWER PRICES FOR CERTAIN HIGH-PRICED SINGLE SOURCE DRUGS.—Title XI of the Social Security Act is amended by adding after section 1184 (42 U.S.C. 1320e–3) the following new part:

"PART E—PRICE NEGOTIATION PROGRAM TO LOWER PRICES FOR CERTAIN HIGH-PRICED SINGLE SOURCE DRUGS

"SEC. 1191. ESTABLISHMENT OF PROGRAM. 42 USC 1320f.

"(a) IN GENERAL.—The Secretary shall establish a Drug Price Negotiation Program (in this part referred to as the 'program'). Under the program, with respect to each price applicability period, the Secretary shall—

"(1) publish a list of selected drugs in accordance with section 1192; Publication. Lists.

"(2) enter into agreements with manufacturers of selected drugs with respect to such period, in accordance with section 1193; Contracts.

"(3) negotiate and, if applicable, renegotiate maximum fair prices for such selected drugs, in accordance with section 1194;

"(4) carry out the publication and administrative duties and compliance monitoring in accordance with sections 1195 and 1196.

"(b) DEFINITIONS RELATING TO TIMING.—For purposes of this part:

"(1) INITIAL PRICE APPLICABILITY YEAR.—The term 'initial price applicability year' means a year (beginning with 2026).

"(2) PRICE APPLICABILITY PERIOD.—The term 'price applicability period' means, with respect to a qualifying single source drug, the period beginning with the first initial price applicability year with respect to which such drug is a selected drug and ending with the last year during which the drug is a selected drug.

"(3) SELECTED DRUG PUBLICATION DATE.—The term 'selected drug publication date' means, with respect to each initial price applicability year, February 1 of the year that begins 2 years prior to such year.

"(4) NEGOTIATION PERIOD.—The term 'negotiation period' means, with respect to an initial price applicability year with respect to a selected drug, the period—

"(A) beginning on the sooner of—

"(i) the date on which the manufacturer of the drug and the Secretary enter into an agreement under section 1193 with respect to such drug; or

"(ii) February 28 following the selected drug publication date with respect to such selected drug; and

"(B) ending on November 1 of the year that begins 2 years prior to the initial price applicability year.

"(c) OTHER DEFINITIONS.—For purposes of this part:

"(1) MANUFACTURER.—The term 'manufacturer' has the meaning given that term in section 1847A(c)(6)(A).

"(2) MAXIMUM FAIR PRICE ELIGIBLE INDIVIDUAL.—The term 'maximum fair price eligible individual' means, with respect to a selected drug—

"(A) in the case such drug is dispensed to the individual at a pharmacy, by a mail order service, or by another dispenser, an individual who is enrolled in a prescription drug plan under part D of title XVIII or an MA–PD plan under part C of such title if coverage is provided under such plan for such selected drug; and

"(B) in the case such drug is furnished or administered to the individual by a hospital, physician, or other provider of services or supplier, an individual who is enrolled under part B of title XVIII, including an individual who is enrolled in an MA plan under part C of such title, if payment may be made under part B for such selected drug.

"(3) MAXIMUM FAIR PRICE.—The term 'maximum fair price' means, with respect to a year during a price applicability period and with respect to a selected drug (as defined in section 1192(c)) with respect to such period, the price negotiated pursuant to section 1194, and updated pursuant to section 1195(b), as applicable, for such drug and year.

"(4) REFERENCE PRODUCT.—The term 'reference product' has the meaning given such term in section 351(i) of the Public Health Service Act.

"(5) TOTAL EXPENDITURES.—The term 'total expenditures' includes, in the case of expenditures with respect to part D of title XVIII, the total gross covered prescription drug costs (as defined in section 1860D–15(b)(3)). The term 'total expenditures' excludes, in the case of expenditures with respect to part B of such title, expenditures for a drug or biological product that are bundled or packaged into the payment for another service.

"(6) UNIT.—The term 'unit' means, with respect to a drug or biological product, the lowest identifiable amount (such as a capsule or tablet, milligram of molecules, or grams) of the drug or biological product that is dispensed or furnished.

"(d) TIMING FOR INITIAL PRICE APPLICABILITY YEAR 2026.—Notwithstanding the provisions of this part, in the case of initial price applicability year 2026, the following rules shall apply for purposes of implementing the program: Regulations. Applicability.

"(1) Subsection (b)(3) shall be applied by substituting 'September 1, 2023' for ', with respect to each initial price applicability year, February 1 of the year that begins 2 years prior to such year'.

"(2) Subsection (b)(4) shall be applied—

"(A) in subparagraph (A)(ii), by substituting 'October 1, 2023' for 'February 28 following the selected drug publication date with respect to such selected drug'; and

"(B) in subparagraph (B), by substituting 'August 1, 2024' for 'November 1 of the year that begins 2 years prior to the initial price applicability year'.

"(3) Section 1192 shall be applied—

"(A) in subsection (b)(1)(A), by substituting 'during the period beginning on June 1, 2022, and ending on May 31, 2023' for 'during the most recent period of 12 months prior to the selected drug publication date (but ending not later than October 31 of the year prior to the year of such drug publication date), with respect to such year, for which data are available'; and

"(B) in subsection (d)(1)(A), by substituting 'during the period beginning on June 1, 2022, and ending on May 31, 2023' for 'during the most recent period for which data are available of at least 12 months prior to the selected drug publication date (but ending no later than October 31 of the year prior to the year of such drug publication date), with respect to such year'.

"(4) Section 1193(a) shall be applied by substituting 'October 1, 2023' for 'February 28 following the selected drug publication date with respect to such selected drug'.

"(5) Section 1194(b)(2) shall be applied—

"(A) in subparagraph (A), by substituting 'October 2, 2023' for 'March 1 of the year of the selected drug publication date, with respect to the selected drug';

"(B) in subparagraph (B), by substituting 'February 1, 2024' for 'the June 1 following the selected drug publication date'; and

"(C) in subparagraph (E), by substituting 'August 1, 2024' for 'the first day of November following the selected

drug publication date, with respect to the initial price applicability year '.

"(6) Section 1195(a)(1) shall be applied by substituting 'September 1, 2024' for 'November 30 of the year that is 2 years prior to such initial price applicability year'.

42 USC 1320f–1.

"SEC. 1192. SELECTION OF NEGOTIATION-ELIGIBLE DRUGS AS SELECTED DRUGS.

Deadlines. Publication. List. Time periods.

"(a) IN GENERAL.—Not later than the selected drug publication date with respect to an initial price applicability year, in accordance with subsection (b), the Secretary shall select and publish a list of—

"(1) with respect to the initial price applicability year 2026, 10 negotiation-eligible drugs described in subparagraph (A) of subsection (d)(1), but not subparagraph (B) of such subsection, with respect to such year (or, all (if such number is less than 10) such negotiation-eligible drugs with respect to such year);

"(2) with respect to the initial price applicability year 2027, 15 negotiation-eligible drugs described in subparagraph (A) of subsection (d)(1), but not subparagraph (B) of such subsection, with respect to such year (or, all (if such number is less than 15) such negotiation-eligible drugs with respect to such year);

"(3) with respect to the initial price applicability year 2028, 15 negotiation-eligible drugs described in subparagraph (A) or (B) of subsection (d)(1) with respect to such year (or, all (if such number is less than 15) such negotiation-eligible drugs with respect to such year); and

"(4) with respect to the initial price applicability year 2029 or a subsequent year, 20 negotiation-eligible drugs described in subparagraph (A) or (B) of subsection (d)(1), with respect to such year (or, all (if such number is less than 20) such negotiation-eligible drugs with respect to such year).

Subject to subsection (c)(2) and section 1194(f)(5), each drug published on the list pursuant to the previous sentence shall be subject to the negotiation process under section 1194 for the negotiation period with respect to such initial price applicability year (and the renegotiation process under such section as applicable for any subsequent year during the applicable price applicability period).

"(b) SELECTION OF DRUGS.—

"(1) IN GENERAL.—In carrying out subsection (a), subject to paragraph (2), the Secretary shall, with respect to an initial price applicability year, do the following:

Determination. Time periods.

"(A) Rank negotiation-eligible drugs described in subsection (d)(1) according to the total expenditures for such drugs under parts B and D of title XVIII, as determined by the Secretary, during the most recent period of 12 months prior to the selected drug publication date (but ending not later than October 31 of the year prior to the year of such drug publication date), with respect to such year, for which data are available, with the negotiation-eligible drugs with the highest total expenditures being ranked the highest.

"(B) Select from such ranked drugs with respect to such year the negotiation-eligible drugs with the highest such rankings.

Applicability.

"(2) HIGH SPEND PART D DRUGS FOR 2026 AND 2027.—With respect to the initial price applicability year 2026 and with

respect to the initial price applicability year 2027, the Secretary shall apply paragraph (1) as if the reference to 'negotiation-eligible drugs described in subsection (d)(1)' were a reference to 'negotiation-eligible drugs described in subsection (d)(1)(A)' and as if the reference to 'total expenditures for such drugs under parts B and D of title XVIII' were a reference to 'total expenditures for such drugs under part D of title XVIII'.

"(c) SELECTED DRUG.—

Time period. Determination.

"(1) IN GENERAL.—For purposes of this part, in accordance with subsection (e)(2) and subject to paragraph (2), each negotiation-eligible drug included on the list published under subsection (a) with respect to an initial price applicability year shall be referred to as a 'selected drug' with respect to such year and each subsequent year beginning before the first year that begins at least 9 months after the date on which the Secretary determines at least one drug or biological product—

"(A) is approved or licensed (as applicable)—

"(i) under section 505(j) of the Federal Food, Drug, and Cosmetic Act using such drug as the listed drug; or

"(ii) under section 351(k) of the Public Health Service Act using such drug as the reference product; and

"(B) is marketed pursuant to such approval or licensure.

"(2) CLARIFICATION.—A negotiation-eligible drug—

"(A) that is included on the list published under subsection (a) with respect to an initial price applicability year; and

"(B) for which the Secretary makes a determination described in paragraph (1) before or during the negotiation period with respect to such initial price applicability year;

shall not be subject to the negotiation process under section 1194 with respect to such negotiation period and shall continue to be considered a selected drug under this part with respect to the number of negotiation-eligible drugs published on the list under subsection (a) with respect to such initial price applicability year.

"(d) NEGOTIATION-ELIGIBLE DRUG.—

Determinations. Time periods. Definition.

"(1) IN GENERAL.—For purposes of this part, subject to paragraph (2), the term 'negotiation-eligible drug' means, with respect to the selected drug publication date with respect to an initial price applicability year, a qualifying single source drug, as defined in subsection (e), that is described in either of the following subparagraphs (or, with respect to the initial price applicability year 2026 or 2027, that is described in subparagraph (A)):

"(A) PART D HIGH SPEND DRUGS.—The qualifying single source drug is, determined in accordance with subsection (e)(2), among the 50 qualifying single source drugs with the highest total expenditures under part D of title XVIII, as determined by the Secretary in accordance with paragraph (3), during the most recent 12-month period for which data are available prior to such selected drug publication date (but ending no later than October 31 of the year prior to the year of such drug publication date).

"(B) PART B HIGH SPEND DRUGS.—The qualifying single source drug is, determined in accordance with subsection (e)(2), among the 50 qualifying single source drugs with the highest total expenditures under part B of title XVIII, as determined by the Secretary in accordance with paragraph (3), during such most recent 12-month period, as described in subparagraph (A).

"(2) EXCEPTION FOR SMALL BIOTECH DRUGS.—

"(A) IN GENERAL.—Subject to subparagraph (C), the term 'negotiation-eligible drug' shall not include, with respect to the initial price applicability years 2026, 2027, and 2028, a qualifying single source drug that meets either of the following:

"(i) PART D DRUGS.—The total expenditures for the qualifying single source drug under part D of title XVIII, as determined by the Secretary in accordance with paragraph (3)(B), during 2021—

"(I) are equal to or less than 1 percent of the total expenditures under such part D, as so determined, for all covered part D drugs (as defined in section 1860D–2(e)) during such year; and

"(II) are equal to at least 80 percent of the total expenditures under such part D, as so determined, for all covered part D drugs for which the manufacturer of the drug has an agreement in effect under section 1860D–14A during such year.

"(ii) PART B DRUGS.—The total expenditures for the qualifying single source drug under part B of title XVIII, as determined by the Secretary in accordance with paragraph (3)(B), during 2021—

"(I) are equal to or less than 1 percent of the total expenditures under such part B, as so determined, for all qualifying single source drugs for which payment may be made under such part B during such year; and

"(II) are equal to at least 80 percent of the total expenditures under such part B, as so determined, for all qualifying single source drugs of the manufacturer for which payment may be made under such part B during such year.

"(B) CLARIFICATIONS RELATING TO MANUFACTURERS.—

"(i) AGGREGATION RULE.—All persons treated as a single employer under subsection (a) or (b) of section 52 of the Internal Revenue Code of 1986 shall be treated as one manufacturer for purposes of this paragraph.

Effective dates.

"(ii) LIMITATION.—A drug shall not be considered to be a qualifying single source drug described in clause (i) or (ii) of subparagraph (A) if the manufacturer of such drug is acquired after 2021 by another manufacturer that does not meet the definition of a specified manufacturer under section 1860D–14C(g)(4)(B)(ii), effective at the beginning of the plan year immediately following such acquisition or, in the case of an acquisition before 2025, effective January 1, 2025.

"(C) DRUGS NOT INCLUDED AS SMALL BIOTECH DRUGS.—A new formulation, such as an extended release formulation, of a qualifying single source drug shall not be considered a qualifying single source drug described in subparagraph (A).

"(3) CLARIFICATIONS AND DETERMINATIONS.—

"(A) PREVIOUSLY SELECTED DRUGS AND SMALL BIOTECH DRUGS EXCLUDED.—In applying subparagraphs (A) and (B) of paragraph (1), the Secretary shall not consider or count—

"(i) drugs that are already selected drugs; and

"(ii) for initial price applicability years 2026, 2027, and 2028, qualifying single source drugs described in paragraph (2)(A).

"(B) USE OF DATA.—In determining whether a qualifying single source drug satisfies any of the criteria described in paragraph (1) or (2), the Secretary shall use data that is aggregated across dosage forms and strengths of the drug, including new formulations of the drug, such as an extended release formulation, and not based on the specific formulation or package size or package type of the drug.

"(e) QUALIFYING SINGLE SOURCE DRUG.—

"(1) IN GENERAL.—For purposes of this part, the term 'qualifying single source drug' means, with respect to an initial price applicability year, subject to paragraphs (2) and (3), a covered part D drug (as defined in section 1860D–2(e)) that is described in any of the following or a drug or biological product for which payment may be made under part B of title XVIII that is described in any of the following: Definition.

"(A) DRUG PRODUCTS.—A drug— Time periods.

"(i) that is approved under section 505(c) of the Federal Food, Drug, and Cosmetic Act and is marketed pursuant to such approval;

"(ii) for which, as of the selected drug publication date with respect to such initial price applicability year, at least 7 years will have elapsed since the date of such approval; and

"(iii) that is not the listed drug for any drug that is approved and marketed under section 505(j) of such Act.

"(B) BIOLOGICAL PRODUCTS.—A biological product—

"(i) that is licensed under section 351(a) of the Public Health Service Act and is marketed under section 351 of such Act;

"(ii) for which, as of the selected drug publication date with respect to such initial price applicability year, at least 11 years will have elapsed since the date of such licensure; and

"(iii) that is not the reference product for any biological product that is licensed and marketed under section 351(k) of such Act.

"(2) TREATMENT OF AUTHORIZED GENERIC DRUGS.—

"(A) IN GENERAL.—In the case of a qualifying single source drug described in subparagraph (A) or (B) of paragraph (1) that is the listed drug (as such term is used in section 505(j) of the Federal Food, Drug, and Cosmetic Act) or a product described in clause (ii) of subparagraph

(B), with respect to an authorized generic drug, in applying the provisions of this part, such authorized generic drug and such listed drug or such product shall be treated as the same qualifying single source drug.

"(B) AUTHORIZED GENERIC DRUG DEFINED.—For purposes of this paragraph, the term 'authorized generic drug' means—

"(i) in the case of a drug, an authorized generic drug (as such term is defined in section 505(t)(3) of the Federal Food, Drug, and Cosmetic Act); and

"(ii) in the case of a biological product, a product that—

"(I) has been licensed under section 351(a) of such Act; and

"(II) is marketed, sold, or distributed directly or indirectly to retail class of trade under a different labeling, packaging (other than repackaging as the reference product in blister packs, unit doses, or similar packaging for use in institutions), product code, labeler code, trade name, or trade mark than the reference product.

"(3) EXCLUSIONS.—In this part, the term 'qualifying single source drug' does not include any of the following:

"(A) CERTAIN ORPHAN DRUGS.—A drug that is designated as a drug for only one rare disease or condition under section 526 of the Federal Food, Drug, and Cosmetic Act and for which the only approved indication (or indications) is for such disease or condition.

Time periods. Determination.

"(B) LOW SPEND MEDICARE DRUGS.—A drug or biological product with respect to which the total expenditures under parts B and D of title XVIII, as determined by the Secretary in accordance with subsection (d)(3)(B)—

"(i) with respect to initial price applicability year 2026, is less than, during the period beginning on June 1, 2022, and ending on May 31, 2023, $200,000,000;

"(ii) with respect to initial price applicability year 2027, is less than, during the most recent 12-month period applicable under subparagraphs (A) and (B) of subsection (d)(1) for such year, the dollar amount specified in clause (i) increased by the annual percentage increase in the consumer price index for all urban consumers (all items; United States city average) for the period beginning on June 1, 2023, and ending on September 30, 2024; or

"(iii) with respect to a subsequent initial price applicability year, is less than, during the most recent 12-month period applicable under subparagraphs (A) and (B) of subsection (d)(1) for such year, the dollar amount specified in this subparagraph for the previous initial price applicability year increased by the annual percentage increase in such consumer price index for the 12-month period ending on September 30 of the year prior to the year of the selected drug publication date with respect to such subsequent initial price applicability year.

"(C) PLASMA-DERIVED PRODUCTS.—A biological product that is derived from human whole blood or plasma.

"SEC. 1193. MANUFACTURER AGREEMENTS. 42 USC 1320f–2.

"(a) IN GENERAL.—For purposes of section 1191(a)(2), the Secretary shall enter into agreements with manufacturers of selected drugs with respect to a price applicability period, by not later than February 28 following the selected drug publication date with respect to such selected drug, under which— Deadline.

"(1) during the negotiation period for the initial price applicability year for the selected drug, the Secretary and the manufacturer, in accordance with section 1194, negotiate to determine (and, by not later than the last date of such period, agree to) a maximum fair price for such selected drug of the manufacturer in order for the manufacturer to provide access to such price— Determination. Deadline.

"(A) to maximum fair price eligible individuals who with respect to such drug are described in subparagraph (A) of section 1191(c)(2) and are dispensed such drug (and to pharmacies, mail order services, and other dispensers, with respect to such maximum fair price eligible individuals who are dispensed such drugs) during, subject to paragraph (2), the price applicability period; and

"(B) to hospitals, physicians, and other providers of services and suppliers with respect to maximum fair price eligible individuals who with respect to such drug are described in subparagraph (B) of such section and are furnished or administered such drug during, subject to paragraph (2), the price applicability period;

"(2) the Secretary and the manufacturer shall, in accordance with section 1194, renegotiate (and, by not later than the last date of the period of renegotiation, agree to) the maximum fair price for such drug, in order for the manufacturer to provide access to such maximum fair price (as so renegotiated)— Deadline.

"(A) to maximum fair price eligible individuals who with respect to such drug are described in subparagraph (A) of section 1191(c)(2) and are dispensed such drug (and to pharmacies, mail order services, and other dispensers, with respect to such maximum fair price eligible individuals who are dispensed such drugs) during any year during the price applicability period (beginning after such renegotiation) with respect to such selected drug; and

"(B) to hospitals, physicians, and other providers of services and suppliers with respect to maximum fair price eligible individuals who with respect to such drug are described in subparagraph (B) of such section and are furnished or administered such drug during any year described in subparagraph (A);

"(3) subject to subsection (d), access to the maximum fair price (including as renegotiated pursuant to paragraph (2)), with respect to such a selected drug, shall be provided by the manufacturer to—

"(A) maximum fair price eligible individuals, who with respect to such drug are described in subparagraph (A) of section 1191(c)(2), at the pharmacy, mail order service, or other dispenser at the point-of-sale of such drug (and

shall be provided by the manufacturer to the pharmacy, mail order service, or other dispenser, with respect to such maximum fair price eligible individuals who are dispensed such drugs), as described in paragraph (1)(A) or (2)(A), as applicable; and

"(B) hospitals, physicians, and other providers of services and suppliers with respect to maximum fair price eligible individuals who with respect to such drug are described in subparagraph (B) of such section and are furnished or administered such drug, as described in paragraph (1)(B) or (2)(B), as applicable;

"(4) the manufacturer submits to the Secretary, in a form and manner specified by the Secretary, for the negotiation period for the price applicability period (and, if applicable, before any period of renegotiation pursuant to section 1194(f)) with respect to such drug—

"(A) information on the non-Federal average manufacturer price (as defined in section 8126(h)(5) of title 38, United States Code) for the drug for the applicable year or period; and

Requirement.

"(B) information that the Secretary requires to carry out the negotiation (or renegotiation process) under this part; and

Compliance.
Requirements.
Determination.

"(5) the manufacturer complies with requirements determined by the Secretary to be necessary for purposes of administering the program and monitoring compliance with the program.

"(b) AGREEMENT IN EFFECT UNTIL DRUG IS NO LONGER A SELECTED DRUG.—An agreement entered into under this section shall be effective, with respect to a selected drug, until such drug is no longer considered a selected drug under section 1192(c).

Determination.

"(c) CONFIDENTIALITY OF INFORMATION.—Information submitted to the Secretary under this part by a manufacturer of a selected drug that is proprietary information of such manufacturer (as determined by the Secretary) shall be used only by the Secretary or disclosed to and used by the Comptroller General of the United States for purposes of carrying out this part.

"(d) NONDUPLICATION WITH 340B CEILING PRICE.—Under an agreement entered into under this section, the manufacturer of a selected drug—

"(1) shall not be required to provide access to the maximum fair price under subsection (a)(3), with respect to such selected drug and maximum fair price eligible individuals who are eligible to be furnished, administered, or dispensed such selected drug at a covered entity described in section 340B(a)(4) of the Public Health Service Act, to such covered entity if such selected drug is subject to an agreement described in section 340B(a)(1) of such Act and the ceiling price (defined in section 340B(a)(1) of such Act) is lower than the maximum fair price for such selected drug; and

Requirement.

"(2) shall be required to provide access to the maximum fair price to such covered entity with respect to maximum fair price eligible individuals who are eligible to be furnished, administered, or dispensed such selected drug at such entity at such ceiling price in a nonduplicated amount to the ceiling price if such maximum fair price is below the ceiling price for such selected drug.

"SEC. 1194. NEGOTIATION AND RENEGOTIATION PROCESS. 42 USC 1320f–3.

"(a) IN GENERAL.—For purposes of this part, under an agreement under section 1193 between the Secretary and a manufacturer of a selected drug (or selected drugs), with respect to the period for which such agreement is in effect and in accordance with subsections (b), (c), and (d), the Secretary and the manufacturer—

"(1) shall during the negotiation period with respect to such drug, in accordance with this section, negotiate a maximum fair price for such drug for the purpose described in section 1193(a)(1); and

"(2) renegotiate, in accordance with the process specified pursuant to subsection (f), such maximum fair price for such drug for the purpose described in section 1193(a)(2) if such drug is a renegotiation-eligible drug under such subsection.

"(b) NEGOTIATION PROCESS REQUIREMENTS.—

"(1) METHODOLOGY AND PROCESS.—The Secretary shall develop and use a consistent methodology and process, in accordance with paragraph (2), for negotiations under subsection (a) that aims to achieve the lowest maximum fair price for each selected drug.

"(2) SPECIFIC ELEMENTS OF NEGOTIATION PROCESS.—As part of the negotiation process under this section, with respect to a selected drug and the negotiation period with respect to the initial price applicability year with respect to such drug, the following shall apply: Applicability. Deadlines.

"(A) SUBMISSION OF INFORMATION.—Not later than March 1 of the year of the selected drug publication date, with respect to the selected drug, the manufacturer of the drug shall submit to the Secretary, in accordance with section 1193(a)(4), the information described in such section.

"(B) INITIAL OFFER BY SECRETARY.—Not later than the June 1 following the selected drug publication date, the Secretary shall provide the manufacturer of the selected drug with a written initial offer that contains the Secretary's proposal for the maximum fair price of the drug and a concise justification based on the factors described in section 1194(e) that were used in developing such offer. Proposal.

"(C) RESPONSE TO INITIAL OFFER.— Proposal.

"(i) IN GENERAL.—Not later than 30 days after the date of receipt of an initial offer under subparagraph (B), the manufacturer shall either accept such offer or propose a counteroffer to such offer.

"(ii) COUNTEROFFER REQUIREMENTS.—If a manufacturer proposes a counteroffer, such counteroffer—

"(I) shall be in writing; and

"(II) shall be justified based on the factors described in subsection (e).

"(D) RESPONSE TO COUNTEROFFER.—After receiving a counteroffer under subparagraph (C), the Secretary shall respond in writing to such counteroffer.

"(E) DEADLINE.—All negotiations between the Secretary and the manufacturer of the selected drug shall end prior to the first day of November following the selected drug publication date, with respect to the initial price applicability year.

"(F) LIMITATIONS ON OFFER AMOUNT.—In negotiating the maximum fair price of a selected drug, with respect to the initial price applicability year for the selected drug, and, as applicable, in renegotiating the maximum fair price for such drug, with respect to a subsequent year during the price applicability period for such drug, the Secretary shall not offer (or agree to a counteroffer for) a maximum fair price for the selected drug that—

"(i) exceeds the ceiling determined under subsection (c) for the selected drug and year; or

"(ii) as applicable, is less than the floor determined under subsection (d) for the selected drug and year.

"(c) CEILING FOR MAXIMUM FAIR PRICE.—

"(1) GENERAL CEILING.—

"(A) IN GENERAL.—The maximum fair price negotiated under this section for a selected drug, with respect to the first initial price applicability year of the price applicability period with respect to such drug, shall not exceed the lower of the amount under subparagraph (B) or the amount under subparagraph (C).

"(B) SUBPARAGRAPH (B) AMOUNT.—An amount equal to the following:

"(i) COVERED PART D DRUG.—In the case of a covered part D drug (as defined in section 1860D–2(e)), the sum of the plan specific enrollment weighted amounts for each prescription drug plan or MA–PD plan (as determined under paragraph (2)).

"(ii) PART B DRUG OR BIOLOGICAL.—In the case of a drug or biological product for which payment may be made under part B of title XVIII, the payment amount under section 1847A(b)(4) for the drug or biological product for the year prior to the year of the selected drug publication date with respect to the initial price applicability year for the drug or biological product.

"(C) SUBPARAGRAPH (C) AMOUNT.—An amount equal to the applicable percent described in paragraph (3), with respect to such drug, of the following:

"(i) INITIAL PRICE APPLICABILITY YEAR 2026.—In the case of a selected drug with respect to which such initial price applicability year is 2026, the average non-Federal average manufacturer price for such drug for 2021 (or, in the case that there is not an average non-Federal average manufacturer price available for such drug for 2021, for the first full year following the market entry for such drug), increased by the percentage increase in the consumer price index for all urban consumers (all items; United States city average) from September 2021 (or December of such first full year following the market entry), as applicable, to September of the year prior to the year of the selected drug publication date with respect to such initial price applicability year.

"(ii) INITIAL PRICE APPLICABILITY YEAR 2027 AND SUBSEQUENT YEARS.—In the case of a selected drug with respect to which such initial price applicability year is 2027 or a subsequent year, the lower of—

"(I) the average non-Federal average manufacturer price for such drug for 2021 (or, in the case that there is not an average non-Federal average manufacturer price available for such drug for 2021, for the first full year following the market entry for such drug), increased by the percentage increase in the consumer price index for all urban consumers (all items; United States city average) from September 2021 (or December of such first full year following the market entry), as applicable, to September of the year prior to the year of the selected drug publication date with respect to such initial price applicability year; or

"(II) the average non-Federal average manufacturer price for such drug for the year prior to the selected drug publication date with respect to such initial price applicability year.

"(2) PLAN SPECIFIC ENROLLMENT WEIGHTED AMOUNT.—For purposes of paragraph (1)(B)(i), the plan specific enrollment weighted amount for a prescription drug plan or an MA–PD plan with respect to a covered Part D drug is an amount equal to the product of—

"(A) the negotiated price of the drug under such plan under part D of title XVIII, net of all price concessions received by such plan or pharmacy benefit managers on behalf of such plan, for the most recent year for which data is available; and

"(B) a fraction—

"(i) the numerator of which is the total number of individuals enrolled in such plan in such year; and

"(ii) the denominator of which is the total number of individuals enrolled in a prescription drug plan or an MA–PD plan in such year.

"(3) APPLICABLE PERCENT DESCRIBED.—For purposes of this subsection, the applicable percent described in this paragraph is the following:

"(A) SHORT-MONOPOLY DRUGS AND VACCINES.—With respect to a selected drug (other than an extended-monopoly drug and a long-monopoly drug), 75 percent.

"(B) EXTENDED-MONOPOLY DRUGS.—With respect to an extended-monopoly drug, 65 percent.

"(C) LONG-MONOPOLY DRUGS.—With respect to a long-monopoly drug, 40 percent.

"(4) EXTENDED-MONOPOLY DRUG DEFINED.—

"(A) IN GENERAL.—In this part, subject to subparagraph (B), the term 'extended-monopoly drug' means, with respect to an initial price applicability year, a selected drug for which at least 12 years, but fewer than 16 years, have elapsed since the date of approval of such drug under section 505(c) of the Federal Food, Drug, and Cosmetic Act or since the date of licensure of such drug under section 351(a) of the Public Health Service Act, as applicable. Time period.

"(B) EXCLUSIONS.—The term 'extended-monopoly drug' shall not include any of the following:

"(i) A vaccine that is licensed under section 351 of the Public Health Service Act and marketed pursuant to such section.

"(ii) A selected drug for which a manufacturer had an agreement under this part with the Secretary with respect to an initial price applicability year that is before 2030.

"(C) CLARIFICATION.—Nothing in subparagraph (B)(ii) shall limit the transition of a selected drug described in paragraph (3)(A) to a long-monopoly drug if the selected drug meets the definition of a long-monopoly drug.

"(5) LONG-MONOPOLY DRUG DEFINED.—

Time period.

"(A) IN GENERAL.—In this part, subject to subparagraph (B), the term 'long-monopoly drug' means, with respect to an initial price applicability year, a selected drug for which at least 16 years have elapsed since the date of approval of such drug under section 505(c) of the Federal Food, Drug, and Cosmetic Act or since the date of licensure of such drug under section 351(a) of the Public Health Service Act, as applicable.

"(B) EXCLUSION.—The term 'long-monopoly drug' shall not include a vaccine that is licensed under section 351 of the Public Health Service Act and marketed pursuant to such section.

Time period.

"(6) AVERAGE NON-FEDERAL AVERAGE MANUFACTURER PRICE.—In this part, the term 'average non-Federal average manufacturer price' means the average of the non-Federal average manufacturer price (as defined in section 8126(h)(5) of title 38, United States Code) for the 4 calendar quarters of the year involved.

Time periods.

"(d) TEMPORARY FLOOR FOR SMALL BIOTECH DRUGS.—In the case of a selected drug that is a qualifying single source drug described in section 1192(d)(2) and with respect to which the first initial price applicability year of the price applicability period with respect to such drug is 2029 or 2030, the maximum fair price negotiated under this section for such drug for such initial price applicability year may not be less than 66 percent of the average non-Federal average manufacturer price for such drug (as defined in subsection (c)(6)) for 2021 (or, in the case that there is not an average non-Federal average manufacturer price available for such drug for 2021, for the first full year following the market entry for such drug), increased by the percentage increase in the consumer price index for all urban consumers (all items; United States city average) from September 2021 (or December of such first full year following the market entry), as applicable, to September of the year prior to the selected drug publication date with respect to the initial price applicability year.

"(e) FACTORS.—For purposes of negotiating the maximum fair price of a selected drug under this part with the manufacturer of the drug, the Secretary shall consider the following factors, as applicable to the drug, as the basis for determining the offers and counteroffers under subsection (b) for the drug:

"(1) MANUFACTURER-SPECIFIC DATA.—The following data, with respect to such selected drug, as submitted by the manufacturer:

"(A) Research and development costs of the manufacturer for the drug and the extent to which the manufacturer has recouped research and development costs.

"(B) Current unit costs of production and distribution of the drug.

"(C) Prior Federal financial support for novel therapeutic discovery and development with respect to the drug.

"(D) Data on pending and approved patent applications, exclusivities recognized by the Food and Drug Administration, and applications and approvals under section 505(c) of the Federal Food, Drug, and Cosmetic Act or section 351(a) of the Public Health Service Act for the drug.

"(E) Market data and revenue and sales volume data for the drug in the United States.

"(2) EVIDENCE ABOUT ALTERNATIVE TREATMENTS.—The following evidence, as available, with respect to such selected drug and therapeutic alternatives to such drug:

"(A) The extent to which such drug represents a therapeutic advance as compared to existing therapeutic alternatives and the costs of such existing therapeutic alternatives.

"(B) Prescribing information approved by the Food and Drug Administration for such drug and therapeutic alternatives to such drug.

"(C) Comparative effectiveness of such drug and therapeutic alternatives to such drug, taking into consideration the effects of such drug and therapeutic alternatives to such drug on specific populations, such as individuals with disabilities, the elderly, the terminally ill, children, and other patient populations.

"(D) The extent to which such drug and therapeutic alternatives to such drug address unmet medical needs for a condition for which treatment or diagnosis is not addressed adequately by available therapy.

In using evidence described in subparagraph (C), the Secretary shall not use evidence from comparative clinical effectiveness research in a manner that treats extending the life of an elderly, disabled, or terminally ill individual as of lower value than extending the life of an individual who is younger, nondisabled, or not terminally ill.

"(f) RENEGOTIATION PROCESS.—

"(1) IN GENERAL.—In the case of a renegotiation-eligible drug (as defined in paragraph (2)) that is selected under paragraph (3), the Secretary shall provide for a process of renegotiation (for years (beginning with 2028) during the price applicability period, with respect to such drug) of the maximum fair price for such drug consistent with paragraph (4). Effective date.

"(2) RENEGOTIATION-ELIGIBLE DRUG DEFINED.—In this section, the term 'renegotiation-eligible drug' means a selected drug that is any of the following:

"(A) ADDITION OF NEW INDICATION.—A selected drug for which a new indication is added to the drug.

"(B) CHANGE OF STATUS TO AN EXTENDED-MONOPOLY DRUG.—A selected drug that—

"(i) is not an extended-monopoly or a long-monopoly drug; and

"(ii) for which there is a change in status to that of an extended-monopoly drug.

"(C) CHANGE OF STATUS TO A LONG-MONOPOLY DRUG.—A selected drug that—

"(i) is not a long-monopoly drug; and

"(ii) for which there is a change in status to that of a long-monopoly drug.

Determination.

"(D) MATERIAL CHANGES.—A selected drug for which the Secretary determines there has been a material change of any of the factors described in paragraph (1) or (2) of subsection (e).

Effective date.

"(3) SELECTION OF DRUGS FOR RENEGOTIATION.—For each year (beginning with 2028), the Secretary shall select among renegotiation-eligible drugs for renegotiation as follows:

"(A) ALL EXTENDED-MONOPOLY NEGOTIATION-ELIGIBLE DRUGS.—The Secretary shall select all renegotiation-eligible drugs described in paragraph (2)(B).

"(B) ALL LONG-MONOPOLY NEGOTIATION-ELIGIBLE DRUGS.—The Secretary shall select all renegotiation-eligible drugs described in paragraph (2)(C).

"(C) REMAINING DRUGS.—Among the remaining renegotiation-eligible drugs described in subparagraphs (A) and (D) of paragraph (2), the Secretary shall select renegotiation-eligible drugs for which the Secretary expects renegotiation is likely to result in a significant change in the maximum fair price otherwise negotiated.

"(4) RENEGOTIATION PROCESS.—

"(A) IN GENERAL.—The Secretary shall specify the process for renegotiation of maximum fair prices with the manufacturer of a renegotiation-eligible drug selected for renegotiation under this subsection.

"(B) CONSISTENT WITH NEGOTIATION PROCESS.—The process specified under subparagraph (A) shall, to the extent practicable, be consistent with the methodology and process established under subsection (b) and in accordance with subsections (c), (d), and (e), and for purposes of applying subsections (c)(1)(A) and (d), the reference to the first initial price applicability year of the price applicability period with respect to such drug shall be treated as the first initial price applicability year of such period for which the maximum fair price established pursuant to such renegotiation applies, including for applying subsection (c)(3)(B) in the case of renegotiation-eligible drugs described in paragraph (3)(A) of this subsection and subsection (c)(3)(C) in the case of renegotiation-eligible drugs described in paragraph (3)(B) of this subsection.

"(5) CLARIFICATION.—A renegotiation-eligible drug for which the Secretary makes a determination described in section 1192(c)(1) before or during the period of renegotiation shall not be subject to the renegotiation process under this section.

Effective date.

"(g) CLARIFICATION.—The maximum fair price for a selected drug described in subparagraph (A) or (B) of paragraph (1) shall take effect no later than the first day of the first calendar quarter that begins after the date described in subparagraph (A) or (B), as applicable.

"SEC. 1195. PUBLICATION OF MAXIMUM FAIR PRICES.

Deadlines.
Time periods.
42 USC 1320f–4.

"(a) IN GENERAL.—With respect to an initial price applicability year and a selected drug with respect to such year—

"(1) not later than November 30 of the year that is 2 years prior to such initial price applicability year, the Secretary shall publish the maximum fair price for such drug negotiated with the manufacturer of such drug under this part; and

"(2) not later than March 1 of the year prior to such initial price applicability year, the Secretary shall publish, subject to section 1193(c), the explanation for the maximum fair price with respect to the factors as applied under section 1194(e) for such drug described in paragraph (1).

"(b) UPDATES.—

"(1) SUBSEQUENT YEAR MAXIMUM FAIR PRICES.—For a selected drug, for each year subsequent to the first initial price applicability year of the price applicability period with respect to such drug, with respect to which an agreement for such drug is in effect under section 1193, not later than November 30 of the year that is 2 years prior to such subsequent year, the Secretary shall publish the maximum fair price applicable to such drug and year, which shall be—

"(A) subject to subparagraph (B), the amount equal to the maximum fair price published for such drug for the previous year, increased by the annual percentage increase in the consumer price index for all urban consumers (all items; United States city average) for the 12-month period ending with the July immediately preceding such November 30; or

"(B) in the case the maximum fair price for such drug was renegotiated, for the first year for which such price as so renegotiated applies, such renegotiated maximum fair price.

Determination.

"(2) PRICES NEGOTIATED AFTER DEADLINE.—In the case of a selected drug with respect to an initial price applicability year for which the maximum fair price is determined under this part after the date of publication under this section, the Secretary shall publish such maximum fair price by not later than 30 days after the date such maximum price is so determined.

"SEC. 1196. ADMINISTRATIVE DUTIES AND COMPLIANCE MONITORING.

42 USC 1320f–5.

"(a) ADMINISTRATIVE DUTIES.—For purposes of section 1191(a)(4), the administrative duties described in this section are the following:

"(1) The establishment of procedures to ensure that the maximum fair price for a selected drug is applied before—

"(A) any coverage or financial assistance under other health benefit plans or programs that provide coverage or financial assistance for the purchase or provision of prescription drug coverage on behalf of maximum fair price eligible individuals; and

"(B) any other discounts.

"(2) The establishment of procedures to compute and apply the maximum fair price across different strengths and dosage forms of a selected drug and not based on the specific formulation or package size or package type of such drug.

"(3) The establishment of procedures to carry out the provisions of this part, as applicable, with respect to—

"(A) maximum fair price eligible individuals who are enrolled in a prescription drug plan under part D of title XVIII or an MA–PD plan under part C of such title; and

"(B) maximum fair price eligible individuals who are enrolled under part B of such title, including who are enrolled in an MA plan under part C of such title.

"(4) The establishment of a negotiation process and renegotiation process in accordance with section 1194.

"(5) The establishment of a process for manufacturers to submit information described in section 1194(b)(2)(A).

"(6) The sharing with the Secretary of the Treasury of such information as is necessary to determine the tax imposed by section 5000D of the Internal Revenue Code of 1986, including the application of such tax to a manufacturer, producer, or importer or the determination of any date described in section 5000D(c)(1) of such Code. For purposes of the preceding sentence, such information shall include—

"(A) the date on which the Secretary receives notification of any termination of an agreement under the Medicare coverage gap discount program under section 1860D-14A and the date on which any subsequent agreement under such program is entered into;

"(B) the date on which the Secretary receives notification of any termination of an agreement under the manufacturer discount program under section 1860D-14C and the date on which any subsequent agreement under such program is entered into; and

"(C) the date on which the Secretary receives notification of any termination of a rebate agreement described in section 1927(b) and the date on which any subsequent rebate agreement described in such section is entered into.

"(7) The establishment of procedures for purposes of applying section 1192(d)(2)(B).

"(b) COMPLIANCE MONITORING.—The Secretary shall monitor compliance by a manufacturer with the terms of an agreement under section 1193 and establish a mechanism through which violations of such terms shall be reported.

42 USC 1320f–6.

"SEC. 1197. CIVIL MONETARY PENALTIES.

"(a) VIOLATIONS RELATING TO OFFERING OF MAXIMUM FAIR PRICE.—Any manufacturer of a selected drug that has entered into an agreement under section 1193, with respect to a year during the price applicability period with respect to such drug, that does not provide access to a price that is equal to or less than the maximum fair price for such drug for such year—

"(1) to a maximum fair price eligible individual who with respect to such drug is described in subparagraph (A) of section 1191(c)(2) and who is dispensed such drug during such year (and to pharmacies, mail order services, and other dispensers, with respect to such maximum fair price eligible individuals who are dispensed such drugs); or

"(2) to a hospital, physician, or other provider of services or supplier with respect to maximum fair price eligible individuals who with respect to such drug is described in subparagraph (B) of such section and is furnished or administered such drug

by such hospital, physician, or provider or supplier during such year;

shall be subject to a civil monetary penalty equal to ten times the amount equal to the product of the number of units of such drug so furnished, dispensed, or administered during such year and the difference between the price for such drug made available for such year by such manufacturer with respect to such individual or hospital, physician, provider of services, or supplier and the maximum fair price for such drug for such year.

"(b) VIOLATIONS OF CERTAIN TERMS OF AGREEMENT.—Any manufacturer of a selected drug that has entered into an agreement under section 1193, with respect to a year during the price applicability period with respect to such drug, that is in violation of a requirement imposed pursuant to section 1193(a)(5), including the requirement to submit information pursuant to section 1193(a)(4), shall be subject to a civil monetary penalty equal to $1,000,000 for each day of such violation.

"(c) FALSE INFORMATION.—Any manufacturer that knowingly provides false information pursuant to section 1196(a)(7) shall be subject to a civil monetary penalty equal to $100,000,000 for each item of such false information.

"(d) APPLICATION.—The provisions of section 1128A (other than subsections (a) and (b)) shall apply to a civil monetary penalty under this section in the same manner as such provisions apply to a penalty or proceeding under section 1128A(a).

"SEC. 1198. LIMITATION ON ADMINISTRATIVE AND JUDICIAL REVIEW. 42 USC 1320f–7.

"There shall be no administrative or judicial review of any of the following:

"(1) The determination of a unit, with respect to a drug or biological product, pursuant to section 1191(c)(6).

"(2) The selection of drugs under section 1192(b), the determination of negotiation-eligible drugs under section 1192(d), and the determination of qualifying single source drugs under section 1192(e).

"(3) The determination of a maximum fair price under subsection (b) or (f) of section 1194.

"(4) The determination of renegotiation-eligible drugs under section 1194(f)(2) and the selection of renegotiation-eligible drugs under section 1194(f)(3).".

(b) APPLICATION OF MAXIMUM FAIR PRICES AND CONFORMING AMENDMENTS.—

(1) UNDER MEDICARE.—

(A) APPLICATION TO PAYMENTS UNDER PART B.—Section 1847A(b)(1)(B) of the Social Security Act (42 U.S.C. 1395w–3a(b)(1)(B)) is amended by inserting "or in the case of such a drug or biological product that is a selected drug (as referred to in section 1192(c)), with respect to a price applicability period (as defined in section 1191(b)(2)), 106 percent of the maximum fair price (as defined in section 1191(c)(3)) applicable for such drug and a year during such period" after "paragraph (4)".

(B) APPLICATION UNDER MA OF COST-SHARING FOR PART B DRUGS BASED OFF OF NEGOTIATED PRICE.—Section 1852(a)(1)(B)(iv) of the Social Security Act (42 U.S.C. 1395w–22(a)(1)(B)(iv)) is amended—

(i) by redesignating subclause (VII) as subclause (VIII); and

(ii) by inserting after subclause (VI) the following subclause:

"(VII) A drug or biological product that is a selected drug (as referred to in section 1192(c)).".

(C) EXCEPTION TO PART D NON-INTERFERENCE.—Section 1860D–11(i) of the Social Security Act (42 U.S.C. 1395w–111(i)) is amended—

(i) in paragraph (1), by striking "and" at the end;

(ii) in paragraph (2), by striking "or institute a price structure for the reimbursement of covered part D drugs." and inserting ", except as provided under section 1860D–4(b)(3)(l); and"; and

(iii) by adding at the end the following new paragraph:

"(3) may not institute a price structure for the reimbursement of covered part D drugs, except as provided under part E of title XI.".

(D) APPLICATION AS NEGOTIATED PRICE UNDER PART D.—Section 1860D–2(d)(1) of the Social Security Act (42 U.S.C. 1395w–102(d)(1)) is amended—

(i) in subparagraph (B), by inserting ", subject to subparagraph (D)," after "negotiated prices"; and

(ii) by adding at the end the following new subparagraph:

"(D) APPLICATION OF MAXIMUM FAIR PRICE FOR SELECTED DRUGS.—In applying this section, in the case of a covered part D drug that is a selected drug (as referred to in section 1192(c)), with respect to a price applicability period (as defined in section 1191(b)(2)), the negotiated prices used for payment (as described in this subsection) shall be no greater than the maximum fair price (as defined in section 1191(c)(3)) for such drug and for each year during such period plus any dispensing fees for such drug.".

(E) COVERAGE OF SELECTED DRUGS.—Section 1860D–4(b)(3) of the Social Security Act (42 U.S.C. 1395w–104(b)(3)) is amended by adding at the end the following new subparagraph:

"(I) REQUIRED INCLUSION OF SELECTED DRUGS.—

Time periods.

"(i) IN GENERAL.—For 2026 and each subsequent year, the PDP sponsor offering a prescription drug plan shall include each covered part D drug that is a selected drug under section 1192 for which a maximum fair price (as defined in section 1191(c)(3)) is in effect with respect to the year.

"(ii) CLARIFICATION.—Nothing in clause (i) shall be construed as prohibiting a PDP sponsor from removing such a selected drug from a formulary if such removal would be permitted under section 423.120(b)(5)(iv) of title 42, Code of Federal Regulations (or any successor regulation).".

(F) INFORMATION FROM PRESCRIPTION DRUG PLANS AND MA–PD PLANS REQUIRED.—

(i) PRESCRIPTION DRUG PLANS.—Section 1860D–12(b) of the Social Security Act (42 U.S.C. 1395w–

112(b)) is amended by adding at the end the following new paragraph:

"(8) PROVISION OF INFORMATION RELATED TO MAXIMUM FAIR PRICES.—Each contract entered into with a PDP sponsor under this part with respect to a prescription drug plan offered by such sponsor shall require the sponsor to provide information to the Secretary as requested by the Secretary for purposes of carrying out section 1194.". Contracts. Requirement.

(ii) MA–PD PLANS.—Section 1857(f)(3) of the Social Security Act (42 U.S.C. 1395w–27(f)(3)) is amended by adding at the end the following new subparagraph:

"(E) PROVISION OF INFORMATION RELATED TO MAXIMUM FAIR PRICES.—Section 1860D–12(b)(8).".

(G) CONDITIONS FOR COVERAGE.—

(i) MEDICARE PART D.—Section 1860D–43(c) of the Social Security Act (42 U.S.C. 1395w–153(c)) is amended—

(I) by redesignating paragraphs (1) and (2) as subparagraphs (A) and (B), respectively;

(II) by striking "AGREEMENTS.—Subsection" and inserting the following: "AGREEMENTS.—

"(1) IN GENERAL.—Subject to paragraph (2), subsection"; and

(III) by adding at the end the following new paragraph:

"(2) EXCEPTION.—Paragraph (1)(A) shall not apply to a covered part D drug of a manufacturer for any period described in section 5000D(c)(1) of the Internal Revenue Code of 1986 with respect to the manufacturer.".

(ii) MEDICAID AND MEDICARE PART B.—Section 1927(a)(3) of the Social Security Act (42 U.S.C. 1396r–8(a)(3)) is amended by adding at the end the following new sentence: "The preceding sentence shall not apply to a single source drug or innovator multiple source drug of a manufacturer for any period described in section 5000D(c)(1) of the Internal Revenue Code of 1986 with respect to the manufacturer.".

(H) DISCLOSURE OF INFORMATION UNDER MEDICARE PART D.—

(i) CONTRACT REQUIREMENTS.—Section 1860D–12(b)(3)(D)(i) of the Social Security Act (42 U.S.C. 1395w–112(b)(3)(D)(i)) is amended by inserting ", or carrying out part E of title XI" after "appropriate)".

(ii) SUBSIDIES.—Section 1860D–15(f)(2)(A)(i) of the Social Security Act (42 U.S.C. 1395w–115(f)(2)(A)(i)) is amended by inserting "or part E of title XI" after "this section".

(2) DRUG PRICE NEGOTIATION PROGRAM PRICES INCLUDED IN BEST PRICE.—Section 1927(c)(1)(C) of the Social Security Act (42 U.S.C. 1396r–8(c)(1)(C)) is amended—

(A) in clause (i)(VI), by striking "any prices charged" and inserting "subject to clause (ii)(V), any prices charged"; and

(B) in clause (ii)—

(i) in subclause (III), by striking "; and" at the end;

(ii) in subclause (IV), by striking the period at the end and inserting "; and"; and

(iii) by adding at the end the following new subclause:

"(V) in the case of a rebate period and a covered outpatient drug that is a selected drug (as referred to in section 1192(c)) during such rebate period, shall be inclusive of the maximum fair price (as defined in section 1191(c)(3)) for such drug with respect to such period.".

(3) MAXIMUM FAIR PRICES EXCLUDED FROM AVERAGE MANUFACTURER PRICE.—Section 1927(k)(1)(B)(i) of the Social Security Act (42 U.S.C. 1396r–8(k)(1)(B)(i)) is amended—

(A) in subclause (IV) by striking "; and" at the end;

(B) in subclause (V) by striking the period at the end and inserting "; and"; and

(C) by adding at the end the following new subclause:

"(VI) any reduction in price paid during the rebate period to the manufacturer for a drug by reason of application of part E of title XI.".

42 USC 1320f note.

(c) IMPLEMENTATION FOR 2026 THROUGH 2028.—The Secretary of Health and Human Services shall implement this section, including the amendments made by this section, for 2026, 2027, and 2028 by program instruction or other forms of program guidance.

SEC. 11002. SPECIAL RULE TO DELAY SELECTION AND NEGOTIATION OF BIOLOGICS FOR BIOSIMILAR MARKET ENTRY.

(a) IN GENERAL.—Part E of title XI of the Social Security Act, as added by section 11001, is amended—

42 USC 1320f–1.

(1) in section 1192—

(A) in subsection (a), in the flush matter following paragraph (4), by inserting "and subsection (b)(3)" after "the previous sentence";

(B) in subsection (b)—

(i) in paragraph (1), by adding at the end the following new subparagraph:

"(C) In the case of a biological product for which the inclusion of the biological product as a selected drug on a list published under subsection (a) has been delayed under subsection (f)(2), remove such biological product from the rankings under subparagraph (A) before making the selections under subparagraph (B).."; and

(ii) by adding at the end the following new paragraph:

"(3) INCLUSION OF DELAYED BIOLOGICAL PRODUCTS.—Pursuant to subparagraphs (B)(ii)(I) and (C)(i) of subsection (f)(2), the Secretary shall select and include on the list published under subsection (a) the biological products described in such subparagraphs. Such biological products shall count towards the required number of drugs to be selected under subsection (a)(1).."; and

(C) by adding at the end the following new subsection:

"(f) SPECIAL RULE TO DELAY SELECTION AND NEGOTIATION OF BIOLOGICS FOR BIOSIMILAR MARKET ENTRY.—

"(1) APPLICATION.—

"(A) IN GENERAL.—Subject to subparagraph (B), in the case of a biological product that would (but for this subsection) be an extended-monopoly drug (as defined in section 1194(c)(4)) included as a selected drug on the list published under subsection (a) with respect to an initial price applicability year, the rules described in paragraph (2) shall apply if the Secretary determines that there is a high likelihood (as described in paragraph (3)) that a biosimilar biological product (for which such biological product will be the reference product) will be licensed and marketed under section 351(k) of the Public Health Service Act before the date that is 2 years after the selected drug publication date with respect to such initial price applicability year. Determination. Time period.

"(B) REQUEST REQUIRED.—

"(i) IN GENERAL.—The Secretary shall not provide for a delay under—

"(I) paragraph (2)(A) unless a request is made for such a delay by a manufacturer of a biosimilar biological product prior to the selected drug publication date for the list published under subsection (a) with respect to the initial price applicability year for which the biological product may have been included as a selected drug on such list but for subparagraph (2)(A); or

"(II) paragraph (2)(B)(iii) unless a request is made for such a delay by such a manufacturer prior to the selected drug publication date for the list published under subsection (a) with respect to the initial price applicability year that is 1 year after the initial price applicability year for which the biological product described in subsection (a) would have been included as a selected drug on such list but for paragraph (2)(A). Time period.

"(ii) INFORMATION AND DOCUMENTS.—

"(I) IN GENERAL.—A request made under clause (i) shall be submitted to the Secretary by such manufacturer at a time and in a form and manner specified by the Secretary, and contain—

"(aa) information and documents necessary for the Secretary to make determinations under this subsection, as specified by the Secretary and including, to the extent available, items described in subclause (III); and

"(bb) all agreements related to the biosimilar biological product filed with the Federal Trade Commission or the Assistant Attorney General pursuant to subsections (a) and (c) of section 1112 of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003.

"(II) ADDITIONAL INFORMATION AND DOCUMENTS.—After the Secretary has reviewed the request and materials submitted under subclause (I), the manufacturer shall submit any additional

information and documents requested by the Secretary necessary to make determinations under this subsection.

"(III) ITEMS DESCRIBED.—The items described in this clause are the following:

"(aa) The manufacturing schedule for such biosimilar biological product submitted to the Food and Drug Administration during its review of the application under such section 351(k).

Time period.

"(bb) Disclosures (in filings by the manufacturer of such biosimilar biological product with the Securities and Exchange Commission required under section 12(b), 12(g), 13(a), or 15(d) of the Securities Exchange Act of 1934 about capital investment, revenue expectations, and actions taken by the manufacturer that are typical of the normal course of business in the year (or the 2 years, as applicable) before marketing of a biosimilar biological product) that pertain to the marketing of such biosimilar biological product, or comparable documentation that is distributed to the shareholders of privately held companies.

"(C) AGGREGATION RULE.—

"(i) IN GENERAL.—All persons treated as a single employer under subsection (a) or (b) of section 52 of the Internal Revenue Code of 1986, or in a partnership, shall be treated as one manufacturer for purposes of paragraph (2)(D)(iv).

"(ii) PARTNERSHIP DEFINED.—In clause (i), the term 'partnership' means a syndicate, group, pool, joint venture, or other organization through or by means of which any business, financial operation, or venture is carried on by the manufacturer of the biological product and the manufacturer of the biosimilar biological product.

Time periods. Determination.

"(2) RULES DESCRIBED.—The rules described in this paragraph are the following:

"(A) DELAYED SELECTION AND NEGOTIATION FOR 1 YEAR.—If a determination of high likelihood is made under paragraph (3), the Secretary shall delay the inclusion of the biological product as a selected drug on the list published under subsection (a) until such list is published with respect to the initial price applicability year that is 1 year after the initial price applicability year for which the biological product would have been included as a selected drug on such list.

"(B) IF NOT LICENSED AND MARKETED DURING THE INITIAL DELAY.—

"(i) IN GENERAL.—If, during the time period between the selected drug publication date on which the biological product would have been included on the list as a selected drug pursuant to subsection (a) but for subparagraph (A) and the selected drug publication date with respect to the initial price applicability year that is 1 year after the initial price applicability

year for which such biological product would have been included as a selected drug on such list, the Secretary determines that the biosimilar biological product for which the manufacturer submitted the request under paragraph (1)(B)(i)(II) (and for which the Secretary previously made a high likelihood determination under paragraph (3)) has not been licensed and marketed under section 351(k) of the Public Health Service Act, the Secretary shall, at the request of such manufacturer—

"(I) reevaluate whether there is a high likelihood (as described in paragraph (3)) that such biosimilar biological product will be licensed and marketed under such section 351(k) before the date that is 2 years after the selected drug publication date for which such biological product would have been included as a selected drug on such list published but for subparagraph (A); and

"(II) evaluate whether, on the basis of clear and convincing evidence, the manufacturer of such biosimilar biological product has made a significant amount of progress (as determined by the Secretary) towards both such licensure and the marketing of such biosimilar biological product (based on information from items described in subclauses (I)(bb) and (II) of paragraph (1)(B)(ii)) since the receipt by the Secretary of the request made by such manufacturer under paragraph (1)(B)(i)(I). Evaluation.

"(ii) SELECTION AND NEGOTIATION.—If the Secretary determines that there is not a high likelihood that such biosimilar biological product will be licensed and marketed as described in clause (i)(I) or there has not been a significant amount of progress as described in clause (i)(II)—

"(I) the Secretary shall include the biological product as a selected drug on the list published under subsection (a) with respect to the initial price applicability year that is 1 year after the initial price applicability year for which such biological product would have been included as a selected drug on such list but for subparagraph (A); and

"(II) the manufacturer of such biological product shall pay a rebate under paragraph (4) with respect to the year for which such manufacturer would have provided access to a maximum fair price for such biological product but for subparagraph (A).

"(iii) SECOND 1-YEAR DELAY.—If the Secretary determines that there is a high likelihood that such biosimilar biological product will be licensed and marketed (as described in clause (i)(I)) and a significant amount of progress has been made by the manufacturer of such biosimilar biological product towards such licensure and marketing (as described in clause (i)(II)), the Secretary shall delay the inclusion of the biological product as a selected drug on the list published under

subsection (a) until the selected drug publication date of such list with respect to the initial price applicability year that is 2 years after the initial price applicability year for which such biological product would have been included as a selected drug on such list but for this subsection.

"(C) IF NOT LICENSED AND MARKETED DURING THE YEAR TWO DELAY.—If, during the time period between the selected drug publication date of the list for which the biological product would have been included as a selected drug but for subparagraph (B)(iii) and the selected drug publication date with respect to the initial price applicability year that is 2 years after the initial price applicability year for which such biological product would have been included as a selected drug on such list but for this subsection, the Secretary determines that such biosimilar biological product has not been licensed and marketed—

"(i) the Secretary shall include such biological product as a selected drug on such list with respect to the initial price applicability year that is 2 years after the initial price applicability year for which such biological product would have been included as a selected drug on such list; and

"(ii) the manufacturer of such biological product shall pay a rebate under paragraph (4) with respect to the years for which such manufacturer would have provided access to a maximum fair price for such biological product but for this subsection.

"(D) LIMITATIONS ON DELAYS.—

"(i) LIMITED TO 2 YEARS.—In no case shall the Secretary delay the inclusion of a biological product on the list published under subsection (a) for more than 2 years.

"(ii) EXCLUSION OF BIOLOGICAL PRODUCTS THAT TRANSITIONED TO A LONG-MONOPOLY DRUG DURING THE DELAY.—In the case of a biological product for which the inclusion on the list published pursuant to subsection (a) was delayed by 1 year under subparagraph (A) and for which there would have been a change in status to a long-monopoly drug (as defined in section 1194(c)(5)) if such biological product had been a selected drug, in no case may the Secretary provide for a second 1-year delay under subparagraph (B)(iii).

"(iii) EXCLUSION OF BIOLOGICAL PRODUCTS IF MORE THAN 1 YEAR SINCE LICENSURE.—In no case shall the Secretary delay the inclusion of a biological product on the list published under subsection (a) if more than 1 year has elapsed since the biosimilar biological product has been licensed under section 351(k) of the Public Health Service Act and marketing has not commenced for such biosimilar biological product.

"(iv) CERTAIN MANUFACTURERS OF BIOSIMILAR BIOLOGICAL PRODUCTS EXCLUDED.—In no case shall the Secretary delay the inclusion of a biological product

as a selected drug on the list published under subsection (a) if Secretary determined that the manufacturer of the biosimilar biological product described in paragraph (1)(A)—

"(I) is the same as the manufacturer of the reference product described in such paragraph or is treated as being the same pursuant to paragraph (1)(C); or

"(II) has, based on information from items described in paragraph (1)(B)(ii)(I)(bb), entered into any agreement described in such paragraph with the manufacturer of the reference product described in paragraph (1)(A) that—

"(aa) requires or incentivizes the manufacturer of the biosimilar biological product to submit a request described in paragraph (1)(B); or

"(bb) restricts the quantity (either directly or indirectly) of the biosimilar biological product that may be sold in the United States over a specified period of time.

"(3) HIGH LIKELIHOOD.—For purposes of this subsection, there is a high likelihood described in paragraph (1) or paragraph (2), as applicable, if the Secretary finds that—

"(A) an application for licensure under section 351(k) of the Public Health Service Act for the biosimilar biological product has been accepted for review or approved by the Food and Drug Administration; and

"(B) information from items described in sub clauses (I)(bb) and (III) of paragraph (1)(B)(ii) submitted to the Secretary by the manufacturer requesting a delay under such paragraph provides clear and convincing evidence that such biosimilar biological product will, within the time period specified under paragraph (1)(A) or (2)(B)(i)(I), be marketed.

"(4) REBATE.—

"(A) IN GENERAL.—For purposes of subparagraphs (B)(ii)(II) and (C)(ii) of paragraph (2), in the case of a biological product for which the inclusion on the list under subsection (a) was delayed under this subsection and for which the Secretary has negotiated and entered into an agreement under section 1193 with respect to such biological product, the manufacturer shall be required to pay a rebate to the Secretary at such time and in such manner as determined by the Secretary.

"(B) AMOUNT.—Subject to subparagraph (C), the amount of the rebate under subparagraph (A) with respect to a biological product shall be equal to the estimated amount— Estimate.

"(i) in the case of a biological product that is a covered part D drug (as defined in section 1860D–2(e)), that is the sum of the products of—

"(I) 75 percent of the amount by which—

"(aa) the average manufacturer price, as reported by the manufacturer of such covered part D drug under section 1927 (or, if not reported by such manufacturer under section

1927, as reported by such manufacturer to the Secretary pursuant to the agreement under section 1193(a)) for such biological product, with respect to each of the calendar quarters of the price applicability period that would have applied but for this subsection; exceeds

"(bb) in the initial price applicability year that would have applied but for a delay under—

"(AA) paragraph (2)(A), the maximum fair price negotiated under section 1194 for such biological product under such agreement; or

"(BB) paragraph (2)(B)(iii), such maximum fair price, increased as described in section 1195(b)(1)(A); and

"(II) the number of units dispensed under part D of title XVIII for such covered part D drug during each such calendar quarter of such price applicability period; and

"(ii) in the case of a biological product for which payment may be made under part B of title XVIII, that is the sum of the products of—

"(I) 80 percent of the amount by which—

"(aa) the payment amount for such biological product under section 1847A(b), with respect to each of the calendar quarters of the price applicability period that would have applied but for this subsection; exceeds

"(bb) in the initial price applicability year that would have applied but for a delay under—

"(AA) paragraph (2)(A), the maximum fair price negotiated under section 1194 for such biological product under such agreement; or

"(BB) paragraph (2)(B)(iii), such maximum fair price, increased as described in section 1195(b)(1)(A); and

"(II) the number of units (excluding units that are packaged into the payment amount for an item or service and are not separately payable under such part B) of the billing and payment code of such biological product administered or furnished under such part B during each such calendar quarter of such price applicability period.

"(C) SPECIAL RULE FOR DELAYED BIOLOGICAL PRODUCTS THAT ARE LONG-MONOPOLY DRUGS.—

Determination.

"(i) IN GENERAL.—In the case of a biological product with respect to which a rebate is required to be paid under this paragraph, if such biological product qualifies as a long-monopoly drug (as defined in section 1194(c)(5)) at the time of its inclusion on the list published under subsection (a), in determining the amount of the rebate for such biological product under subparagraph (B), the amount described in clause (ii) shall

be substituted for the maximum fair price described in clause (i)(I) or (ii)(I) of such subparagraph (B), as applicable.

"(ii) AMOUNT DESCRIBED.—The amount described in this clause is an amount equal to 65 percent of the average non-Federal average manufacturer price for the biological product for 2021 (or, in the case that there is not an average non-Federal average manufacturer price available for such biological product for 2021, for the first full year following the market entry for such biological product), increased by the percentage increase in the consumer price index for all urban consumers (all items; United States city average) from September 2021 (or December of such first full year following the market entry), as applicable, to September of the year prior to the selected drug publication date with respect to the initial price applicability year that would have applied but for this subsection. Time periods.

"(D) REBATE DEPOSITS.—Amounts paid as rebates under this paragraph shall be deposited into—

"(i) in the case payment is made for such biological product under part B of title XVIII, the Federal Supplementary Medical Insurance Trust Fund established under section 1841; and

"(ii) in the case such biological product is a covered part D drug (as defined in section 1860D–2(e)), the Medicare Prescription Drug Account under section 1860D–16 in such Trust Fund.

"(5) DEFINITIONS OF BIOSIMILAR BIOLOGICAL PRODUCT.—In this subsection, the term 'biosimilar biological product' has the meaning given such term in section 1847A(c)(6).";

(2) in section 1193(a)(4)— 42 USC 1320f–2.

(A) in the matter preceding subparagraph (A), by inserting ", and for section 1192(f)," after "section 1194(f))";

(B) in subparagraph (A), by striking "and" at the end;

(C) by adding at the end the following new subparagraph:

"(C) information that the Secretary requires to carry out section 1192(f), including rebates under paragraph (4) of such section; and";

(3) in section 1196(a)(7), by striking "section 1192(d)(2)(B)" and inserting "subsections (d)(2)(B) and (f)(1)(C) of section 1192"; 42 USC 1320f–5.

(4) in section 1197— 42 USC 1320f–6.

(A) by redesignating subsections (b), (c), and (d) as subsections (c), (d), and (e), respectively; and

(B) by inserting after subsection (a) the following new subsection:

"(b) VIOLATIONS RELATING TO PROVIDING REBATES.—Any manufacturer that fails to comply with the rebate requirements under section 1192(f)(4) shall be subject to a civil monetary penalty equal to 10 times the amount of the rebate the manufacturer failed to pay under such section."; and Penalties.

(5) in section 1198(b)(2), by inserting "the application of section 1192(f)," after "section 1192(e)". 42 USC 1320f–7.

(b) CONFORMING AMENDMENTS FOR DISCLOSURE OF CERTAIN INFORMATION.—Section 1927(b)(3)(D)(i) of the Social Security Act (42 U.S.C. 1396r–8(b)(3)(D)(i)) is amended by striking "or to carry out section 1847B" and inserting "or to carry out section 1847B or section 1192(f), including rebates under paragraph (4) of such section".

42 USC 1320f–1 note.

(c) IMPLEMENTATION FOR 2026 THROUGH 2028.—The Secretary of Health and Human Services shall implement this section, including the amendments made by this section, for 2026, 2027, and 2028 by program instruction or other forms of program guidance.

SEC. 11003. EXCISE TAX IMPOSED ON DRUG MANUFACTURERS DURING NONCOMPLIANCE PERIODS.

(a) IN GENERAL.—Subtitle D of the Internal Revenue Code of 1986 is amended by adding at the end the following new chapter:

26 USC 5000D prec.

"CHAPTER 50A—DESIGNATED DRUGS

"Sec. 5000D. Designated drugs during noncompliance periods.

26 USC 5000D.

"SEC. 5000D. DESIGNATED DRUGS DURING NONCOMPLIANCE PERIODS.

"(a) IN GENERAL.—There is hereby imposed on the sale by the manufacturer, producer, or importer of any designated drug during a day described in subsection (b) a tax in an amount such that the applicable percentage is equal to the ratio of—

"(1) such tax, divided by

"(2) the sum of such tax and the price for which so sold.

"(b) NONCOMPLIANCE PERIODS.—A day is described in this subsection with respect to a designated drug if it is a day during one of the following periods:

"(1) The period beginning on the March 1st (or, in the case of initial price applicability year 2026, the October 2nd) immediately following the date on which such drug is included on the list published under section 1192(a) of the Social Security Act and ending on the earlier of—

"(A) the first date on which the manufacturer of such designated drug has in place an agreement described in section 1193(a) of such Act with respect to such drug, or

"(B) the date that the Secretary of Health and Human Services has made a determination described in section 1192(c)(1) of such Act with respect to such designated drug.

"(2) The period beginning on the November 2nd immediately following the March 1st described in paragraph (1) (or, in the case of initial price applicability year 2026, the August 2nd immediately following the October 2nd described in such paragraph) and ending on the earlier of—

"(A) the first date on which the manufacturer of such designated drug and the Secretary of Health and Human Services have agreed to a maximum fair price under an agreement described in section 1193(a) of the Social Security Act, or

"(B) the date that the Secretary of Health and Human Services has made a determination described in section 1192(c)(1) of such Act with respect to such designated drug.

"(3) In the case of any designated drug which is a selected drug (as defined in section 1192(c) of the Social Security Act)

that the Secretary of Health and Human Services has selected for renegotiation under section 1194(f) of such Act, the period beginning on the November 2nd of the year that begins 2 years prior to the first initial price applicability year of the price applicability period for which the maximum fair price established pursuant to such renegotiation applies and ending on the earlier of—

"(A) the first date on which the manufacturer of such designated drug has agreed to a renegotiated maximum fair price under such agreement, or

"(B) the date that the Secretary of Health and Human Services has made a determination described in section 1192(c)(1) of such Act with respect to such designated drug.

"(4) With respect to information that is required to be submitted to the Secretary of Health and Human Services under an agreement described in section 1193(a) of the Social Security Act, the period beginning on the date on which such Secretary certifies that such information is overdue and ending on the date that such information is so submitted.

"(c) SUSPENSION OF TAX.— Contracts.

"(1) IN GENERAL.—A day shall not be taken into account as a day during a period described in subsection (b) if such day is also a day during the period—

"(A) beginning on the first date on which—

"(i) the notice of terminations of all applicable agreements of the manufacturer have been received by the Secretary of Health and Human Services, and Notice.

"(ii) none of the drugs of the manufacturer of the designated drug are covered by an agreement under section 1860D-14A or 1860D-14C of the Social Security Act, and

"(B) ending on the last day of February following the earlier of—

"(i) the first day after the date described in subparagraph (A) on which the manufacturer enters into any subsequent applicable agreement, or

"(ii) the first date any drug of the manufacturer of the designated drug is covered by an agreement under section 1860D-14A or 1860D-14C of the Social Security Act.

"(2) APPLICABLE AGREEMENT.—For purposes of this subsection, the term 'applicable agreement' means the following: Definition.

"(A) An agreement under—

"(i) the Medicare coverage gap discount program under section 1860D-14A of the Social Security Act, or

"(ii) the manufacturer discount program under section 1860D-14C of such Act.

"(B) A rebate agreement described in section 1927(b) of such Act.

"(d) APPLICABLE PERCENTAGE.—For purposes of this section, the term 'applicable percentage' means— Definition.

"(1) in the case of sales of a designated drug during the first 90 days described in subsection (b) with respect to such drug, 65 percent,

"(2) in the case of sales of such drug during the 91st day through the 180th day described in subsection (b) with respect to such drug, 75 percent,

"(3) in the case of sales of such drug during the 181st day through the 270th day described in subsection (b) with respect to such drug, 85 percent, and

"(4) in the case of sales of such drug during any subsequent day, 95 percent.

"(e) DEFINITIONS.—For purposes of this section—

"(1) DESIGNATED DRUG.—The term 'designated drug' means any negotiation-eligible drug (as defined in section 1192(d) of the Social Security Act) included on the list published under section 1192(a) of such Act which is manufactured or produced in the United States or entered into the United States for consumption, use, or warehousing.

"(2) UNITED STATES.—The term 'United States' has the meaning given such term by section 4612(a)(4).

"(3) OTHER TERMS.—The terms 'initial price applicability year', 'price applicability period', and 'maximum fair price' have the meaning given such terms in section 1191 of the Social Security Act.

"(f) SPECIAL RULES.—

Applicability.

"(1) COORDINATION WITH RULES FOR POSSESSIONS OF THE UNITED STATES.—Rules similar to the rules of paragraphs (2) and (4) of section 4132(c) shall apply for purposes of this section.

"(2) ANTI-ABUSE RULE.—In the case of a sale which was timed for the purpose of avoiding the tax imposed by this section, the Secretary may treat such sale as occurring during a day described in subsection (b).

Applicability.

"(g) EXPORTS.—Rules similar to the rules of section 4662(e) (other than section 4662(e)(2)(A)(ii)(II)) shall apply for purposes of this chapter.

Guidelines.

"(h) REGULATIONS.—The Secretary shall prescribe such regulations and other guidance as may be necessary to carry out this section.".

(b) NO DEDUCTION FOR EXCISE TAX PAYMENTS.—Section 275(a)(6) of the Internal Revenue Code of 1986 is amended by inserting "50A," after "46,".

26 USC 275.

(c) CLERICAL AMENDMENT.—The table of chapters for subtitle D of the Internal Revenue Code of 1986 is amended by adding at the end the following new item:

26 USC 4001 prec.

"CHAPTER 50A—DESIGNATED DRUGS".

(d) EFFECTIVE DATE.—The amendments made by this section shall apply to sales after the date of the enactment of this Act.

26 USC 5000D note.

SEC. 11004. FUNDING.

In addition to amounts otherwise available, there is appropriated to the Centers for Medicare & Medicaid Services, out of any money in the Treasury not otherwise appropriated, $3,000,000,000 for fiscal year 2022, to remain available until expended, to carry out the provisions of, including the amendments made by, this part.

PART 2—PRESCRIPTION DRUG INFLATION REBATES

SEC. 11101. MEDICARE PART B REBATE BY MANUFACTURERS.

(a) IN GENERAL.—Section 1847A of the Social Security Act (42 U.S.C. 1395w–3a) is amended by redesignating subsection (i) as subsection (j) and by inserting after subsection (h) the following subsection:

"(i) REBATE BY MANUFACTURERS FOR SINGLE SOURCE DRUGS AND BIOLOGICALS WITH PRICES INCREASING FASTER THAN INFLATION.—

"(1) REQUIREMENTS.—

Deadlines.
Effective dates.
Time periods.
Reports.

"(A) SECRETARIAL PROVISION OF INFORMATION.—Not later than 6 months after the end of each calendar quarter beginning on or after January 1, 2023, the Secretary shall, for each part B rebatable drug, report to each manufacturer of such part B rebatable drug the following for such calendar quarter:

"(i) Information on the total number of units of the billing and payment code described in subparagraph (A)(i) of paragraph (3) with respect to such drug and calendar quarter.

"(ii) Information on the amount (if any) of the excess average sales price increase described in subparagraph (A)(ii) of such paragraph for such drug and calendar quarter.

"(iii) The rebate amount specified under such paragraph for such part B rebatable drug and calendar quarter.

"(B) MANUFACTURER REQUIREMENT.—For each calendar quarter beginning on or after January 1, 2023, the manufacturer of a part B rebatable drug shall, for such drug, not later than 30 days after the date of receipt from the Secretary of the information described in subparagraph (A) for such calendar quarter, provide to the Secretary a rebate that is equal to the amount specified in paragraph (3) for such drug for such calendar quarter.

"(C) TRANSITION RULE FOR REPORTING.—The Secretary may, for each part B rebatable drug, delay the timeframe for reporting the information described in subparagraph (A) for calendar quarters beginning in 2023 and 2024 until not later than September 30, 2025.

"(2) PART B REBATABLE DRUG DEFINED.—

"(A) IN GENERAL.—In this subsection, the term 'part B rebatable drug' means a single source drug or biological (as defined in subparagraph (D) of subsection (c)(6)), including a biosimilar biological product (as defined in subparagraph (H) of such subsection) but excluding a qualifying biosimilar biological product (as defined in subsection (b)(8)(B)(iii)), for which payment is made under this part, except such term shall not include such a drug or biological—

Determination.

"(i) if, as determined by the Secretary, the average total allowed charges for such drug or biological under this part for a year per individual that uses such

a drug or biological are less than, subject to subparagraph (B), $100; or

"(ii) that is a vaccine described in subparagraph (A) or (B) of section 1861(s)(10).

Time periods.

"(B) INCREASE.—The dollar amount applied under subparagraph (A)(i)—

"(i) for 2024, shall be the dollar amount specified under such subparagraph for 2023, increased by the percentage increase in the consumer price index for all urban consumers (United States city average) for the 12-month period ending with June of the previous year; and

"(ii) for a subsequent year, shall be the dollar amount specified in this clause (or clause (i)) for the previous year (without application of subparagraph (C)), increased by the percentage increase in the consumer price index for all urban consumers (United States city average) for the 12-month period ending with June of the previous year.

"(C) ROUNDING.—Any dollar amount determined under subparagraph (B) that is not a multiple of $10 shall be rounded to the nearest multiple of $10.

Time periods.
Estimate.

"(3) REBATE AMOUNT.—

"(A) IN GENERAL.—For purposes of paragraph (1), the amount specified in this paragraph for a part B rebatable drug assigned to a billing and payment code for a calendar quarter is, subject to subparagraphs (B) and (G) and paragraph (4), the estimated amount equal to the product of—

"(i) the total number of units determined under subparagraph (B) for the billing and payment code of such drug; and

"(ii) the amount (if any) by which—

"(I) the amount equal to—

"(aa) in the case of a part B rebatable drug described in paragraph (1)(B) of subsection (b), 106 percent of the amount determined under paragraph (4) of such section for such drug during the calendar quarter; or

"(bb) in the case of a part B rebatable drug described in paragraph (1)(C) of such subsection, the payment amount under such paragraph for such drug during the calendar quarter; exceeds

"(II) the inflation-adjusted payment amount determined under subparagraph (C) for such part B rebatable drug during the calendar quarter.

"(B) TOTAL NUMBER OF UNITS.—For purposes of subparagraph (A)(i), the total number of units for the billing and payment code with respect to a part B rebatable drug furnished during a calendar quarter described in subparagraph (A) is equal to—

"(i) the number of units for the billing and payment code of such drug furnished during such calendar quarter, minus

"(ii) the number of units for such billing and payment code of such drug furnished during such calendar quarter—

"(I) with respect to which the manufacturer provides a discount under the program under section 340B of the Public Health Service Act or a rebate under section 1927; or

"(II) that are packaged into the payment amount for an item or service and are not separately payable.

"(C) DETERMINATION OF INFLATION-ADJUSTED PAYMENT AMOUNT.—The inflation-adjusted payment amount determined under this subparagraph for a part B rebatable drug for a calendar quarter is—

"(i) the payment amount for the billing and payment code for such drug in the payment amount benchmark quarter (as defined in subparagraph (D)); increased by

"(ii) the percentage by which the rebate period CPI–U (as defined in subparagraph (F)) for the calendar quarter exceeds the benchmark period CPI–U (as defined in subparagraph (E)).

"(D) PAYMENT AMOUNT BENCHMARK QUARTER.—The term 'payment amount benchmark quarter' means the calendar quarter beginning July 1, 2021. Definition.

"(E) BENCHMARK PERIOD CPI–U.—The term 'benchmark period CPI–U' means the consumer price index for all urban consumers (United States city average) for January 2021. Definition.

"(F) REBATE PERIOD CPI–U.—The term 'rebate period CPI–U' means, with respect to a calendar quarter described in subparagraph (C), the greater of the benchmark period CPI–U and the consumer price index for all urban consumers (United States city average) for the first month of the calendar quarter that is two calendar quarters prior to such described calendar quarter.

"(G) REDUCTION OR WAIVER FOR SHORTAGES AND SEVERE SUPPLY CHAIN DISRUPTIONS.—The Secretary shall reduce or waive the amount under subparagraph (A) with respect to a part B rebatable drug and a calendar quarter—

"(i) in the case of a part B rebatable drug that is described as currently in shortage on the shortage list in effect under section 506E of the Federal Food, Drug, and Cosmetic Act at any point during the calendar quarter; or

"(ii) in the case of a biosimilar biological product, when the Secretary determines there is a severe supply chain disruption during the calendar quarter, such as that caused by a natural disaster or other unique or unexpected event. Determination.

"(4) SPECIAL TREATMENT OF CERTAIN DRUGS AND EXEMPTION.— Effective dates. Applicability. Time periods.

"(A) SUBSEQUENTLY APPROVED DRUGS.—In the case of a part B rebatable drug first approved or licensed by the Food and Drug Administration after December 1, 2020, clause (i) of paragraph (3)(C) shall be applied as if the term 'payment amount benchmark quarter' were defined

under paragraph (3)(D) as the third full calendar quarter after the day on which the drug was first marketed and clause (ii) of paragraph (3)(C) shall be applied as if the term 'benchmark period CPI–U' were defined under paragraph (3)(E) as if the reference to 'January 2021' under such paragraph were a reference to 'the first month of the first full calendar quarter after the day on which the drug was first marketed'.

"(B) TIMELINE FOR PROVISION OF REBATES FOR SUBSEQUENTLY APPROVED DRUGS.—In the case of a part B rebatable drug first approved or licensed by the Food and Drug Administration after December 1, 2020, paragraph (1)(B) shall be applied as if the reference to 'January 1, 2023' under such paragraph were a reference to 'the later of the 6th full calendar quarter after the day on which the drug was first marketed or January 1, 2023'.

"(C) SELECTED DRUGS.—In the case of a part B rebatable drug that is a selected drug (as defined in section 1192(c)) with respect to a price applicability period (as defined in section 1191(b)(2)), in the case such drug is no longer considered to be a selected drug under section 1192(c), for each applicable period (as defined under subsection (g)(7)) beginning after the price applicability period with respect to such drug, clause (i) of paragraph (3)(C) shall be applied as if the term 'payment amount benchmark quarter' were defined under paragraph (3)(D) as the calendar quarter beginning January 1 of the last year during such price applicability period with respect to such selected drug and clause (ii) of paragraph (3)(C) shall be applied as if the term 'benchmark period CPI–U' were defined under paragraph (3)(E) as if the reference to 'January 2021' under such paragraph were a reference to 'the July of the year preceding such last year'.

Effective date.
Time period.

"(5) APPLICATION TO BENEFICIARY COINSURANCE.—In the case of a part B rebatable drug furnished on or after April 1, 2023, if the payment amount described in paragraph (3)(A)(ii)(I) (or, in the case of a part B rebatable drug that is a selected drug (as defined in section 1192(c)), the payment amount described in subsection (b)(1)(B) for such drug) for a calendar quarter exceeds the inflation adjusted payment for such quarter—

"(A) in computing the amount of any coinsurance applicable under this part to an individual to whom such drug is furnished, the computation of such coinsurance shall be equal to 20 percent of the inflation-adjusted payment amount determined under paragraph (3)(C) for such part B rebatable drug; and

Applicability.
Determination.

"(B) the amount of such coinsurance for such calendar quarter, as computed under subparagraph (A), shall be applied as a percent, as determined by the Secretary, to the payment amount that would otherwise apply under subparagraphs (B) or (C) of subsection (b)(1).

"(6) REBATE DEPOSITS.—Amounts paid as rebates under paragraph (1)(B) shall be deposited into the Federal Supplementary Medical Insurance Trust Fund established under section 1841.

"(7) CIVIL MONEY PENALTY.—If a manufacturer of a part B rebatable drug has failed to comply with the requirements under paragraph (1)(B) for such drug for a calendar quarter, the manufacturer shall be subject to, in accordance with a process established by the Secretary pursuant to regulations, a civil money penalty in an amount equal to at least 125 percent of the amount specified in paragraph (3) for such drug for such calendar quarter. The provisions of section 1128A (other than subsections (a) (with respect to amounts of penalties or additional assessments) and (b)) shall apply to a civil money penalty under this paragraph in the same manner as such provisions apply to a penalty or proceeding under section 1128A(a). Time period. Applicability.

"(8) LIMITATION ON ADMINISTRATIVE OR JUDICIAL REVIEW.—There shall be no administrative or judicial review of any of the following:

"(A) The determination of units under this subsection.

"(B) The determination of whether a drug is a part B rebatable drug under this subsection.

"(C) The calculation of the rebate amount under this subsection.

"(D) The computation of coinsurance under paragraph (5) of this subsection.

"(E) The computation of amounts paid under section 1833(a)(1)(EE).".

(b) AMOUNTS PAYABLE; COST-SHARING.—Section 1833 of the Social Security Act (42 U.S.C. 1395l) is amended—

(1) in subsection (a)(1)—

(A) in subparagraph (G), by inserting ", subject to subsection (i)(9)," after "the amounts paid";

(B) in subparagraph (S), by striking "with respect to" and inserting "subject to subparagraph (EE), with respect to";

(C) by striking "and (DD)" and inserting "(DD)"; and

(D) by inserting before the semicolon at the end the following: ", and (EE) with respect to a part B rebatable drug (as defined in paragraph (2) of section 1847A(i)) furnished on or after April 1, 2023, for which the payment amount for a calendar quarter under paragraph (3)(A)(ii)(I) of such section (or, in the case of a part B rebatable drug that is a selected drug (as defined in section 1192(c) for which, the payment amount described in section 1847A(b)(1)(B)) for such drug for such quarter exceeds the inflation-adjusted payment under paragraph (3)(A)(ii)(II) of such section for such quarter, the amounts paid shall be equal to the percent of the payment amount under paragraph (3)(A)(ii)(I) of such section or section 1847A(b)(1)(B), as applicable, that equals the difference between (i) 100 percent, and (ii) the percent applied under section 1847A(i)(5)(B)"; Effective date. Time period. Applicability.

(2) in subsection (i), by adding at the end the following new paragraph:

"(9) In the case of a part B rebatable drug (as defined in paragraph (2) of section 1847A(i)) for which payment under this subsection is not packaged into a payment for a service furnished on or after April 1, 2023, under the revised payment system under this subsection, in lieu of calculation of coinsurance and the amount Effective date. Determination. Applicability.

of payment otherwise applicable under this subsection, the provisions of section 1847A(i)(5) and paragraph (1)(EE) of subsection (a), shall, as determined appropriate by the Secretary, apply under this subsection in the same manner as such provisions of section 1847A(i)(5) and subsection (a) apply under such section and subsection."; and

(3) in subsection (t)(8), by adding at the end the following new subparagraph:

Effective date. Time period. Determination. Applicability.

"(F) PART B REBATABLE DRUGS.—In the case of a part B rebatable drug (as defined in paragraph (2) of section 1847A(i), except if such drug does not have a copayment amount as a result of application of subparagraph (E)) for which payment under this part is not packaged into a payment for a covered OPD service (or group of services) furnished on or after April 1, 2023, and the payment for such drug under this subsection is the same as the amount for a calendar quarter under paragraph (3)(A)(ii)(I) of section 1847A(i), under the system under this subsection, in lieu of calculation of the copayment amount and the amount of payment otherwise applicable under this subsection (other than the application of the limitation described in subparagraph (C)), the provisions of section 1847A(i)(5) and paragraph (1)(EE) of subsection (a), shall, as determined appropriate by the Secretary, apply under this subsection in the same manner as such provisions of section 1847A(i)(5) and subsection (a) apply under such section and subsection.".

(c) CONFORMING AMENDMENTS.—

(1) TO PART B ASP CALCULATION.—Section 1847A(c)(3) of the Social Security Act (42 U.S.C. 1395w–3a(c)(3)) is amended by inserting "subsection (i) or" before "section 1927".

(2) EXCLUDING PART B DRUG INFLATION REBATE FROM BEST PRICE.—Section 1927(c)(1)(C)(ii)(I) of the Social Security Act (42 U.S.C. 1396r–8(c)(1)(C)(ii)(I)) is amended by inserting "or section 1847A(i)" after "this section".

(3) COORDINATION WITH MEDICAID REBATE INFORMATION DISCLOSURE.—Section 1927(b)(3)(D)(i) of the Social Security Act (42 U.S.C. 1396r–8(b)(3)(D)(i)) is amended by inserting "and the rebate" after "the payment amount".

(4) EXCLUDING PART B DRUG INFLATION REBATES FROM AVERAGE MANUFACTURER PRICE.—Section 1927(k)(1)(B)(i) of the Social Security Act (42 U.S.C. 1396r–8(k)(1)(B)(i)), as amended by section 11001(b)(3), is amended—

(A) in subclause (V), by striking "and" at the end;

(B) in subclause (VI), by striking the period at the end and inserting a semicolon; and

(C) by adding at the end the following new subclause:

"(VII) rebates paid by manufacturers under section 1847A(i); and".

Time period.

(d) FUNDING.—In addition to amounts otherwise available, there are appropriated to the Centers for Medicare & Medicaid Services, out of any money in the Treasury not otherwise appropriated, $80,000,000 for fiscal year 2022, including $12,500,000 to carry out the provisions of, including the amendments made by, this section in fiscal year 2022, and $7,500,000 to carry out the provisions of, including the amendments made by, this section

in each of fiscal years 2023 through 2031, to remain available until expended.

SEC. 11102. MEDICARE PART D REBATE BY MANUFACTURERS.

(a) IN GENERAL.—Part D of title XVIII of the Social Security Act is amended by inserting after section 1860D–14A (42 U.S.C. 1395w–114a) the following new section:

"SEC. 1860D–14B. MANUFACTURER REBATE FOR CERTAIN DRUGS WITH PRICES INCREASING FASTER THAN INFLATION. 42 USC 1395w–114b.

"(a) REQUIREMENTS.—

"(1) SECRETARIAL PROVISION OF INFORMATION.—Not later than 9 months after the end of each applicable period (as defined in subsection (g)(7)), subject to paragraph (3), the Secretary shall, for each part D rebatable drug, report to each manufacturer of such part D rebatable drug the following for such period: Reports.

"(A) The amount (if any) of the excess annual manufacturer price increase described in subsection (b)(1)(A)(ii) for each dosage form and strength with respect to such drug and period.

"(B) The rebate amount specified under subsection (b) for each dosage form and strength with respect to such drug and period.

"(2) MANUFACTURER REQUIREMENTS.—For each applicable period, the manufacturer of a part D rebatable drug, for each dosage form and strength with respect to such drug, not later than 30 days after the date of receipt from the Secretary of the information described in paragraph (1) for such period, shall provide to the Secretary a rebate that is equal to the amount specified in subsection (b) for such dosage form and strength with respect to such drug for such period. Deadline.

"(3) TRANSITION RULE FOR REPORTING.—The Secretary may, for each rebatable covered part D drug, delay the timeframe for reporting the information and rebate amount described in subparagraphs (A) and (B) of such paragraph for the applicable periods beginning October 1, 2022, and October 1, 2023, until not later than December 31, 2025. Time period. Effective date.

"(b) REBATE AMOUNT.— Determinations.

"(1) IN GENERAL.—

"(A) CALCULATION.—For purposes of this section, the amount specified in this subsection for a dosage form and strength with respect to a part D rebatable drug and applicable period is, subject to subparagraph (C), paragraph (5)(B), and paragraph (6), the estimated amount equal to the product of—

"(i) subject to subparagraph (B) of this paragraph, the total number of units of such dosage form and strength for each rebatable covered part D drug dispensed under this part during the applicable period; and

"(ii) the amount (if any) by which—

"(I) the annual manufacturer price (as determined in paragraph (2)) paid for such dosage form and strength with respect to such part D rebatable drug for the period; exceeds

"(II) the inflation-adjusted payment amount determined under paragraph (3) for such dosage

form and strength with respect to such part D rebatable drug for the period.

Effective date.

"(B) EXCLUDED UNITS.—For purposes of subparagraph (A)(i), beginning with plan year 2026, the Secretary shall exclude from the total number of units for a dosage form and strength with respect to a part D rebatable drug, with respect to an applicable period, units of each dosage form and strength of such part D rebatable drug for which the manufacturer provides a discount under the program under section 340B of the Public Health Service Act.

"(C) REDUCTION OR WAIVER FOR SHORTAGES AND SEVERE SUPPLY CHAIN DISRUPTIONS.—The Secretary shall reduce or waive the amount under subparagraph (A) with respect to a part D rebatable drug and an applicable period—

"(i) in the case of a part D rebatable drug that is described as currently in shortage on the shortage list in effect under section 506E of the Federal Food, Drug, and Cosmetic Act at any point during the applicable period;

"(ii) in the case of a generic part D rebatable drug (described in subsection (g)(1)(C)(ii)) or a biosimilar (defined as a biological product licensed under section 351(k) of the Public Health Service Act), when the Secretary determines there is a severe supply chain disruption during the applicable period, such as that caused by a natural disaster or other unique or unexpected event; and

"(iii) in the case of a generic Part D rebatable drug (as so described), if the Secretary determines that without such reduction or waiver, the drug is likely to be described as in shortage on such shortage list during a subsequent applicable period.

"(2) DETERMINATION OF ANNUAL MANUFACTURER PRICE.—The annual manufacturer price determined under this paragraph for a dosage form and strength, with respect to a part D rebatable drug and an applicable period, is the sum of the products of—

"(A) the average manufacturer price (as defined in subsection (g)(6)) of such dosage form and strength, as calculated for a unit of such drug, with respect to each of the calendar quarters of such period; and

"(B) the ratio of—

"(i) the total number of units of such dosage form and strength reported under section 1927 with respect to each such calendar quarter of such period; to

"(ii) the total number of units of such dosage form and strength reported under section 1927 with respect to such period, as determined by the Secretary.

"(3) DETERMINATION OF INFLATION-ADJUSTED PAYMENT AMOUNT.—The inflation-adjusted payment amount determined under this paragraph for a dosage form and strength with respect to a part D rebatable drug for an applicable period, subject to paragraph (5), is—

"(A) the benchmark period manufacturer price determined under paragraph (4) for such dosage form and strength with respect to such drug and period; increased by

"(B) the percentage by which the applicable period CPI–U (as defined in subsection (g)(5)) for the period exceeds the benchmark period CPI–U (as defined in subsection (g)(4)).

"(4) DETERMINATION OF BENCHMARK PERIOD MANUFACTURER PRICE.—The benchmark period manufacturer price determined under this paragraph for a dosage form and strength, with respect to a part D rebatable drug and an applicable period, is the sum of the products of—

"(A) the average manufacturer price (as defined in subsection (g)(6)) of such dosage form and strength, as calculated for a unit of such drug, with respect to each of the calendar quarters of the payment amount benchmark period (as defined in subsection (g)(3)); and

"(B) the ratio of—

"(i) the total number of units reported under section 1927 of such dosage form and strength with respect to each such calendar quarter of such payment amount benchmark period; to

"(ii) the total number of units reported under section 1927 of such dosage form and strength with respect to such payment amount benchmark period.

"(5) SPECIAL TREATMENT OF CERTAIN DRUGS AND EXEMPTION.—

"(A) SUBSEQUENTLY APPROVED DRUGS.—In the case of a part D rebatable drug first approved or licensed by the Food and Drug Administration after October 1, 2021, subparagraphs (A) and (B) of paragraph (4) shall be applied as if the term 'payment amount benchmark period' were defined under subsection (g)(3) as the first calendar year beginning after the day on which the drug was first marketed and subparagraph (B) of paragraph (3) shall be applied as if the term 'benchmark period CPI–U' were defined under subsection (g)(4) as if the reference to 'January 2021' under such subsection were a reference to 'January of the first year beginning after the date on which the drug was first marketed'.

Effective dates. Applicability. Time period.

"(B) TREATMENT OF NEW FORMULATIONS.—

"(i) IN GENERAL.—In the case of a part D rebatable drug that is a line extension of a part D rebatable drug that is an oral solid dosage form, the Secretary shall establish a formula for determining the rebate amount under paragraph (1) and the inflation adjusted payment amount under paragraph (3) with respect to such part D rebatable drug and an applicable period, consistent with the formula applied under subsection (c)(2)(C) of section 1927 for determining a rebate obligation for a rebate period under such section.

"(ii) LINE EXTENSION DEFINED.—In this subparagraph, the term 'line extension' means, with respect to a part D rebatable drug, a new formulation of the drug, such as an extended release formulation, but does not include an abuse-deterrent formulation of the drug (as determined by the Secretary), regardless of whether such abuse-deterrent formulation is an extended release formulation.

Effective date.
Applicability.

"(C) SELECTED DRUGS.—In the case of a part D rebatable drug that is a selected drug (as defined in section 1192(c)) with respect to a price applicability period (as defined in section 1191(b)(2)), in the case such drug is no longer considered to be a selected drug under section 1192(c), for each applicable period (as defined under subsection (g)(7)) beginning after the price applicability period with respect to such drug, subparagraphs (A) and (B) of paragraph (4) shall be applied as if the term 'payment amount benchmark period' were defined under subsection (g)(3) as the last year beginning during such price applicability period with respect to such selected drug and subparagraph (B) of paragraph (3) shall be applied as if the term 'benchmark period CPI–U' were defined under subsection (g)(4) as if the reference to 'January 2021' under such subsection were a reference to 'January of the last year beginning during such price applicability period with respect to such drug'.

"(6) RECONCILIATION IN CASE OF REVISED INFORMATION.—The Secretary shall provide for a method and process under which, in the case where a PDP sponsor of a prescription drug plan or an MA organization offering an MA–PD plan submits revisions to the number of units of a rebatable covered part D drug dispensed, the Secretary determines, pursuant to such revisions, adjustments, if any, to the calculation of the amount specified in this subsection for a dosage form and strength with respect to such part D rebatable drug and an applicable period and reconciles any overpayments or underpayments in amounts paid as rebates under this subsection. Any identified underpayment shall be rectified by the manufacturer not later than 30 days after the date of receipt from the Secretary of information on such underpayment.

Deadline.

"(c) REBATE DEPOSITS.—Amounts paid as rebates under subsection (b) shall be deposited into the Medicare Prescription Drug Account in the Federal Supplementary Medical Insurance Trust Fund established under section 1841.

"(d) INFORMATION.—For purposes of carrying out this section, the Secretary shall use information submitted by—

"(1) manufacturers under section 1927(b)(3);

"(2) States under section 1927(b)(2)(A); and

"(3) PDP sponsors of prescription drug plans and MA organization offering MA–PD plans under this part.

"(e) CIVIL MONEY PENALTY.—If a manufacturer of a part D rebatable drug has failed to comply with the requirement under subsection (a)(2) with respect to such drug for an applicable period, the manufacturer shall be subject to a civil money penalty in an amount equal to 125 percent of the amount specified in subsection (b) for such drug for such period. The provisions of section 1128A (other than subsections (a) (with respect to amounts of penalties or additional assessments) and (b)) shall apply to a civil money penalty under this subsection in the same manner as such provisions apply to a penalty or proceeding under section 1128A(a).

Applicability.

"(f) LIMITATION ON ADMINISTRATIVE OR JUDICIAL REVIEW.—There shall be no administrative or judicial review of any of the following:

"(1) The determination of units under this section.

"(2) The determination of whether a drug is a part D rebatable drug under this section.

"(3) The calculation of the rebate amount under this section.

"(g) DEFINITIONS.—In this section:

"(1) PART D REBATABLE DRUG.—

"(A) IN GENERAL.—Except as provided in subparagraph (B), the term 'part D rebatable drug' means, with respect to an applicable period, a drug or biological described in subparagraph (C) that is a covered part D drug (as such term is defined under section 1860D–2(e)).

"(B) EXCLUSION.—

"(i) IN GENERAL.—Such term shall, with respect to an applicable period, not include a drug or biological if the average annual total cost under this part for such period per individual who uses such a drug or biological, as determined by the Secretary, is less than, subject to clause (ii), $100, as determined by the Secretary using the most recent data available or, if data is not available, as estimated by the Secretary. Determinations. Estimate.

"(ii) INCREASE.—The dollar amount applied under clause (i)— Time periods. Effective dates.

"(I) for the applicable period beginning October 1, 2023, shall be the dollar amount specified under such clause for the applicable period beginning October 1, 2022, increased by the percentage increase in the consumer price index for all urban consumers (United States city average) for the 12-month period beginning with October of 2023; and

"(II) for a subsequent applicable period, shall be the dollar amount specified in this clause for the previous applicable period, increased by the percentage increase in the consumer price index for all urban consumers (United States city average) for the 12-month period beginning with October of the previous period.

Any dollar amount specified under this clause that is not a multiple of $10 shall be rounded to the nearest multiple of $10.

"(C) DRUG OR BIOLOGICAL DESCRIBED.—A drug or biological described in this subparagraph is a drug or biological that, as of the first day of the applicable period involved, is—

"(i) a drug approved under a new drug application under section 505(c) of the Federal Food, Drug, and Cosmetic Act;

"(ii) a drug approved under an abbreviated new drug application under section 505(j) of the Federal Food, Drug, and Cosmetic Act, in the case where—

"(I) the reference listed drug approved under section 505(c) of the Federal Food, Drug, and Cosmetic Act, including any 'authorized generic drug' (as that term is defined in section 505(t)(3) of the Federal Food, Drug, and Cosmetic Act), is not being marketed, as identified in the Food and Drug Administration's National Drug Code Directory;

"(II) there is no other drug approved under section 505(j) of the Federal Food, Drug, and Cosmetic Act that is rated as therapeutically equivalent (under the Food and Drug Administration's most recent publication of 'Approved Drug Products with Therapeutic Equivalence Evaluations') and that is being marketed, as identified in the Food and Drug Administration's National Drug Code Directory;

Time period.

"(III) the manufacturer is not a 'first applicant' during the '180-day exclusivity period', as those terms are defined in section 505(j)(5)(B)(iv) of the Federal Food, Drug, and Cosmetic Act; and

"(IV) the manufacturer is not a 'first approved applicant' for a competitive generic therapy, as that term is defined in section 505(j)(5)(B)(v) of the Federal Food, Drug, and Cosmetic Act; or

"(iii) a biological licensed under section 351 of the Public Health Service Act.

"(2) UNIT.—The term 'unit' means, with respect to a part D rebatable drug, the lowest dispensable amount (such as a capsule or tablet, milligram of molecules, or grams) of the part D rebatable drug, as reported under section 1927.

"(3) PAYMENT AMOUNT BENCHMARK PERIOD.—The term 'payment amount benchmark period' means the period beginning January 1, 2021, and ending in the month immediately prior to October 1, 2021.

"(4) BENCHMARK PERIOD CPI–U.—The term 'benchmark period CPI–U' means the consumer price index for all urban consumers (United States city average) for January 2021.

"(5) APPLICABLE PERIOD CPI–U.—The term 'applicable period CPI–U' means, with respect to an applicable period, the consumer price index for all urban consumers (United States city average) for the first month of such applicable period.

"(6) AVERAGE MANUFACTURER PRICE.—The term 'average manufacturer price' has the meaning, with respect to a part D rebatable drug of a manufacturer, given such term in section 1927(k)(1), with respect to a covered outpatient drug of a manufacturer for a rebate period under section 1927.

"(7) APPLICABLE PERIOD.—The term 'applicable period' means a 12-month period beginning with October 1 of a year (beginning with October 1, 2022).

"(h) IMPLEMENTATION FOR 2022, 2023, AND 2024.—The Secretary shall implement this section for 2022, 2023, and 2024 by program instruction or other forms of program guidance.".

(b) CONFORMING AMENDMENTS.—

(1) TO PART B ASP CALCULATION.—Section 1847A(c)(3) of the Social Security Act (42 U.S.C. 1395w–3a(c)(3)), as amended by section 11101(c)(1), is amended by striking "subsection (i) or section 1927" and inserting "subsection (i), section 1927, or section 1860D–14B".

(2) EXCLUDING PART D DRUG INFLATION REBATE FROM BEST PRICE.—Section 1927(c)(1)(C)(ii)(I) of the Social Security Act (42 U.S.C. 1396r–8(c)(1)(C)(ii)(I)), as amended by section 11101(c)(2), is amended by striking "or section 1847A(i)" and inserting ", section 1847A(i), or section 1860D–14B".

(3) COORDINATION WITH MEDICAID REBATE INFORMATION DISCLOSURE.—Section 1927(b)(3)(D)(i) of the Social Security Act (42 U.S.C. 1396r–8(b)(3)(D)(i)), as amended by sections 11002(b) and 11101(c)(3), is amended by striking "or section 1192(f), including rebates under paragraph (4) of such section" and inserting ", section 1192(f), including rebates under paragraph (4) of such section, or section 1860D–14B".

(4) EXCLUDING PART D DRUG INFLATION REBATES FROM AVERAGE MANUFACTURER PRICE.—Section 1927(k)(1)(B)(i) of the Social Security Act (42 U.S.C. 1396r–8(k)(1)(B)(i)), as amended by section 11001(b)(3) and section 11101(c)(4), is amended by adding at the end the following new subclause:

(A) in subclause (VI), by striking "and" at the end;

(B) in subclause (VII), by striking the period at the end and inserting a semicolon; and

(C) by adding at the end the following new subclause:

"(VIII) rebates paid by manufacturers under section 1860D–14B.".

(c) FUNDING.—In addition to amounts otherwise available, there are appropriated to the Centers for Medicare & Medicaid Services, out of any money in the Treasury not otherwise appropriated, $80,000,000 for fiscal year 2022, including $12,500,000 to carry out the provisions of, including the amendments made by, this section in fiscal year 2022, and $7,500,000 to carry out the provisions of, including the amendments made by, this section in each of fiscal years 2023 through 2031, to remain available until expended. Time periods.

PART 3—PART D IMPROVEMENTS AND MAXIMUM OUT-OF-POCKET CAP FOR MEDICARE BENEFICIARIES

SEC. 11201. MEDICARE PART D BENEFIT REDESIGN.

Time periods.

(a) BENEFIT STRUCTURE REDESIGN.—Section 1860D–2(b) of the Social Security Act (42 U.S.C. 1395w–102(b)) is amended—

(1) in paragraph (2)—

(A) in subparagraph (A), in the matter preceding clause (i), by inserting "for a year preceding 2025 and for costs above the annual deductible specified in paragraph (1) and up to the annual out-of-pocket threshold specified in paragraph (4)(B) for 2025 and each subsequent year" after "paragraph (3)";

(B) in subparagraph (C)—

(i) in clause (i), in the matter preceding subclause (I), by inserting "for a year preceding 2025," after "paragraph (4),"; and

(ii) in clause (ii)(III), by striking "and each subsequent year" and inserting "through 2024"; and

(C) in subparagraph (D)—

(i) in clause (i)—

(I) in the matter preceding subclause (I), by inserting "for a year preceding 2025," after "paragraph (4),"; and

(II) in subclause (I)(bb), by striking "a year after 2018" and inserting "each of years 2019 through 2024"; and

(ii) in clause (ii)(V), by striking "2019 and each subsequent year" and inserting "each of years 2019 through 2024";

(2) in paragraph (3)(A)—

(A) in the matter preceding clause (i), by inserting "for a year preceding 2025," after "and (4),"; and

(B) in clause (ii), by striking "for a subsequent year" and inserting "for each of years 2007 through 2024"; and

(3) in paragraph (4)—

(A) in subparagraph (A)—

(i) in clause (i)—

(I) by redesignating subclauses (I) and (II) as items (aa) and (bb), respectively, and moving the margin of each such redesignated item 2 ems to the right;

(II) in the matter preceding item (aa), as redesignated by subclause (I), by striking "is equal to the greater of—" and inserting "is equal to—

"(I) for a year preceding 2024, the greater of—";

(III) by striking the period at the end of item (bb), as redesignated by subclause (I), and inserting "; and"; and

(IV) by adding at the end the following:

"(II) for 2024 and each succeeding year, $0."; and

(ii) in clause (ii)—

(I) by striking "clause (i)(I)" and inserting "clause (i)(I)(aa)"; and

(II) by adding at the end the following new sentence: "The Secretary shall continue to calculate the dollar amounts specified in clause (i)(I)(aa), including with the adjustment under this clause, after 2023 for purposes of section 1860D–14(a)(1)(D)(iii).";

(B) in subparagraph (B)—

(i) in clause (i)—

(I) in subclause (V), by striking "or" at the end;

(II) in subclause (VI)—

(aa) by striking "for a subsequent year" and inserting "for each of years 2021 through 2024"; and

(bb) by striking the period at the end and inserting a semicolon; and

(III) by adding at the end the following new subclauses:

"(VII) for 2025, is equal to $2,000; or

"(VIII) for a subsequent year, is equal to the amount specified in this subparagraph for the previous year, increased by the annual percentage increase described in paragraph (6) for the year involved."; and

(ii) in clause (ii), by striking "clause (i)(II)" and inserting "clause (i)";

(C) in subparagraph (C)—

(i) in clause (i), by striking "and for amounts" and inserting "and, for a year preceding 2025, for amounts"; and

(ii) in clause (iii)—

(I) by redesignating subclauses (I) through (IV) as items (aa) through (dd) and indenting appropriately;

(II) by striking "if such costs are borne or paid" and inserting "if such costs—

"(I) are borne or paid—"; and

(III) in item (dd), by striking the period at the end and inserting "; or"; and

(IV) by adding at the end the following new subclause:

"(II) for 2025 and subsequent years, are reimbursed through insurance, a group health plan, or certain other third party payment arrangements, but not including the coverage provided by a prescription drug plan or an MA–PD plan that is basic prescription drug coverage (as defined in subsection (a)(3)) or any payments by a manufacturer under the manufacturer discount program under section 1860D–14C."; and

(D) in subparagraph (E), by striking "In applying" and inserting "For each of years 2011 through 2024, in applying".

(b) REINSURANCE PAYMENT AMOUNT.—Section 1860D–15(b) of the Social Security Act (42 U.S.C. 1395w–115(b)) is amended—

(1) in paragraph (1)—

(A) by striking "equal to 80 percent" and inserting "equal to—

"(A) for a year preceding 2025, 80 percent";

(B) in subparagraph (A), as added by subparagraph (A), by striking the period at the end and inserting "; and"; and

(C) by adding at the end the following new subparagraph:

"(B) for 2025 and each subsequent year, the sum of—

"(i) with respect to applicable drugs (as defined in section 1860D–14C(g)(2)), an amount equal to 20 percent of such allowable reinsurance costs attributable to that portion of gross covered prescription drug costs as specified in paragraph (3) incurred in the coverage year after such individual has incurred costs that exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B); and

"(ii) with respect to covered part D drugs that are not applicable drugs (as so defined), an amount equal to 40 percent of such allowable reinsurance costs attributable to that portion of gross covered prescription drug costs as specified in paragraph (3) incurred in the coverage year after such individual has incurred costs that exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B).";

(2) in paragraph (2)—

(A) by striking "COSTS.—For purposes" and inserting "COSTS.—

"(A) IN GENERAL.—Subject to subparagraph (B), for purposes"; and

(B) by adding at the end the following new subparagraph:

Definition.

"(B) INCLUSION OF MANUFACTURER DISCOUNTS ON APPLICABLE DRUGS.—For purposes of applying subparagraph (A), the term 'allowable reinsurance costs' shall include the portion of the negotiated price (as defined in section 1860D–14C(g)(6)) of an applicable drug (as defined in section 1860D–14C(g)(2)) that was paid by a manufacturer under the manufacturer discount program under section 1860D–14C."; and

(3) in paragraph (3)—

(A) in the first sentence, by striking "For purposes" and inserting "Subject to paragraph (2)(B), for purposes"; and

(B) in the second sentence, by inserting "(or, with respect to 2025 and subsequent years, in the case of an applicable drug, as defined in section 1860D–14C(g)(2), by a manufacturer)" after "by the individual or under the plan".

(c) MANUFACTURER DISCOUNT PROGRAM.—

(1) IN GENERAL.—Part D of title XVIII of the Social Security Act (42 U.S.C. 1395w–101 through 42 U.S.C. 1395w–153), as amended by section 11102, is amended by inserting after section 1860D–14B the following new sections:

42 USC 1395w–114c.

"SEC. 1860D–14C. MANUFACTURER DISCOUNT PROGRAM.

"(a) ESTABLISHMENT.—The Secretary shall establish a manufacturer discount program (in this section referred to as the 'program'). Under the program, the Secretary shall enter into agreements described in subsection (b) with manufacturers and provide for the performance of the duties described in subsection (c).

"(b) TERMS OF AGREEMENT.—

"(1) IN GENERAL.—

Effective date.

"(A) AGREEMENT.—An agreement under this section shall require the manufacturer to provide, in accordance with this section, discounted prices for applicable drugs of the manufacturer that are dispensed to applicable beneficiaries on or after January 1, 2025.

"(B) CLARIFICATION.—Nothing in this section shall be construed as affecting—

"(i) the application of a coinsurance of 25 percent of the negotiated price, as applied under paragraph (2)(A) of section 1860D–2(b), for costs described in such paragraph; or

"(ii) the application of the copayment amount described in paragraph (4)(A) of such section, with respect to costs described in such paragraph.

Deadlines.

"(C) TIMING OF AGREEMENT.—

"(i) SPECIAL RULE FOR 2025.—In order for an agreement with a manufacturer to be in effect under this section with respect to the period beginning on January 1, 2025, and ending on December 31, 2025, the manufacturer shall enter into such agreement not later than March 1, 2024.

"(ii) 2026 AND SUBSEQUENT YEARS.—In order for an agreement with a manufacturer to be in effect under this section with respect to plan year 2026 or a subsequent plan year, the manufacturer shall enter into such agreement not later than a calendar quarter or semi-annual deadline established by the Secretary.

"(2) PROVISION OF APPROPRIATE DATA.—Each manufacturer with an agreement in effect under this section shall collect and have available appropriate data, as determined by the Secretary, to ensure that it can demonstrate to the Secretary compliance with the requirements under the program. Determination.

"(3) COMPLIANCE WITH REQUIREMENTS FOR ADMINISTRATION OF PROGRAM.—Each manufacturer with an agreement in effect under this section shall comply with requirements imposed by the Secretary, as applicable, for purposes of administering the program, including any determination under subparagraph (A) of subsection (c)(1) or procedures established under such subsection (c)(1).

"(4) LENGTH OF AGREEMENT.—

"(A) IN GENERAL.—An agreement under this section shall be effective for an initial period of not less than 12 months and shall be automatically renewed for a period of not less than 1 year unless terminated under subparagraph (B).

"(B) TERMINATION.—

"(i) BY THE SECRETARY.—The Secretary shall provide for termination of an agreement under this section for a knowing and willful violation of the requirements of the agreement or other good cause shown. Such termination shall not be effective earlier than 30 days after the date of notice to the manufacturer of such termination. The Secretary shall provide, upon request, a manufacturer with a hearing concerning such a termination, and such hearing shall take place prior to the effective date of the termination with sufficient time for such effective date to be repealed if the Secretary determines appropriate. Time period. Hearings.

"(ii) BY A MANUFACTURER.—A manufacturer may terminate an agreement under this section for any reason. Any such termination shall be effective, with respect to a plan year— Effective dates.

"(I) if the termination occurs before January 31 of a plan year, as of the day after the end of the plan year; and

"(II) if the termination occurs on or after January 31 of a plan year, as of the day after the end of the succeeding plan year.

"(iii) EFFECTIVENESS OF TERMINATION.—Any termination under this subparagraph shall not affect discounts for applicable drugs of the manufacturer that are due under the agreement before the effective date of its termination.

"(5) EFFECTIVE DATE OF AGREEMENT.—An agreement under this section shall take effect at the start of a calendar quarter or another date specified by the Secretary.

"(c) DUTIES DESCRIBED.—The duties described in this subsection are the following:

"(1) ADMINISTRATION OF PROGRAM.—Administering the program, including—

"(A) the determination of the amount of the discounted price of an applicable drug of a manufacturer;

"(B) the establishment of procedures to ensure that, not later than the applicable number of calendar days after the dispensing of an applicable drug by a pharmacy or mail order service, the pharmacy or mail order service is reimbursed for an amount equal to the difference between—

"(i) the negotiated price of the applicable drug; and

"(ii) the discounted price of the applicable drug;

"(C) the establishment of procedures to ensure that the discounted price for an applicable drug under this section is applied before any coverage or financial assistance under other health benefit plans or programs that provide coverage or financial assistance for the purchase or provision of prescription drug coverage on behalf of applicable beneficiaries as specified by the Secretary; and

"(D) providing a reasonable dispute resolution mechanism to resolve disagreements between manufacturers, prescription drug plans and MA–PD plans, and the Secretary.

"(2) MONITORING COMPLIANCE.—The Secretary shall monitor compliance by a manufacturer with the terms of an agreement under this section.

"(3) COLLECTION OF DATA FROM PRESCRIPTION DRUG PLANS AND MA–PD PLANS.—The Secretary may collect appropriate data from prescription drug plans and MA–PD plans in a timeframe that allows for discounted prices to be provided for applicable drugs under this section.

"(d) ADMINISTRATION.—

"(1) IN GENERAL.—Subject to paragraph (2), the Secretary shall provide for the implementation of this section, including the performance of the duties described in subsection (c).

"(2) LIMITATION.—In providing for the implementation of this section, the Secretary shall not receive or distribute any funds of a manufacturer under the program.

"(e) CIVIL MONEY PENALTY.—

Determination.

"(1) IN GENERAL.—A manufacturer that fails to provide discounted prices for applicable drugs of the manufacturer dispensed to applicable beneficiaries in accordance with an agreement in effect under this section shall be subject to a civil money penalty for each such failure in an amount the Secretary determines is equal to the sum of—

"(A) the amount that the manufacturer would have paid with respect to such discounts under the agreement, which will then be used to pay the discounts which the manufacturer had failed to provide; and

"(B) 25 percent of such amount.

"(2) APPLICATION.—The provisions of section 1128A (other than subsections (a) and (b)) shall apply to a civil money penalty under this subsection in the same manner as such provisions apply to a penalty or proceeding under section 1128A(a).

"(f) CLARIFICATION REGARDING AVAILABILITY OF OTHER COVERED PART D DRUGS.—Nothing in this section shall prevent an applicable beneficiary from purchasing a covered part D drug that is not an applicable drug (including a generic drug or a drug that is not on the formulary of the prescription drug plan or MA–PD plan that the applicable beneficiary is enrolled in).

"(g) DEFINITIONS.—In this section:

"(1) APPLICABLE BENEFICIARY.—The term 'applicable beneficiary' means an individual who, on the date of dispensing a covered part D drug—

"(A) is enrolled in a prescription drug plan or an MA–PD plan;

"(B) is not enrolled in a qualified retiree prescription drug plan; and

"(C) has incurred costs, as determined in accordance with section 1860D–2(b)(4)(C), for covered part D drugs in the year that exceed the annual deductible specified in section 1860D–2(b)(1).

"(2) APPLICABLE DRUG.—The term 'applicable drug', with respect to an applicable beneficiary—

"(A) means a covered part D drug—

"(i) approved under a new drug application under section 505(c) of the Federal Food, Drug, and Cosmetic Act or, in the case of a biologic product, licensed under section 351 of the Public Health Service Act; and

"(ii)(I) if the PDP sponsor of the prescription drug plan or the MA organization offering the MA–PD plan uses a formulary, which is on the formulary of the prescription drug plan or MA–PD plan that the applicable beneficiary is enrolled in;

"(II) if the PDP sponsor of the prescription drug plan or the MA organization offering the MA–PD plan does not use a formulary, for which benefits are available under the prescription drug plan or MA–PD plan that the applicable beneficiary is enrolled in; or

"(III) is provided through an exception or appeal; and

"(B) does not include a selected drug (as referred to under section 1192(c)) during a price applicability period (as defined in section 1191(b)(2)) with respect to such drug.

"(3) APPLICABLE NUMBER OF CALENDAR DAYS.—The term 'applicable number of calendar days' means—

"(A) with respect to claims for reimbursement submitted electronically, 14 days; and

"(B) with respect to claims for reimbursement submitted otherwise, 30 days.

"(4) DISCOUNTED PRICE.—

"(A) IN GENERAL.—The term 'discounted price' means, subject to subparagraphs (B) and (C), with respect to an applicable drug of a manufacturer dispensed during a year to an applicable beneficiary—

"(i) who has not incurred costs, as determined in accordance with section 1860D–2(b)(4)(C), for covered part D drugs in the year that are equal to or exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i) for the year, 90 percent of the negotiated price of such drug; and

"(ii) who has incurred such costs, as so determined, in the year that are equal to or exceed such threshold for the year, 80 percent of the negotiated price of such drug.

"(B) PHASE-IN FOR CERTAIN DRUGS DISPENSED TO LIS BENEFICIARIES.—

"(i) IN GENERAL.—In the case of an applicable drug of a specified manufacturer (as defined in clause (ii)) that is marketed as of the date of enactment of this subparagraph and dispensed for an applicable beneficiary who is a subsidy eligible individual (as defined in section 1860D–14(a)(3)), the term 'discounted price' means the specified LIS percent (as defined in clause (iii)) of the negotiated price of the applicable drug of the manufacturer.

"(ii) SPECIFIED MANUFACTURER.—

"(I) IN GENERAL.—In this subparagraph, subject to subclause (II), the term 'specified manufacturer' means a manufacturer of an applicable drug for which, in 2021—

"(aa) the manufacturer had a coverage gap discount agreement under section 1860D–14A;

"(bb) the total expenditures for all of the specified drugs of the manufacturer covered by such agreement or agreements for such year and covered under this part during such year represented less than 1.0 percent of the total expenditures under this part for all covered Part D drugs during such year; and

"(cc) the total expenditures for all of the specified drugs of the manufacturer that are single source drugs and biological products for which payment may be made under part B during such year represented less than 1.0 percent of the total expenditures under part B for all drugs or biological products for which payment may be made under such part during such year.

"(II) SPECIFIED DRUGS.—

"(aa) IN GENERAL.—For purposes of this clause, the term 'specified drug' means, with respect to a specified manufacturer, for 2021, an applicable drug that is produced, prepared, propagated, compounded, converted, or processed by the manufacturer.

"(bb) AGGREGATION RULE.—All persons treated as a single employer under subsection (a) or (b) of section 52 of the Internal Revenue Code of 1986 shall be treated as one manufacturer for purposes of this subparagraph. For purposes of making a determination pursuant to the previous sentence, an agreement under this section shall require that a manufacturer provide and attest to such information as specified by the Secretary as necessary.

Determination.
Requirement.
Attestation.

"(III) LIMITATION.—The term 'specified manufacturer' shall not include a manufacturer

Time periods.
Effective dates.

described in subclause (I) if such manufacturer is acquired after 2021 by another manufacturer that is not a specified manufacturer, effective at the beginning of the plan year immediately following such acquisition or, in the case of an acquisition before 2025, effective January 1, 2025.

"(iii) SPECIFIED LIS PERCENT.—In this subparagraph, the 'specified LIS percent' means, with respect to a year—

"(I) for an applicable drug dispensed for an applicable beneficiary described in clause (i) who has not incurred costs, as determined in accordance with section 1860D–2(b)(4)(C), for covered part D drugs in the year that are equal to or exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i) for the year—

"(aa) for 2025, 99 percent;
"(bb) for 2026, 98 percent;
"(cc) for 2027, 95 percent;
"(dd) for 2028, 92 percent; and
"(ee) for 2029 and each subsequent year, 90 percent; and

"(II) for an applicable drug dispensed for an applicable beneficiary described in clause (i) who has incurred costs, as determined in accordance with section 1860D–2(b)(4)(C), for covered part D drugs in the year that are equal to or exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i) for the year—

"(aa) for 2025, 99 percent;
"(bb) for 2026, 98 percent;
"(cc) for 2027, 95 percent;
"(dd) for 2028, 92 percent;
"(ee) for 2029, 90 percent;
"(ff) for 2030, 85 percent; and
"(gg) for 2031 and each subsequent year, 80 percent.

"(C) PHASE-IN FOR SPECIFIED SMALL MANUFACTURERS.—

"(i) IN GENERAL.—In the case of an applicable drug of a specified small manufacturer (as defined in clause (ii)) that is marketed as of the date of enactment of this subparagraph and dispensed for an applicable beneficiary, the term 'discounted price' means the specified small manufacturer percent (as defined in clause (iii)) of the negotiated price of the applicable drug of the manufacturer.

"(ii) SPECIFIED SMALL MANUFACTURER.—

"(I) IN GENERAL.—In this subparagraph, subject to subclause (III), the term 'specified small manufacturer' means a manufacturer of an applicable drug for which, in 2021—

"(aa) the manufacturer is a specified manufacturer (as defined in subparagraph (B)(ii)); and

"(bb) the total expenditures under part D for any one of the specified small manufacturer drugs of the manufacturer that are covered by the agreement or agreements under section 1860D–14A of such manufacturer for such year and covered under this part during such year are equal to or more than 80 percent of the total expenditures under this part for all specified small manufacturer drugs of the manufacturer that are covered by such agreement or agreements for such year and covered under this part during such year.

"(II) SPECIFIED SMALL MANUFACTURER DRUGS.—

"(aa) IN GENERAL.—For purposes of this clause, the term 'specified small manufacturer drugs' means, with respect to a specified small manufacturer, for 2021, an applicable drug that is produced, prepared, propagated, compounded, converted, or processed by the manufacturer.

"(bb) AGGREGATION RULE.—All persons treated as a single employer under subsection (a) or (b) of section 52 of the Internal Revenue Code of 1986 shall be treated as one manufacturer for purposes of this subparagraph. For purposes of making a determination pursuant to the previous sentence, an agreement under this section shall require that a manufacturer provide and attest to such information as specified by the Secretary as necessary.

"(III) LIMITATION.—The term 'specified small manufacturer' shall not include a manufacturer described in subclause (I) if such manufacturer is acquired after 2021 by another manufacturer that is not a specified small manufacturer, effective at the beginning of the plan year immediately following such acquisition or, in the case of an acquisition before 2025, effective January 1, 2025.

"(iii) SPECIFIED SMALL MANUFACTURER PERCENT.—In this subparagraph, the term 'specified small manufacturer percent' means, with respect to a year—

"(I) for an applicable drug dispensed for an applicable beneficiary who has not incurred costs, as determined in accordance with section 1860D–2(b)(4)(C), for covered part D drugs in the year that are equal to or exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i) for the year—

"(aa) for 2025, 99 percent;

"(bb) for 2026, 98 percent;

"(cc) for 2027, 95 percent;

"(dd) for 2028, 92 percent; and

"(ee) for 2029 and each subsequent year, 90 percent; and

"(II) for an applicable drug dispensed for an applicable beneficiary who has incurred costs, as

determined in accordance with section 1860D–2(b)(4)(C), for covered part D drugs in the year that are equal to or exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i) for the year—

"(aa) for 2025, 99 percent;
"(bb) for 2026, 98 percent;
"(cc) for 2027, 95 percent;
"(dd) for 2028, 92 percent;
"(ee) for 2029, 90 percent;
"(ff) for 2030, 85 percent; and
"(gg) for 2031 and each subsequent year, 80 percent.

"(D) TOTAL EXPENDITURES.—For purposes of this paragraph, the term 'total expenditures' includes, in the case of expenditures with respect to part D, the total gross covered prescription drug costs as defined in section 1860D–15(b)(3). The term 'total expenditures' excludes, in the case of expenditures with respect to part B, expenditures for a drug or biological that are bundled or packaged into the payment for another service.

"(E) SPECIAL CASE FOR CERTAIN CLAIMS.—

"(i) CLAIMS SPANNING DEDUCTIBLE.—In the case where the entire amount of the negotiated price of an individual claim for an applicable drug with respect to an applicable beneficiary does not fall above the annual deductible specified in section 1860D–2(b)(1) for the year, the manufacturer of the applicable drug shall provide the discounted price under this section on only the portion of the negotiated price of the applicable drug that falls above such annual deductible.

"(ii) CLAIMS SPANNING OUT-OF-POCKET THRESHOLD.—In the case where the entire amount of the negotiated price of an individual claim for an applicable drug with respect to an applicable beneficiary does not fall entirely below or entirely above the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i) for the year, the manufacturer of the applicable drug shall provide the discounted price—

"(I) in accordance with subparagraph (A)(i) on the portion of the negotiated price of the applicable drug that falls below such threshold; and

"(II) in accordance with subparagraph (A)(ii) on the portion of such price of such drug that falls at or above such threshold.

"(5) MANUFACTURER.—The term 'manufacturer' means any entity which is engaged in the production, preparation, propagation, compounding, conversion, or processing of prescription drug products, either directly or indirectly by extraction from substances of natural origin, or independently by means of chemical synthesis, or by a combination of extraction and chemical synthesis. Such term does not include a wholesale distributor of drugs or a retail pharmacy licensed under State law.

"(6) NEGOTIATED PRICE.—The term 'negotiated price' has the meaning given such term for purposes of section 1860D–

2(d)(1)(B), and, with respect to an applicable drug, such negotiated price shall include any dispensing fee and, if applicable, any vaccine administration fee for the applicable drug.

"(7) QUALIFIED RETIREE PRESCRIPTION DRUG PLAN.—The term 'qualified retiree prescription drug plan' has the meaning given such term in section 1860D–22(a)(2).

42 USC 1395w–114d.

"SEC. 1860D–14D. SELECTED DRUG SUBSIDY PROGRAM.

"With respect to covered part D drugs that would be applicable drugs (as defined in section 1860D–14C(g)(2)) but for the application of subparagraph (B) of such section, the Secretary shall provide a process whereby, in the case of an applicable beneficiary (as defined in section 1860D–14C(g)(1)) who, with respect to a year, is enrolled in a prescription drug plan or is enrolled in an MA–PD plan, has not incurred costs that are equal to or exceed the annual out-of-pocket threshold specified in section 1860D–2(b)(4)(B)(i), and is dispensed such a drug, the Secretary (periodically and on a timely basis) provides the PDP sponsor or the MA organization offering the plan, a subsidy with respect to such drug that is equal to 10 percent of the negotiated price (as defined in section 1860D–14C(g)(6)) of such drug.".

(2) SUNSET OF MEDICARE COVERAGE GAP DISCOUNT PROGRAM.—Section 1860D–14A of the Social Security Act (42 U.S.C. 1395w–114a) is amended—

(A) in subsection (a), in the first sentence, by striking "The Secretary" and inserting "Subject to subsection (h), the Secretary"; and

(B) by adding at the end the following new subsection:

"(h) SUNSET OF PROGRAM.—

"(1) IN GENERAL.—The program shall not apply with respect to applicable drugs dispensed on or after January 1, 2025, and, subject to paragraph (2), agreements under this section shall be terminated as of such date.

"(2) CONTINUED APPLICATION FOR APPLICABLE DRUGS DISPENSED PRIOR TO SUNSET.—The provisions of this section (including all responsibilities and duties) shall continue to apply on and after January 1, 2025, with respect to applicable drugs dispensed prior to such date.".

(3) SELECTED DRUG SUBSIDY PAYMENTS FROM MEDICARE PRESCRIPTION DRUG ACCOUNT.—Section 1860D–16(b)(1) of the Social Security Act (42 U.S.C. 1395w–116(b)(1)) is amended—

(A) in subparagraph (C), by striking "and" at the end;

(B) in subparagraph (D), by striking the period at the end and inserting "; and"; and

(C) by adding at the end the following new subparagraph:

"(E) payments under section 1860D–14D (relating to selected drug subsidy payments).".

(d) MEDICARE PART D PREMIUM STABILIZATION.—

(1) 2024 THROUGH 2029.—Section 1860D–13 of the Social Security Act (42 U.S.C. 1395w–113) is amended—

(A) in subsection (a)—

(i) in paragraph (1)(A), by inserting "or (8) (as applicable)" after "paragraph (2)";

(ii) in paragraph (2), in the matter preceding subparagraph (A), by striking "The base" and inserting "Subject to paragraph (8), the base";

(iii) in paragraph (7)—

(I) in subparagraph (B)(ii), by inserting "or (8) (as applicable)" after "paragraph (2)"; and

(II) in subparagraph (E)(i), by inserting "or (8) (as applicable)" after "paragraph (2)"; and

(iv) by adding at the end the following new paragraph:

"(8) PREMIUM STABILIZATION.— Time period.

"(A) IN GENERAL.—The base beneficiary premium under this paragraph for a prescription drug plan for a month in 2024 through 2029 shall be computed as follows:

"(i) 2024.—The base beneficiary premium for a month in 2024 shall be equal to the lesser of—

"(I) the base beneficiary premium computed under paragraph (2) for a month in 2023 increased by 6 percent; or

"(II) the base beneficiary premium computed under paragraph (2) for a month in 2024 that would have applied if this paragraph had not been enacted.

"(ii) 2025.—The base beneficiary premium for a month in 2025 shall be equal to the lesser of—

"(I) the base beneficiary premium computed under clause (i) for a month in 2024 increased by 6 percent; or

"(II) the base beneficiary premium computed under paragraph (2) for a month in 2025 that would have applied if this paragraph had not been enacted.

"(iii) 2026.—The base beneficiary premium for a month in 2026 shall be equal to the lesser of—

"(I) the base beneficiary premium computed under clause (ii) for a month in 2025 increased by 6 percent; or

"(II) the base beneficiary premium computed under paragraph (2) for a month in 2026 that would have applied if this paragraph had not been enacted.

"(iv) 2027.—The base beneficiary premium for a month in 2027 shall be equal to the lesser of—

"(I) the base beneficiary premium computed under clause (iii) for a month in 2026 increased by 6 percent; or

"(II) the base beneficiary premium computed under paragraph (2) for a month in 2027 that would have applied if this paragraph had not been enacted.

"(v) 2028.—The base beneficiary premium for a month in 2028 shall be equal to the lesser of—

"(I) the base beneficiary premium computed under clause (iv) for a month in 2027 increased by 6 percent; or

"(II) the base beneficiary premium computed under paragraph (2) for a month in 2028 that would have applied if this paragraph had not been enacted.

"(vi) 2029.—The base beneficiary premium for a month in 2029 shall be equal to the lesser of—

"(I) the base beneficiary premium computed under clause (v) for a month in 2028 increased by 6 percent; or

"(II) the base beneficiary premium computed under paragraph (2) for a month in 2029 that would have applied if this paragraph had not been enacted.

"(B) CLARIFICATION REGARDING 2030 AND SUBSEQUENT YEARS.—The base beneficiary premium for a month in 2030 or a subsequent year shall be computed under paragraph (2) without regard to this paragraph."; and

(B) in subsection (b)(3)(A)(ii), by striking "subsection (a)(2)" and inserting "paragraph (2) or (8) of subsection (a) (as applicable)".

(2) ADJUSTMENT TO BENEFICIARY PREMIUM PERCENTAGE FOR 2030 AND SUBSEQUENT YEARS.—Section 1860D–13(a) of the Social Security Act (42 U.S.C. 1395w–113(a)), as amended by paragraph (1), is amended—

(A) in paragraph (3)(A), by inserting "(or, for 2030 and each subsequent year, the percent specified under paragraph (9))" after "25.5 percent"; and

(B) by adding at the end the following new paragraph:

Time periods.
Determination.

"(9) PERCENT SPECIFIED.—

"(A) IN GENERAL.—Subject to subparagraph (B), for purposes of paragraph (3)(A), the percent specified under this paragraph for 2030 and each subsequent year is the percent that the Secretary determines is necessary to ensure that the base beneficiary premium computed under paragraph (2) for a month in 2030 is equal to the lesser of—

"(i) the base beneficiary premium computed under paragraph (8)(A)(vi) for a month in 2029 increased by 6 percent; or

"(ii) the base beneficiary premium computed under paragraph (2) for a month in 2030 that would have applied if this paragraph had not been enacted.

"(B) FLOOR.—The percent specified under subparagraph (A) may not be less than 20 percent.".

(3) CONFORMING AMENDMENTS.—

(A) Section 1854(b)(2)(B) of the Social Security Act 42 U.S.C. 1395w–24(b)(2)(B)) is amended by striking "section 1860D–13(a)(2)" and inserting "paragraph (2) or (8) (as applicable) of section 1860D–13(a)".

(B) Section 1860D–11(g)(6) of the Social Security Act (42 U.S.C. 1395w–111(g)(6)) is amended by inserting "(or, for 2030 and each subsequent year, the percent specified under section 1860D–13(a)(9))" after "25.5 percent".

(C) Section 1860D–13(a)(7)(B)(i) of the Social Security Act (42 U.S.C. 1395w–113(a)(7)(B)(i)) is amended—

(i) in subclause (I), by inserting "(or, for 2030 and each subsequent year, the percent specified under paragraph (9))" after "25.5 percent"; and

(ii) in subclause (II), by inserting "(or, for 2030 and each subsequent year, the percent specified under paragraph (9))" after "25.5 percent".

(D) Section 1860D–15(a) of the Social Security Act (42 U.S.C. 1395w–115(a)) is amended—

(i) in the matter preceding paragraph (1), by inserting "(or, for each of 2024 through 2029, the percent applicable as a result of the application of section 1860D–13(a)(8), or, for 2030 and each subsequent year, 100 percent minus the percent specified under section 1860D–13(a)(9))" after "74.5 percent"; and

(ii) in paragraph (1)(B), by striking "paragraph (2) of section 1860D–13(a)" and inserting "paragraph (2) or (8) of section 1860D–13(a) (as applicable)".

(e) CONFORMING AMENDMENTS.— Time periods.

(1) Section 1860D–2 of the Social Security Act (42 U.S.C. 1395w–102) is amended—

(A) in subsection (a)(2)(A)(i)(I), by striking ", or an increase in the initial" and inserting "or, for a year preceding 2025, an increase in the initial";

(B) in subsection (c)(1)(C)—

(i) in the subparagraph heading, by striking "AT INITIAL COVERAGE LIMIT"; and

(ii) by inserting "for a year preceding 2025 or the annual out-of-pocket threshold specified in subsection (b)(4)(B) for the year for 2025 and each subsequent year" after "subsection (b)(3) for the year" each place it appears; and

(C) in subsection (d)(1)(A), by striking "or an initial" and inserting "or, for a year preceding 2025, an initial".

(2) Section 1860D–4(a)(4)(B)(i) of the Social Security Act (42 U.S.C. 1395w–104(a)(4)(B)(i)) is amended by striking "the initial" and inserting "for a year preceding 2025, the initial".

(3) Section 1860D–14(a) of the Social Security Act (42 U.S.C. 1395w–114(a)) is amended—

(A) in paragraph (1)—

(i) in subparagraph (C), by striking "The continuation" and inserting "For a year preceding 2025, the continuation";

(ii) in subparagraph (D)(iii), by striking "1860D–2(b)(4)(A)(i)(I)" and inserting "1860D–2(b)(4)(A)(i)(I)(aa)"; and

(iii) in subparagraph (E), by striking "The elimination" and inserting "For a year preceding 2024, the elimination"; and

(B) in paragraph (2)(E), by striking "1860D–2(b)(4)(A)(i)(I)" and inserting "1860D–2(b)(4)(A)(i)(I)(aa)".

(4) Section 1860D–21(d)(7) of the Social Security Act (42 U.S.C. 1395w–131(d)(7)) is amended by striking "section 1860D–2(b)(4)(B)(i)" and inserting "section 1860D–2(b)(4)(C)(i)".

(5) Section 1860D–22(a)(2)(A) of the Social Security Act (42 U.S.C. 1395w–132(a)(2)(A)) is amended—

(A) by striking "the value of any discount" and inserting the following: "the value of—

"(i) for years prior to 2025, any discount";

(B) in clause (i), as inserted by subparagraph (A) of this paragraph, by striking the period at the end and inserting "; and"; and

(C) by adding at the end the following new clause:

"(ii) for 2025 and each subsequent year, any discount provided pursuant to section 1860D–14C.".

(6) Section 1860D–41(a)(6) of the Social Security Act (42 U.S.C. 1395w–151(a)(6)) is amended—

(A) by inserting "for a year before 2025" after "1860D–2(b)(3)"; and

(B) by inserting "for such year" before the period.

(7) Section 1860D–43 of the Social Security Act (42 U.S.C. 1395w–153) is amended—

(A) in subsection (a)—

(i) by striking paragraph (1) and inserting the following:

"(1) participate in—

"(A) for 2011 through 2024, the Medicare coverage gap discount program under section 1860D–14A; and

"(B) for 2025 and each subsequent year, the manufacturer discount program under section 1860D–14C;";

(ii) by striking paragraph (2) and inserting the following:

"(2) have entered into and have in effect—

"(A) for 2011 through 2024, an agreement described in subsection (b) of section 1860D–14A with the Secretary; and

"(B) for 2025 and each subsequent year, an agreement described in subsection (b) of section 1860D–14C with the Secretary; and"; and

(iii) in paragraph (3), by striking "such section" and inserting "section 1860D–14A"; and

(B) by striking subsection (b) and inserting the following:

Applicability.

"(b) EFFECTIVE DATE.—Paragraphs (1)(A), (2)(A), and (3) of subsection (a) shall apply to covered part D drugs dispensed under this part on or after January 1, 2011, and before January 1, 2025, and paragraphs (1)(B) and (2)(B) of such subsection shall apply to covered part D drugs dispensed under this part on or after January 1, 2025.".

(8) Section 1927 of the Social Security Act (42 U.S.C. 1396r–8) is amended—

(A) in subsection (c)(1)(C)(i)(VI), by inserting before the period at the end the following: "or under the manufacturer discount program under section 1860D–14C"; and

(B) in subsection (k)(1)(B)(i)(V), by inserting before the period at the end the following: "or under section 1860D–14C".

42 USC 1395w–102 note.

(f) IMPLEMENTATION FOR 2024 THROUGH 2026.—The Secretary shall implement this section, including the amendments made by this section, for 2024, 2025, and 2026 by program instruction or other forms of program guidance.

Time periods.

(g) FUNDING.—In addition to amounts otherwise available, there are appropriated to the Centers for Medicare & Medicaid Services, out of any money in the Treasury not otherwise appropriated, $341,000,000 for fiscal year 2022, including $20,000,000 and $65,000,000 to carry out the provisions of, including the amendments made by, this section in fiscal years 2022 and 2023, respectively, and $32,000,000 to carry out the provisions of, including the amendments made by, this section in each of fiscal years 2024 through 2031, to remain available until expended.

SEC. 11202. MAXIMUM MONTHLY CAP ON COST-SHARING PAYMENTS UNDER PRESCRIPTION DRUG PLANS AND MA–PD PLANS.

(a) IN GENERAL.—Section 1860D–2(b) of the Social Security Act (42 U.S.C. 1395w–102(b)) is amended—

(1) in paragraph (2)—

(A) in subparagraph (A), by striking "and (D)" and inserting ", (D), and (E)"; and

(B) by adding at the end the following new subparagraph:

"(E) MAXIMUM MONTHLY CAP ON COST-SHARING PAYMENTS.—

"(i) IN GENERAL.—For plan years beginning on or after January 1, 2025, each PDP sponsor offering a prescription drug plan and each MA organization offering an MA–PD plan shall provide to any enrollee of such plan, including an enrollee who is a subsidy eligible individual (as defined in paragraph (3) of section 1860D–14(a)), the option to elect with respect to a plan year to pay cost-sharing under the plan in monthly amounts that are capped in accordance with this subparagraph. Effective date.

"(ii) DETERMINATION OF MAXIMUM MONTHLY CAP.—For each month in the plan year for which an enrollee in a prescription drug plan or an MA–PD plan has made an election pursuant to clause (i), the PDP sponsor or MA organization shall determine a maximum monthly cap (as defined in clause (iv)) for such enrollee.

"(iii) BENEFICIARY MONTHLY PAYMENTS.—With respect to an enrollee who has made an election pursuant to clause (i), for each month described in clause (ii), the PDP sponsor or MA organization shall bill such enrollee an amount (not to exceed the maximum monthly cap) for the out-of-pocket costs of such enrollee in such month.

"(iv) MAXIMUM MONTHLY CAP DEFINED.—In this subparagraph, the term 'maximum monthly cap' means, with respect to an enrollee—

"(I) for the first month for which the enrollee has made an election pursuant to clause (i), an amount determined by calculating—

"(aa) the annual out-of-pocket threshold specified in paragraph (4)(B) minus the incurred costs of the enrollee as described in paragraph (4)(C); divided by

"(bb) the number of months remaining in the plan year; and

"(II) for a subsequent month, an amount determined by calculating—

"(aa) the sum of any remaining out-of-pocket costs owed by the enrollee from a previous month that have not yet been billed to the enrollee and any additional out-of-pocket costs incurred by the enrollee; divided by

"(bb) the number of months remaining in the plan year.

Applicability.

"(v) ADDITIONAL REQUIREMENTS.—The following requirements shall apply with respect to the option to make an election pursuant to clause (i) under this subparagraph:

"(I) SECRETARIAL RESPONSIBILITIES.—The Secretary shall provide information to part D eligible individuals on the option to make such election through educational materials, including through the notices provided under section 1804(a).

"(II) TIMING OF ELECTION.—An enrollee in a prescription drug plan or an MA–PD plan may make such an election—

"(aa) prior to the beginning of the plan year; or

"(bb) in any month during the plan year.

"(III) PDP SPONSOR AND MA ORGANIZATION RESPONSIBILITIES.—Each PDP sponsor offering a prescription drug plan or MA organization offering an MA–PD plan—

"(aa) may not limit the option for an enrollee to make such an election to certain covered part D drugs;

Notification.

"(bb) shall, prior to the plan year, notify prospective enrollees of the option to make such an election in promotional materials;

"(cc) shall include information on such option in enrollee educational materials;

Notification.

"(dd) shall have in place a mechanism to notify a pharmacy during the plan year when an enrollee incurs out-of-pocket costs with respect to covered part D drugs that make it likely the enrollee may benefit from making such an election;

"(ee) shall provide that a pharmacy, after receiving a notification described in item (dd) with respect to an enrollee, informs the enrollee of such notification;

"(ff) shall ensure that such an election by an enrollee has no effect on the amount paid to pharmacies (or the timing of such payments) with respect to covered part D drugs dispensed to the enrollee; and

"(gg) shall have in place a financial reconciliation process to correct inaccuracies in payments made by an enrollee under this subparagraph with respect to covered part D drugs during the plan year.

"(IV) FAILURE TO PAY AMOUNT BILLED.—If an enrollee fails to pay the amount billed for a month as required under this subparagraph—

"(aa) the election of the enrollee pursuant to clause (i) shall be terminated and the enrollee shall pay the cost-sharing otherwise applicable for any covered part D drugs subsequently dispensed to the enrollee up to the annual out-of-pocket threshold specified in paragraph (4)(B); and

"(bb) the PDP sponsor or MA organization may preclude the enrollee from making an election pursuant to clause (i) in a subsequent plan year.

"(V) CLARIFICATION REGARDING PAST DUE AMOUNTS.—Nothing in this subparagraph shall be construed as prohibiting a PDP sponsor or an MA organization from billing an enrollee for an amount owed under this subparagraph.

"(VI) TREATMENT OF UNSETTLED BALANCES.—Any unsettled balances with respect to amounts owed under this subparagraph shall be treated as plan losses and the Secretary shall not be liable for any such balances outside of those assumed as losses estimated in plan bids."; and

(2) in paragraph (4)—

(A) in subparagraph (C), by striking "subparagraph (E)" and inserting "subparagraph (E) or subparagraph (F)"; and

(B) by adding at the end the following new subparagraph:

"(F) INCLUSION OF COSTS PAID UNDER MAXIMUM MONTHLY CAP OPTION.—In applying subparagraph (A), with respect to an enrollee who has made an election pursuant to clause (i) of paragraph (2)(E), costs shall be treated as incurred if such costs are paid by a PDP sponsor or an MA organization under the option provided under such paragraph.".

(b) APPLICATION TO ALTERNATIVE PRESCRIPTION DRUG COVERAGE.—Section 1860D–2(c) of the Social Security Act (42 U.S.C. 1395w–102(c)) is amended by adding at the end the following new paragraph:

"(4) SAME MAXIMUM MONTHLY CAP ON COST-SHARING.—The maximum monthly cap on cost-sharing payments shall apply to coverage with respect to an enrollee who has made an election pursuant to clause (i) of subsection (b)(2)(E) under the option provided under such subsection.".

(c) IMPLEMENTATION FOR 2025.—The Secretary shall implement this section, including the amendments made by this section, for 2025 by program instruction or other forms of program guidance. 42 USC 1395w–102 note.

(d) FUNDING.—In addition to amounts otherwise available, there are appropriated to the Centers for Medicare & Medicaid Services, out of any money in the Treasury not otherwise appropriated, $10,000,000 for fiscal year 2023, to remain available until expended, to carry out the provisions of, including the amendments made by, this section. Time period.

PART 4—CONTINUED DELAY OF IMPLEMENTATION OF PRESCRIPTION DRUG REBATE RULE

42 USC 1320a–7b note.

SEC. 11301. EXTENSION OF MORATORIUM ON IMPLEMENTATION OF RULE RELATING TO ELIMINATING THE ANTI-KICKBACK STATUTE SAFE HARBOR PROTECTION FOR PRESCRIPTION DRUG REBATES.

Effective date.

The Secretary of Health and Human Services shall not, prior to January 1, 2032, implement, administer, or enforce the provisions of the final rule published by the Office of the Inspector General of the Department of Health and Human Services on November 30, 2020, and titled "Fraud and Abuse; Removal of Safe Harbor Protection for Rebates Involving Prescription Pharmaceuticals and Creation of New Safe Harbor Protection for Certain Point-of-Sale Reductions in Price on Prescription Pharmaceuticals and Certain Pharmacy Benefit Manager Service Fees" (85 Fed. Reg. 76666).

PART 5—MISCELLANEOUS

SEC. 11401. COVERAGE OF ADULT VACCINES RECOMMENDED BY THE ADVISORY COMMITTEE ON IMMUNIZATION PRACTICES UNDER MEDICARE PART D.

(a) ENSURING TREATMENT OF COST-SHARING AND DEDUCTIBLE IS CONSISTENT WITH TREATMENT OF VACCINES UNDER MEDICARE PART B.—Section 1860D–2 of the Social Security Act (42 U.S.C. 1395w–102), as amended by sections 11201 and 11202, is amended—

(1) in subsection (b)—

(A) in paragraph (1)(A), by striking "The coverage" and inserting "Subject to paragraph (8), the coverage";

(B) in paragraph (2)—

(i) in subparagraph (A), by inserting "and paragraph (8)" after "and (E)";

(ii) in subparagraph (C)(i), in the matter preceding subclause (I), by striking "paragraph (4)" and inserting "paragraphs (4) and (8)"; and

(iii) in subparagraph (D)(i), in the matter preceding subclause (I), by striking "paragraph (4)" and inserting "paragraphs (4) and (8)";

(C) in paragraph (3)(A), in the matter preceding clause (i), by striking "and (4)" and inserting "(4), and (8)";

(D) in paragraph (4)(A)(i), by striking "The coverage" and inserting "Subject to paragraph (8), the coverage"; and

(E) by adding at the end the following new paragraph:

"(8) TREATMENT OF COST-SHARING FOR ADULT VACCINES RECOMMENDED BY THE ADVISORY COMMITTEE ON IMMUNIZATION PRACTICES CONSISTENT WITH TREATMENT OF VACCINES UNDER PART B.—

Effective date.

"(A) IN GENERAL.—For plan years beginning on or after January 1, 2023, with respect to an adult vaccine recommended by the Advisory Committee on Immunization Practices (as defined in subparagraph (B))—

"(i) the deductible under paragraph (1) shall not apply; and

"(ii) there shall be no coinsurance or other cost-sharing under this part with respect to such vaccine.

"(B) ADULT VACCINES RECOMMENDED BY THE ADVISORY COMMITTEE ON IMMUNIZATION PRACTICES.—For purposes of this paragraph, the term 'adult vaccine recommended by the Advisory Committee on Immunization Practices' means a covered part D drug that is a vaccine licensed under section 351 of the Public Health Service Act for use by adult populations and administered in accordance with recommendations of the Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention."; and Definition.

(2) in subsection (c), by adding at the end the following new paragraph:

"(5) TREATMENT OF COST-SHARING FOR ADULT VACCINES RECOMMENDED BY THE ADVISORY COMMITTEE ON IMMUNIZATION PRACTICES.—The coverage is in accordance with subsection (b)(8).".

(b) CONFORMING AMENDMENTS TO COST-SHARING FOR LOW-INCOME INDIVIDUALS.—Section 1860D–14(a) of the Social Security Act (42 U.S.C. 1395w–114(a)), as amended by section 11201, is amended—

(1) in paragraph (1)(D), in each of clauses (ii) and (iii), by striking "In the case" and inserting "Subject to paragraph (6), in the case";

(2) in paragraph (2)—

(A) in subparagraph (B), by striking "A reduction" and inserting "Subject to section 1860D–2(b)(8), a reduction";

(B) in subparagraph (D), by striking "The substitution" and inserting "Subject to paragraph (6), the substitution"; and

(C) in subparagraph (E), by striking "subsection (c)" and inserting "paragraph (6) of this subsection and subsection (c)"; and

(3) by adding at the end the following new paragraph:

"(6) NO APPLICATION OF COST-SHARING OR DEDUCTIBLE FOR ADULT VACCINES RECOMMENDED BY THE ADVISORY COMMITTEE ON IMMUNIZATION PRACTICES.—For plan years beginning on or after January 1, 2023, with respect to an adult vaccine recommended by the Advisory Committee on Immunization Practices (as defined in section 1860D–2(b)(8)(B))— Effective date.

"(A) the deductible under section 1860D–2(b)(1) shall not apply; and

"(B) there shall be no cost-sharing under this section with respect to such vaccine.".

(c) TEMPORARY RETROSPECTIVE SUBSIDY.—

(1) IN GENERAL.—Section 1860D–15 of the Social Security Act (42 U.S.C. 1395w–115) is amended by adding at the end the following new subsection:

"(h) TEMPORARY RETROSPECTIVE SUBSIDY FOR REDUCTION IN COST-SHARING AND DEDUCTIBLE FOR ADULT VACCINES RECOMMENDED BY THE ADVISORY COMMITTEE ON IMMUNIZATION PRACTICES DURING 2023.—

"(1) IN GENERAL.—In addition to amounts otherwise payable under this section to a PDP sponsor of a prescription drug plan or an MA organization offering an MA–PD plan, for plan year 2023, the Secretary shall provide the PDP sponsor

or MA organization offering the plan subsidies in an amount equal to the aggregate reduction in cost-sharing and deductible by reason of the application of section 1860D–2(b)(8) for individuals under the plan during the year.

Deadline.

"(2) TIMING.—The Secretary shall provide a subsidy under paragraph (1), as applicable, not later than 18 months following the end of the applicable plan year.".

(2) TREATMENT AS INCURRED COSTS.—Section 1860D–2(b)(4)(C)(iii)(I) of the Social Security Act (42 U.S.C. 1395w–102(b)(4)(C)(iii)(I)), as amended by section 11201(a)(3)(C), is amended—

(A) in item (cc), by striking "or" at the end; and

(B) by adding at the end the following new item:

"(dd) under section 1860D–15(h); or".

42 USC 1395w–102 note.

(d) RULE OF CONSTRUCTION.—Nothing in this section shall be construed as limiting coverage under part D of title XVIII of the Social Security Act for vaccines that are not recommended by the Advisory Committee on Immunization Practices.

42 USC 1395w–102 note.

(e) IMPLEMENTATION FOR 2023 THROUGH 2025.—The Secretary shall implement this section, including the amendments made by this section, for 2023, 2024, and 2025, by program instruction or other forms of program guidance.

SEC. 11402. PAYMENT FOR BIOSIMILAR BIOLOGICAL PRODUCTS DURING INITIAL PERIOD.

Section 1847A(c)(4) of the Social Security Act (42 U.S.C. 1395w–3a(c)(4)) is amended—

(1) in each of subparagraphs (A) and (B), by redesignating clauses (i) and (ii) as subclauses (I) and (II), respectively, and moving such subclauses 2 ems to the right;

(2) by redesignating subparagraphs (A) and (B) as clauses (i) and (ii) and moving such clauses 2 ems to the right;

(3) by striking "UNAVAILABLE.—In the case" and inserting "UNAVAILABLE.—

"(A) IN GENERAL.—Subject to subparagraph (B), in the case"; and

(4) by adding at the end the following new subparagraph:

"(B) LIMITATION ON PAYMENT AMOUNT FOR BIOSIMILAR BIOLOGICAL PRODUCTS DURING INITIAL PERIOD.—In the case of a biosimilar biological product furnished on or after July 1, 2024, during the initial period described in subparagraph (A) with respect to the biosimilar biological product, the amount payable under this section for the biosimilar biological product is the lesser of the following:

Effective date.

"(i) The amount determined under clause (ii) of such subparagraph for the biosimilar biological product.

"(ii) The amount determined under subsection (b)(1)(B) for the reference biological product.".

SEC. 11403. TEMPORARY INCREASE IN MEDICARE PART B PAYMENT FOR CERTAIN BIOSIMILAR BIOLOGICAL PRODUCTS.

Section 1847A(b)(8) of the Social Security Act (42 U.S.C. 1395w–3a(b)(8)) is amended—

(1) by redesignating subparagraphs (A) and (B) as clauses (i) and (ii), respectively, and moving the margin of each such redesignated clause 2 ems to the right;

(2) by striking "PRODUCT.—The amount" and inserting the following: "PRODUCT.—

"(A) IN GENERAL.—Subject to subparagraph (B), the amount"; and

(3) by adding at the end the following new subparagraph:

"(B) TEMPORARY PAYMENT INCREASE.— Time periods.

"(i) IN GENERAL.—In the case of a qualifying biosimilar biological product that is furnished during the applicable 5-year period for such product, the amount specified in this paragraph for such product with respect to such period is the sum determined under subparagraph (A), except that clause (ii) of such subparagraph shall be applied by substituting '8 percent' for '6 percent'.

"(ii) APPLICABLE 5-YEAR PERIOD.—For purposes of clause (i), the applicable 5-year period for a qualifying biosimilar biological product is—

"(I) in the case of such a product for which payment was made under this paragraph as of September 30, 2022, the 5-year period beginning on October 1, 2022; and Effective date.

"(II) in the case of such a product for which payment is first made under this paragraph during a calendar quarter during the period beginning October 1, 2022, and ending December 31, 2027, the 5-year period beginning on the first day of such calendar quarter during which such payment is first made.

"(iii) QUALIFYING BIOSIMILAR BIOLOGICAL PRODUCT DEFINED.—For purposes of this subparagraph, the term 'qualifying biosimilar biological product' means a biosimilar biological product described in paragraph (1)(C) with respect to which—

"(I) in the case of a product described in clause (ii)(I), the average sales price under paragraph (8)(A)(i) for a calendar quarter during the 5-year period described in such clause is not more than the average sales price under paragraph (4)(A) for such quarter for the reference biological product; and

"(II) in the case of a product described in clause (ii)(II), the average sales price under paragraph (8)(A)(i) for a calendar quarter during the 5-year period described in such clause is not more than the average sales price under paragraph (4)(A) for such quarter for the reference biological product.".

SEC. 11404. EXPANDING ELIGIBILITY FOR LOW-INCOME SUBSIDIES UNDER PART D OF THE MEDICARE PROGRAM. Effective date.

Section 1860D–14(a) of the Social Security Act (42 U.S.C. 1395w–114(a)), as amended by sections 11201 and 11401, is amended—

(1) in the subsection heading, by striking "INDIVIDUALS" and all that follows through "LINE" and inserting "CERTAIN INDIVIDUALS";

(2) in paragraph (1)—

(A) by striking the paragraph heading and inserting "INDIVIDUALS WITH CERTAIN LOW INCOMES"; and

(B) in the matter preceding subparagraph (A)—

(i) by inserting "(or, with respect to a plan year beginning on or after January 1, 2024, 150 percent)" after "135 percent"; and

(ii) by inserting "(or, with respect to a plan year beginning on or after January 1, 2024, paragraph (3)(E))" after "the resources requirement described in paragraph (3)(D)"; and

(3) in paragraph (2)—

(A) by striking the paragraph heading and inserting "OTHER LOW-INCOME INDIVIDUALS"; and

(B) in the matter preceding subparagraph (A), by striking "In the case of a subsidy" and inserting "With respect to a plan year beginning before January 1, 2024, in the case of a subsidy".

SEC. 11405. IMPROVING ACCESS TO ADULT VACCINES UNDER MEDICAID AND CHIP.

(a) MEDICAID.—

(1) REQUIRING COVERAGE OF ADULT VACCINATIONS.—

(A) IN GENERAL.—Section 1902(a)(10)(A) of the Social Security Act (42 U.S.C. 1396a(a)(10)(A)) is amended in the matter preceding clause (i) by inserting "(13)(B)," after "(5),".

(B) MEDICALLY NEEDY.—Section 1902(a)(10)(C)(iv) of such Act (42 U.S.C. 1396a(a)(10)(C)(iv)) is amended by inserting ", (13)(B)," after "(5)".

(2) NO COST SHARING FOR VACCINATIONS.—

(A) GENERAL COST-SHARING LIMITATIONS.—Section 1916 of the Social Security Act (42 U.S.C. 1396o) is amended—

(i) in subsection (a)(2)—

(I) in subparagraph (G), by inserting a comma after "State plan";

(II) in subparagraph (H), by striking "; or" and inserting a comma;

(III) in subparagraph (I), by striking "; and" and inserting ", or"; and

(IV) by adding at the end the following new subparagraph:

"(J) vaccines described in section 1905(a)(13)(B) and the administration of such vaccines; and"; and

(ii) in subsection (b)(2)—

(I) in subparagraph (G), by inserting a comma after "State plan";

(II) in subparagraph (H), by striking "; or" and inserting a comma;

(III) in subparagraph (I), by striking "; and" and inserting ", or"; and

(IV) by adding at the end the following new subparagraph:

"(J) vaccines described in section 1905(a)(13)(B) and the administration of such vaccines; and".

(B) APPLICATION TO ALTERNATIVE COST SHARING.—Section 1916A(b)(3)(B) of the Social Security Act (42 U.S.C.

1396o–1(b)(3)(B)) is amended by adding at the end the following new clause:

"(xiv) Vaccines described in section 1905(a)(13)(B) and the administration of such vaccines.".

(3) INCREASED FMAP FOR ADULT VACCINES AND THEIR ADMINISTRATION.—Section 1905(b) of the Social Security Act (42 U.S.C. 1396d(b)) is amended—

(A) by striking "and (5)" and inserting "(5)";

(B) by striking "services and vaccines described in subparagraphs (A) and (B) of subsection (a)(13), and prohibits cost-sharing for such services and vaccines" and inserting "services described in subsection (a)(13)(A), and prohibits cost-sharing for such services";

(C) by striking "medical assistance for such services and vaccines" and inserting "medical assistance for such services"; and

(D) by inserting ", and (6) during the first 8 fiscal quarters beginning on or after the effective date of this clause, in the case of a State which, as of the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14', provides medical assistance for vaccines described in subsection (a)(13)(B) and their administration and prohibits cost-sharing for such vaccines, the Federal medical assistance percentage, as determined under this subsection and subsection (y), shall be increased by 1 percentage point with respect to medical assistance for such vaccines and their administration" before the first period. Time periods.

(b) CHIP.—

(1) REQUIRING COVERAGE OF ADULT VACCINATIONS.—Section 2103(c) of the Social Security Act (42 U.S.C. 1397cc(c)) is amended by adding at the end the following paragraph:

"(12) REQUIRED COVERAGE OF APPROVED, RECOMMENDED ADULT VACCINES AND THEIR ADMINISTRATION.—Regardless of the type of coverage elected by a State under subsection (a), if the State child health plan or a waiver of such plan provides child health assistance or pregnancy-related assistance (as defined in section 2112) to an individual who is 19 years of age or older, such assistance shall include coverage of vaccines described in section 1905(a)(13)(B) and their administration.".

(2) NO COST-SHARING FOR VACCINATIONS.—Section 2103(e)(2) of such Act (42 U.S.C. 1397cc(e)(2)) is amended by inserting "vaccines described in subsection (c)(12) (and the administration of such vaccines)," after "in vitro diagnostic products described in subsection (c)(10) (and administration of such products),".

(c) EFFECTIVE DATE.—The amendments made by this section take effect on the 1st day of the 1st fiscal quarter that begins on or after the date that is 1 year after the date of enactment of this Act and shall apply to expenditures made under a State plan or waiver of such plan under title XIX of the Social Security Act (42 U.S.C. 1396 through 1396w–6) or under a State child health plan or waiver of such plan under title XXI of such Act (42 U.S.C. 1397aa through 1397mm) on or after such effective date. Applicability. 42 USC 1396a note.

SEC. 11406. APPROPRIATE COST-SHARING FOR COVERED INSULIN PRODUCTS UNDER MEDICARE PART D.

(a) IN GENERAL.—Section 1860D–2 of the Social Security Act (42 U.S.C. 1395w–102), as amended by sections 11201, 11202, and 11401, is amended—

(1) in subsection (b)—

(A) in paragraph (1)(A), by striking "paragraph (8)" and inserting "paragraphs (8) and (9)";

(B) in paragraph (2)—

(i) in subparagraph (A), by striking "paragraph (8)" and inserting "paragraphs (8) and (9)";

(ii) in subparagraph (C)(i), in the matter preceding subclause (I), by striking "and (8)" and inserting ", (8), and (9)"; and

(iii) in subparagraph (D)(i), in the matter preceding subclause (I), by striking "and (8)" and inserting ", (8), and (9)";

(C) in paragraph (3)(A), in the matter preceding clause (i), by striking "and (8)" and inserting "(8), and (9)";

(D) in paragraph (4)(A)(i), by striking "paragraph (8)" and inserting "paragraphs (8) and (9)"; and

(E) by adding at the end the following new paragraph:

"(9) TREATMENT OF COST-SHARING FOR COVERED INSULIN PRODUCTS.—

Time periods.

"(A) NO APPLICATION OF DEDUCTIBLE.—For plan year 2023 and subsequent plan years, the deductible under paragraph (1) shall not apply with respect to any covered insulin product.

"(B) APPLICATION OF COST-SHARING.—

"(i) PLAN YEARS 2023 AND 2024.—For plan years 2023 and 2024, the coverage provides benefits for any covered insulin product, regardless of whether an individual has reached the initial coverage limit under paragraph (3) or the out-of-pocket threshold under paragraph (4), with cost-sharing for a month's supply that does not exceed the applicable copayment amount.

"(ii) PLAN YEAR 2025 AND SUBSEQUENT PLAN YEARS.—For a plan year beginning on or after January 1, 2025, the coverage provides benefits for any covered insulin product, prior to an individual reaching the out-of-pocket threshold under paragraph (4), with cost-sharing for a month's supply that does not exceed the applicable copayment amount.

Definition.

"(C) COVERED INSULIN PRODUCT.—In this paragraph, the term 'covered insulin product' means an insulin product that is a covered part D drug covered under the prescription drug plan or MA–PD plan that is approved under section 505 of the Federal Food, Drug, and Cosmetic Act or licensed under section 351 of the Public Health Service Act and marketed pursuant to such approval or licensure, including any covered insulin product that has been deemed to be licensed under section 351 of the Public Health Service Act pursuant to section 7002(e)(4) of the Biologics Price Competition and Innovation Act of 2009 and marketed pursuant to such section.

Definition.

"(D) APPLICABLE COPAYMENT AMOUNT.—In this paragraph, the term 'applicable copayment amount' means, with

respect to a covered insulin product under a prescription drug plan or an MA–PD plan dispensed—

"(i) during plan years 2023, 2024, and 2025, $35; and

"(ii) during plan year 2026 and each subsequent plan year, the lesser of—

"(I) $35;

"(II) an amount equal to 25 percent of the maximum fair price established for the covered insulin product in accordance with part E of title XI; or

"(III) an amount equal to 25 percent of the negotiated price of the covered insulin product under the prescription drug plan or MA–PD plan.

"(E) SPECIAL RULE FOR FIRST 3 MONTHS OF 2023.—With respect to a month's supply of a covered insulin product dispensed during the period beginning on January 1, 2023, and ending on March 31, 2023, a PDP sponsor offering a prescription drug plan or an MA organization offering an MA–PD plan shall reimburse an enrollee within 30 days for any cost-sharing paid by such enrollee that exceeds the cost-sharing applied by the prescription drug plan or MA–PD plan under subparagraph (B)(i) at the point-of-sale for such month's supply."; and

Reimbursement. Deadline.

(2) in subsection (c), by adding at the end the following new paragraph:

"(6) TREATMENT OF COST-SHARING FOR COVERED INSULIN PRODUCTS.—The coverage is provided in accordance with subsection (b)(9).".

(b) CONFORMING AMENDMENTS TO COST-SHARING FOR LOW-INCOME INDIVIDUALS.—Section 1860D–14(a) of the Social Security Act (42 U.S.C. 1395w–114(a)), as amended by sections 11201, 11401, and 11404, is amended—

(1) in paragraph (1)—

Time periods.

(A) in subparagraph (D)(iii), by adding at the end the following new sentence: "For plan year 2023 and subsequent plan years, the copayment amount applicable under the preceding sentence to a month's supply of a covered insulin product (as defined in section 1860D–2(b)(9)(C)) dispensed to the individual may not exceed the applicable copayment amount for the product under the prescription drug plan or MA–PD plan in which the individual is enrolled."; and

(B) in subparagraph (E), by inserting the following before the period at the end: "or under section 1860D–2(b)(9) in the case of a covered insulin product (as defined in subparagraph (C) of such section)"; and

(2) in paragraph (2)—

(A) in subparagraph (B), by striking "section 1860D–2(b)(8)" and inserting "paragraphs (8) and (9) of section 1860D–2(b)";

(B) in subparagraph (D), by adding at the end the following new sentence: "For plan year 2023, the amount of the coinsurance applicable under the preceding sentence to a month's supply of a covered insulin product (as defined in section 1860D–2(b)(9)(C)) dispensed to the individual may not exceed the applicable copayment amount for the

product under the prescription drug plan or MA–PD plan in which the individual is enrolled."; and

(C) in subparagraph (E), by adding at the end the following new sentence: "For plan year 2023, the amount of the copayment or coinsurance applicable under the preceding sentence to a month's supply of a covered insulin product (as defined in section 1860D–2(b)(9)(C)) dispensed to the individual may not exceed the applicable copayment amount for the product under the prescription drug plan or MA–PD plan in which the individual is enrolled.".

(c) TEMPORARY RETROSPECTIVE SUBSIDY.—Section 1860D–15(h) of the Social Security Act (42 U.S.C. 1395w–115(h)), as added by section 11401(c), is amended—

(1) in the subsection heading, by inserting "AND INSULIN" after "PRACTICES"; and

(2) in paragraph (1), by striking "section 1860D–2(b)(8)" and inserting "paragraph (8) or (9) of section 1860D–2(b)".

42 USC 1395w–102 note.

(d) IMPLEMENTATION FOR 2023 THROUGH 2025.—The Secretary shall implement this section for plan years 2023, 2024, and 2025 by program instruction or other forms of program guidance.

(e) FUNDING.—In addition to amounts otherwise available, there is appropriated to the Centers for Medicare & Medicaid Services, out of any money in the Treasury not otherwise appropriated, $1,500,000 for fiscal year 2022, to remain available until expended, to carry out the provisions of, including the amendments made by, this section.

Effective dates.

SEC. 11407. LIMITATION ON MONTHLY COINSURANCE AND ADJUSTMENTS TO SUPPLIER PAYMENT UNDER MEDICARE PART B FOR INSULIN FURNISHED THROUGH DURABLE MEDICAL EQUIPMENT.

(a) WAIVER OF DEDUCTIBLE.—The first sentence of section 1833(b) of the Social Security Act (42 U.S.C. 1395l(b)) is amended—

(1) by striking "and (12)" and inserting "(12)"; and

(2) by inserting before the period the following: ", and (13) such deductible shall not apply with respect to insulin furnished on or after July 1, 2023, through an item of durable medical equipment covered under section 1861(n).".

(b) COINSURANCE.—

(1) IN GENERAL.—Section 1833(a)(1)(S) of the Social Security Act (42 U.S.C. 1395l(a)(1)(S)) is amended—

(A) by inserting "(i) except as provided in clause (ii)," after "(S)"; and

(B) by inserting after "or 1847B)," the following: "and (ii) with respect to insulin furnished on or after July 1, 2023, through an item of durable medical equipment covered under section 1861(n), the amounts paid shall be, subject to the fourth sentence of this subsection, 80 percent of the payment amount established under section 1847A (or section 1847B, if applicable) for such insulin,".

(2) ADJUSTMENT TO SUPPLIER PAYMENTS; LIMITATION ON MONTHLY COINSURANCE.—Section 1833(a) of the Social Security Act (42 U.S.C. 1395l(a)) is amended, in the flush matter at the end, by adding at the end the following new sentence: "The Secretary shall make such adjustments as may be necessary to the amounts paid as specified under paragraph (1)(S)(ii) for insulin furnished on or after July 1, 2023, through

an item of durable medical equipment covered under section 1861(n), such that the amount of coinsurance payable by an individual enrolled under this part for a month's supply of such insulin does not exceed $35.".

(c) IMPLEMENTATION.—The Secretary of Health and Human Services shall implement this section for 2023 by program instruction or other forms of program guidance. 42 USC 1395*l* note.

SEC. 11408. SAFE HARBOR FOR ABSENCE OF DEDUCTIBLE FOR INSULIN.

(a) IN GENERAL.—Paragraph (2) of section 223(c) of the Internal Revenue Code of 1986 is amended by adding at the end the following new subparagraph: 26 USC 223.

"(G) SAFE HARBOR FOR ABSENCE OF DEDUCTIBLE FOR CERTAIN INSULIN PRODUCTS.—

"(i) IN GENERAL.—A plan shall not fail to be treated as a high deductible health plan by reason of failing to have a deductible for selected insulin products.

"(ii) SELECTED INSULIN PRODUCTS.—For purposes of this subparagraph— Definitions.

"(I) IN GENERAL.—The term 'selected insulin products' means any dosage form (such as vial, pump, or inhaler dosage forms) of any different type (such as rapid-acting, short-acting, intermediate-acting, long-acting, ultra long-acting, and premixed) of insulin.

"(II) INSULIN.—The term 'insulin' means insulin that is licensed under subsection (a) or (k) of section 351 of the Public Health Service Act (42 U.S.C. 262) and continues to be marketed under such section, including any insulin product that has been deemed to be licensed under section 351(a) of such Act pursuant to section 7002(e)(4) of the Biologics Price Competition and Innovation Act of 2009 (Public Law 111–148) and continues to be marketed pursuant to such licensure.".

(b) EFFECTIVE DATE.—The amendment made by this section shall apply to plan years beginning after December 31, 2022. 26 USC 223 note.

Subtitle C—Affordable Care Act Subsidies

SEC. 12001. IMPROVE AFFORDABILITY AND REDUCE PREMIUM COSTS OF HEALTH INSURANCE FOR CONSUMERS.

(a) IN GENERAL.—Clause (iii) of section 36B(b)(3)(A) of the Internal Revenue Code of 1986 is amended—

(1) by striking "in 2021 or 2022" and inserting "after December 31, 2020, and before January 1, 2026", and

(2) by striking "2021 AND 2022" in the heading and inserting "2021 THROUGH 2025".

(b) EXTENSION THROUGH 2025 OF RULE TO ALLOW CREDIT TO TAXPAYERS WHOSE HOUSEHOLD INCOME EXCEEDS 400 PERCENT OF THE POVERTY LINE.—Section 36B(c)(1)(E) of the Internal Revenue Code of 1986 is amended—

(1) by striking "in 2021 or 2022" and inserting "after December 31, 2020, and before January 1, 2026", and

(2) by striking "2021 AND 2022" in the heading and inserting "2021 THROUGH 2025".

26 USC 36B note.

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to taxable years beginning after December 31, 2022.

Subtitle D—Energy Security

SEC. 13001. AMENDMENT OF 1986 CODE.

Except as otherwise expressly provided, whenever in this subtitle an amendment or repeal is expressed in terms of an amendment to, or repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of the Internal Revenue Code of 1986.

PART 1—CLEAN ELECTRICITY AND REDUCING CARBON EMISSIONS

SEC. 13101. EXTENSION AND MODIFICATION OF CREDIT FOR ELECTRICITY PRODUCED FROM CERTAIN RENEWABLE RESOURCES.

26 USC 45.

(a) IN GENERAL.—The following provisions of section 45(d) are each amended by striking "January 1, 2022" each place it appears and inserting "January 1, 2025":

(1) Paragraph (2)(A).
(2) Paragraph (3)(A).
(3) Paragraph (6).
(4) Paragraph (7).
(5) Paragraph (9).
(6) Paragraph (11)(B).

(b) BASE CREDIT AMOUNT.—Section 45 is amended—

(1) in subsection (a)(1), by striking "1.5 cents" and inserting "0.3 cents", and

(2) in subsection (b)(2), by striking "1.5 cent" and inserting "0.3 cent".

(c) APPLICATION OF EXTENSION TO GEOTHERMAL AND SOLAR.—Section 45(d)(4) is amended by striking "and which" and all that follows through "January 1, 2022" and inserting "and the construction of which begins before January 1, 2025".

(d) EXTENSION OF ELECTION TO TREAT QUALIFIED FACILITIES AS ENERGY PROPERTY.—Section 48(a)(5)(C)(ii) is amended by striking "January 1, 2022" and inserting "January 1, 2025".

(e) APPLICATION OF EXTENSION TO WIND FACILITIES.—

(1) IN GENERAL.—Section 45(d)(1) is amended by striking "January 1, 2022" and inserting "January 1, 2025".

(2) APPLICATION OF PHASEOUT PERCENTAGE.—

(A) RENEWABLE ELECTRICITY PRODUCTION CREDIT.—Section 45(b)(5) is amended by inserting "which is placed in service before January 1, 2022" after "using wind to produce electricity".

(B) ENERGY CREDIT.—Section 48(a)(5)(E) is amended by inserting "placed in service before January 1, 2022, and" before "treated as energy property".

(3) QUALIFIED OFFSHORE WIND FACILITIES UNDER ENERGY CREDIT.—Section 48(a)(5)(F)(i) is amended by striking "offshore wind facility" and all that follows and inserting the following: "offshore wind facility, subparagraph (E) shall not apply.".

(f) WAGE AND APPRENTICESHIP REQUIREMENTS.—Section 45(b) is amended by adding at the end the following new paragraphs: 26 USC 45.

"(6) INCREASED CREDIT AMOUNT FOR QUALIFIED FACILITIES.—

"(A) IN GENERAL.—In the case of any qualified facility which satisfies the requirements of subparagraph (B), the amount of the credit determined under subsection (a) (determined after the application of paragraphs (1) through (5) and without regard to this paragraph) shall be equal to such amount multiplied by 5.

"(B) QUALIFIED FACILITY REQUIREMENTS.—A qualified facility meets the requirements of this subparagraph if it is one of the following:

"(i) A facility with a maximum net output of less than 1 megawatt (as measured in alternating current).

"(ii) A facility the construction of which begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (7)(A) and (8). Time period. Publication. Guidelines.

"(iii) A facility which satisfies the requirements of paragraphs (7)(A) and (8).

"(7) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any qualified facility are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in—

"(i) the construction of such facility, and

"(ii) with respect to any taxable year, for any portion of such taxable year which is within the period described in subsection (a)(2)(A)(ii), the alteration or repair of such facility, Determination.

shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such facility is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code. For purposes of determining an increased credit amount under paragraph (6)(A) for a taxable year, the requirement under clause (ii) is applied to such taxable year in which the alteration or repair of the qualified facility occurs." Applicability.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—

"(i) IN GENERAL.—In the case of any taxpayer which fails to satisfy the requirement under subparagraph (A) with respect to the construction of any qualified facility or with respect to the alteration or repair of a facility in any year during the period described in subparagraph (A)(ii), such taxpayer shall be deemed to have satisfied such requirement under such subparagraph with respect to such facility for any year if, with respect to any laborer or mechanic who was paid wages at a rate below the rate described in such subparagraph for any period during such year, such taxpayer—

"(I) makes payment to such laborer or mechanic in an amount equal to the sum of—

"(aa) an amount equal to the difference between—

"(AA) the amount of wages paid to such laborer or mechanic during such period, and

"(BB) the amount of wages required to be paid to such laborer or mechanic pursuant to such subparagraph during such period, plus

"(bb) interest on the amount determined under item (aa) at the underpayment rate established under section 6621 (determined by substituting '6 percentage points' for '3 percentage points' in subsection (a)(2) of such section) for the period described in such item, and

"(II) makes payment to the Secretary of a penalty in an amount equal to the product of—

"(aa) $5,000, multiplied by

"(bb) the total number of laborers and mechanics who were paid wages at a rate below the rate described in subparagraph (A) for any period during such year.

"(ii) DEFICIENCY PROCEDURES NOT TO APPLY.—Subchapter B of chapter 63 (relating to deficiency procedures for income, estate, gift, and certain excise taxes) shall not apply with respect to the assessment or collection of any penalty imposed by this paragraph.

Determination. Applicability.

"(iii) INTENTIONAL DISREGARD.—If the Secretary determines that any failure described in clause (i) is due to intentional disregard of the requirements under subparagraph (A), such clause shall be applied—

"(I) in subclause (I), by substituting 'three times the sum' for 'the sum', and

"(II) in subclause (II), by substituting '$10,000' for '5,000' in item (aa) thereof.

Regulations. Deadline.

"(iv) LIMITATION ON PERIOD FOR PAYMENT.—Pursuant to rules issued by the Secretary, in the case of a final determination by the Secretary with respect to any failure by the taxpayer to satisfy the requirement under subparagraph (A), subparagraph (B)(i) shall not apply unless the payments described in subclauses (I) and (II) of such subparagraph are made by the taxpayer on or before the date which is 180 days after the date of such determination.

"(8) APPRENTICESHIP REQUIREMENTS.—The requirements described in this paragraph with respect to the construction of any qualified facility are as follows:

"(A) LABOR HOURS.—

"(i) PERCENTAGE OF TOTAL LABOR HOURS.—Taxpayers shall ensure that, with respect to the construction of any qualified facility, not less than the applicable percentage of the total labor hours of the construction, alteration, or repair work (including such work performed by any contractor or subcontractor)

with respect to such facility shall, subject to subparagraph (B), be performed by qualified apprentices.

"(ii) APPLICABLE PERCENTAGE.—For purposes of clause (i), the applicable percentage shall be— Effective dates.

"(I) in the case of a qualified facility the construction of which begins before January 1, 2023, 10 percent,

"(II) in the case of a qualified facility the construction of which begins after December 31, 2022, and before January 1, 2024, 12.5 percent, and

"(III) in the case of a qualified facility the construction of which begins after December 31, 2023, 15 percent.

"(B) APPRENTICE TO JOURNEYWORKER RATIO.—The requirement under subparagraph (A)(i) shall be subject to any applicable requirements for apprentice-to-journeyworker ratios of the Department of Labor or the applicable State apprenticeship agency.

"(C) PARTICIPATION.—Each taxpayer, contractor, or subcontractor who employs 4 or more individuals to perform construction, alteration, or repair work with respect to the construction of a qualified facility shall employ 1 or more qualified apprentices to perform such work.

"(D) EXCEPTION.—

"(i) IN GENERAL.—A taxpayer shall not be treated as failing to satisfy the requirements of this paragraph if such taxpayer—

"(I) satisfies the requirements described in clause (ii), or

"(II) subject to clause (iii), in the case of any failure by the taxpayer to satisfy the requirement under subparagraphs (A) and (C) with respect to the construction, alteration, or repair work on any qualified facility to which subclause (I) does not apply, makes payment to the Secretary of a penalty in an amount equal to the product of—

"(aa) $50, multiplied by

"(bb) the total labor hours for which the requirement described in such subparagraph was not satisfied with respect to the construction, alteration, or repair work on such qualified facility.

"(ii) GOOD FAITH EFFORT.—For purposes of clause (i), a taxpayer shall be deemed to have satisfied the requirements under this paragraph with respect to a qualified facility if such taxpayer has requested qualified apprentices from a registered apprenticeship program, as defined in section 3131(e)(3)(B), and—

"(I) such request has been denied, provided that such denial is not the result of a refusal by the taxpayer or any contractors or subcontractors engaged in the performance of construction, alteration, or repair work with respect to such qualified facility to comply with the established standards and requirements of the registered apprenticeship program, or

Deadline.

"(II) the registered apprenticeship program fails to respond to such request within 5 business days after the date on which such registered apprenticeship program received such request.

Determination.

"(iii) INTENTIONAL DISREGARD.—If the Secretary determines that any failure described in subclause (i)(II) is due to intentional disregard of the requirements under subparagraphs (A) and (C), subclause (i)(II) shall be applied by substituting '$500' for '$50' in item (aa) thereof.

"(E) DEFINITIONS.—For purposes of this paragraph—

"(i) LABOR HOURS.—The term 'labor hours'—

"(I) means the total number of hours devoted to the performance of construction, alteration, or repair work by any individual employed by the taxpayer or by any contractor or subcontractor, and

"(II) excludes any hours worked by—

"(aa) foremen,

"(bb) superintendents,

"(cc) owners, or

"(dd) persons employed in a bona fide executive, administrative, or professional capacity (within the meaning of those terms in part 541 of title 29, Code of Federal Regulations).

"(ii) QUALIFIED APPRENTICE.—The term 'qualified apprentice' means an individual who is employed by the taxpayer or by any contractor or subcontractor and who is participating in a registered apprenticeship program, as defined in section 3131(e)(3)(B).

Determination.

"(9) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.".

(g) DOMESTIC CONTENT, PHASEOUT, AND ENERGY COMMUNITIES.—Section 45(b), as amended by subsection (f), is amended—

26 USC 45.

(1) by redesignating paragraph (9) as paragraph (12), and

(2) by inserting after paragraph (8) the following:

"(9) DOMESTIC CONTENT BONUS CREDIT AMOUNT.—

"(A) IN GENERAL.—In the case of any qualified facility which satisfies the requirement under subparagraph (B)(i), the amount of the credit determined under subsection (a) (determined after the application of paragraphs (1) through (8)) shall be increased by an amount equal to 10 percent of the amount so determined.

"(B) REQUIREMENT.—

Certification.

"(i) IN GENERAL.—The requirement described in this clause is satisfied with respect to any qualified facility if the taxpayer certifies to the Secretary (at such time, and in such form and manner, as the Secretary may prescribe) that any steel, iron, or manufactured product which is a component of such facility (upon completion of construction) was produced in the

United States (as determined under section 661 of title 49, Code of Federal Regulations).

"(ii) STEEL AND IRON.—In the case of steel or iron, clause (i) shall be applied in a manner consistent with section 661.5 of title 49, Code of Federal Regulations. Applicability.

"(iii) MANUFACTURED PRODUCT.—For purposes of clause (i), the manufactured products which are components of a qualified facility upon completion of construction shall be deemed to have been produced in the United States if not less than the adjusted percentage (as determined under subparagraph (C)) of the total costs of all such manufactured products of such facility are attributable to manufactured products (including components) which are mined, produced, or manufactured in the United States.

"(C) ADJUSTED PERCENTAGE.—

"(i) IN GENERAL.—Subject to subclause (ii), for purposes of subparagraph (B)(iii), the adjusted percentage shall be 40 percent.

"(ii) OFFSHORE WIND FACILITY.—For purposes of subparagraph (B)(iii), in the case of a qualified facility which is an offshore wind facility, the adjusted percentage shall be 20 percent.

"(10) PHASEOUT FOR ELECTIVE PAYMENT.—

"(A) IN GENERAL.—In the case of a taxpayer making an election under section 6417 with respect to a credit under this section, the amount of such credit shall be replaced with—

"(i) the value of such credit (determined without regard to this paragraph), multiplied by

"(ii) the applicable percentage.

"(B) 100 PERCENT APPLICABLE PERCENTAGE FOR CERTAIN QUALIFIED FACILITIES.—In the case of any qualified facility—

"(i) which satisfies the requirements under paragraph (9)(B), or

"(ii) with a maximum net output of less than 1 megawatt (as measured in alternating current),

the applicable percentage shall be 100 percent.

"(C) PHASED DOMESTIC CONTENT REQUIREMENT.—Subject to subparagraph (D), in the case of any qualified facility which is not described in subparagraph (B), the applicable percentage shall be— Effective dates.

"(i) if construction of such facility began before January 1, 2024, 100 percent, and

"(ii) if construction of such facility began in calendar year 2024, 90 percent.

"(D) EXCEPTION.—

"(i) IN GENERAL.—For purposes of this paragraph, the Secretary shall provide exceptions to the requirements under this paragraph if—

"(I) the inclusion of steel, iron, or manufactured products which are produced in the United States increases the overall costs of construction of qualified facilities by more than 25 percent, or

"(II) relevant steel, iron, or manufactured products are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality.

"(ii) APPLICABLE PERCENTAGE.—In any case in which the Secretary provides an exception pursuant to clause (i), the applicable percentage shall be 100 percent.

"(11) SPECIAL RULE FOR QUALIFIED FACILITY LOCATED IN ENERGY COMMUNITY.—

"(A) IN GENERAL.—In the case of a qualified facility which is located in an energy community, the credit determined under subsection (a) (determined after the application of paragraphs (1) through (10), without the application of paragraph (9)) shall be increased by an amount equal to 10 percent of the amount so determined.

Definition.

"(B) ENERGY COMMUNITY.—For purposes of this paragraph, the term 'energy community' means—

"(i) a brownfield site (as defined in subparagraphs (A), (B), and (D)(ii)(III) of section 101(39) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. 9601(39))),

Determinations.

"(ii) a metropolitan statistical area or non-metropolitan statistical area which—

"(I) has (or, at any time during the period beginning after December 31, 2009, had) 0.17 percent or greater direct employment or 25 percent or greater local tax revenues related to the extraction, processing, transport, or storage of coal, oil, or natural gas (as determined by the Secretary), and

"(II) has an unemployment rate at or above the national average unemployment rate for the previous year (as determined by the Secretary), or

"(iii) a census tract—

Effective dates.

"(I) in which—

"(aa) after December 31, 1999, a coal mine has closed, or

"(bb) after December 31, 2009, a coal-fired electric generating unit has been retired, or

"(II) which is directly adjoining to any census tract described in subclause (I).".

26 USC 45.

(h) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—Section 45(b)(3) is amended to read as follows:

"(3) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—The amount of the credit determined under subsection (a) with respect to any facility for any taxable year (determined after the application of paragraphs (1) and (2)) shall be reduced by the amount which is the product of the amount so determined for such year and the lesser of 15 percent or a fraction—

"(A) the numerator of which is the sum, for the taxable year and all prior taxable years, of proceeds of an issue of any obligations the interest on which is exempt from tax under section 103 and which is used to provide financing for the qualified facility, and

"(B) the denominator of which is the aggregate amount of additions to the capital account for the qualified facility for the taxable year and all prior taxable years.

The amounts under the preceding sentence for any taxable year shall be determined as of the close of the taxable year.". Determination.

(i) ROUNDING ADJUSTMENT.—

(1) IN GENERAL.—Section 45(b)(2) is amended by striking the second sentence and inserting the following: "If the 0.3 cent amount as increased under the preceding sentence is not a multiple of 0.05 cent, such amount shall be rounded to the nearest multiple of 0.05 cent. In any other case, if an amount as increased under this paragraph is not a multiple of 0.1 cent, such amount shall be rounded to the nearest multiple of 0.1 cent.". 26 USC 45.

(2) CONFORMING AMENDMENT.—Section 45(b)(4)(A) is amended by striking "last sentence" and inserting "last two sentences".

(j) HYDROPOWER.—

(1) ELIMINATION OF CREDIT RATE REDUCTION FOR QUALIFIED HYDROELECTRIC PRODUCTION AND MARINE AND HYDROKINETIC RENEWABLE ENERGY.—Section 45(b)(4)(A), as amended by the preceding provisions of this section, is amended by striking "(7), (9), or (11)" and inserting "or (7)".

(2) MARINE AND HYDROKINETIC RENEWABLE ENERGY.—Section 45 is amended—

(A) in subsection (c)(10)(A)—

(i) in clause (iii), by striking "or",

(ii) in clause (iv), by striking the period at the end and inserting ", or" and

(iii) by adding at the end the following:

"(v) pressurized water used in a pipeline (or similar man-made water conveyance) which is operated—

"(I) for the distribution of water for agricultural, municipal, or industrial consumption, and

"(II) not primarily for the generation of electricity.", and

(B) in subsection (d)(11)(A), by striking "150" and inserting "25".

(k) EFFECTIVE DATES.— Applicability. 26 USC 45 note.

(1) IN GENERAL.—Except as provided in paragraphs (2) and (3), the amendments made by this section shall apply to facilities placed in service after December 31, 2021.

(2) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—The amendment made by subsection (h) shall apply to facilities the construction of which begins after the date of enactment of this Act.

(3) DOMESTIC CONTENT, PHASEOUT, ENERGY COMMUNITIES, AND HYDROPOWER.—The amendments made by subsections (g) and (j) shall apply to facilities placed in service after December 31, 2022.

SEC. 13102. EXTENSION AND MODIFICATION OF ENERGY CREDIT.

(a) EXTENSION OF CREDIT.—The following provisions of section 48 are each amended by striking "January 1, 2024" each place it appears and inserting "January 1, 2025":

(1) Subsection (a)(2)(A)(i)(II).

(2) Subsection (a)(3)(A)(ii).

(3) Subsection (c)(1)(D).
(4) Subsection (c)(2)(D).
(5) Subsection (c)(3)(A)(iv).
(6) Subsection (c)(4)(C).
(7) Subsection (c)(5)(D).

(b) FURTHER EXTENSION FOR CERTAIN ENERGY PROPERTY.—Section 48(a)(3)(A)(vii) is amended by striking "January 1, 2024" and inserting "January 1, 2035". 26 USC 48.

(c) PHASEOUT OF CREDIT.—Section 48(a) is amended by striking paragraphs (6) and (7) and inserting the following new paragraph:

Effective dates.

"(6) PHASEOUT FOR CERTAIN ENERGY PROPERTY.—In the case of any qualified fuel cell property, qualified small wind property, or energy property described in clause (i) or clause (ii) of paragraph (3)(A) the construction of which begins after December 31, 2019, and which is placed in service before January 1, 2022, the energy percentage determined under paragraph (2) shall be equal to 26 percent.".

(d) BASE ENERGY PERCENTAGE AMOUNT; PHASEOUT OF CERTAIN ENERGY PROPERTY.—

(1) BASE ENERGY PERCENTAGE AMOUNT.—Section 48(a) is amended—

(A) in paragraph (2)(A)—

(i) in clause (i), by striking "30 percent" and inserting "6 percent", and

(ii) in clause (ii), by striking "10 percent" and inserting "2 percent", and

(B) in paragraph (5)(A)(ii), by striking "30 percent" and inserting "6 percent".

(2) PHASEOUT OF CERTAIN ENERGY PROPERTY.—Section 48(a), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraph:

Effective dates.
Time periods.

"(7) PHASEOUT FOR CERTAIN ENERGY PROPERTY.—In the case of any energy property described in clause (vii) of paragraph (3)(A), the energy percentage determined under paragraph (2) shall be equal to—

"(A) in the case of any property the construction of which begins before January 1, 2033, and which is placed in service after December 31, 2021, 6 percent,

"(B) in the case of any property the construction of which begins after December 31, 2032, and before January 1, 2034, 5.2 percent, and

"(C) in the case of any property the construction of which begins after December 31, 2033, and before January 1, 2035, 4.4 percent.".

(e) 6 PERCENT CREDIT FOR GEOTHERMAL.—Section 48(a)(2)(A)(i)(II) is amended by striking "paragraph (3)(A)(i)" and inserting "clause (i) or (iii) of paragraph (3)(A)".

(f) ENERGY STORAGE TECHNOLOGIES; QUALIFIED BIOGAS PROPERTY; MICROGRID CONTROLLERS; EXTENSION OF OTHER PROPERTY.—

(1) IN GENERAL.—Section 48(a)(3)(A) is amended by striking "or" at the end of clause (vii), and by adding at the end the following new clauses:

"(ix) energy storage technology,
"(x) qualified biogas property, or
"(xi) microgrid controllers,".

(2) APPLICATION OF 6 PERCENT CREDIT.—Section 48(a)(2)(A)(i) is amended by striking "and" at the end of subclauses (IV) and (V) and adding at the end the following new subclauses: 26 USC 48.

"(VI) energy storage technology,

"(VII) qualified biogas property,

"(VIII) microgrid controllers, and

"(IX) energy property described in clauses (v) and (vii) of paragraph (3)(A), and".

(3) DEFINITIONS.—Section 48(c) is amended by adding at the end the following new paragraphs:

"(6) ENERGY STORAGE TECHNOLOGY.—

"(A) IN GENERAL.—The term 'energy storage technology' means—

"(i) property (other than property primarily used in the transportation of goods or individuals and not for the production of electricity) which receives, stores, and delivers energy for conversion to electricity (or, in the case of hydrogen, which stores energy), and has a nameplate capacity of not less than 5 kilowatt hours, and

"(ii) thermal energy storage property.

"(B) MODIFICATIONS OF CERTAIN PROPERTY.—In the case of any property which either—

"(i) was placed in service before the date of enactment of this section and would be described in subparagraph (A)(i), except that such property has a capacity of less than 5 kilowatt hours and is modified in a manner that such property (after such modification) has a nameplate capacity of not less than 5 kilowatt hours, or

"(ii) is described in subparagraph (A)(i) and is modified in a manner that such property (after such modification) has an increase in nameplate capacity of not less than 5 kilowatt hours,

such property shall be treated as described in subparagraph (A)(i) except that the basis of any existing property prior to such modification shall not be taken into account for purposes of this section. In the case of any property to which this subparagraph applies, subparagraph (D) shall be applied by substituting 'modification' for 'construction'. Applicability.

"(C) THERMAL ENERGY STORAGE PROPERTY.—

"(i) IN GENERAL.—Subject to clause (ii), for purposes of this paragraph, the term 'thermal energy storage property' means property comprising a system which—

"(I) is directly connected to a heating, ventilation, or air conditioning system,

"(II) removes heat from, or adds heat to, a storage medium for subsequent use, and

"(III) provides energy for the heating or cooling of the interior of a residential or commercial building.

"(ii) EXCLUSION.—The term 'thermal energy storage property' shall not include—

"(I) a swimming pool,

"(II) combined heat and power system property, or

"(III) a building or its structural components.

"(D) TERMINATION.—The term 'energy storage technology' shall not include any property the construction of which begins after December 31, 2024.

"(7) QUALIFIED BIOGAS PROPERTY.—

"(A) IN GENERAL.—The term 'qualified biogas property' means property comprising a system which—

"(i) converts biomass (as defined in section 45K(c)(3), as in effect on the date of enactment of this paragraph) into a gas which—

"(I) consists of not less than 52 percent methane by volume, or

"(II) is concentrated by such system into a gas which consists of not less than 52 percent methane, and

"(ii) captures such gas for sale or productive use, and not for disposal via combustion.

"(B) INCLUSION OF CLEANING AND CONDITIONING PROPERTY.—The term 'qualified biogas property' includes any property which is part of such system which cleans or conditions such gas.

"(C) TERMINATION.—The term 'qualified biogas property' shall not include any property the construction of which begins after December 31, 2024.

"(8) MICROGRID CONTROLLER.—

"(A) IN GENERAL.—The term 'microgrid controller' means equipment which is—

"(i) part of a qualified microgrid, and

"(ii) designed and used to monitor and control the energy resources and loads on such microgrid.

"(B) QUALIFIED MICROGRID.—The term 'qualified microgrid' means an electrical system which—

"(i) includes equipment which is capable of generating not less than 4 kilowatts and not greater than 20 megawatts of electricity,

"(ii) is capable of operating—

"(I) in connection with the electrical grid and as a single controllable entity with respect to such grid, and

"(II) independently (and disconnected) from such grid, and

"(iii) is not part of a bulk-power system (as defined in section 215 of the Federal Power Act (16 U.S.C. 824o)).

"(C) TERMINATION.—The term 'microgrid controller' shall not include any property the construction of which begins after December 31, 2024.".

(4) DENIAL OF DOUBLE BENEFIT FOR QUALIFIED BIOGAS PROPERTY.—Section 45(e) is amended by adding at the end the following new paragraph:

26 USC 45.

"(12) COORDINATION WITH ENERGY CREDIT FOR QUALIFIED BIOGAS PROPERTY.—The term 'qualified facility' shall not include any facility which produces electricity from gas produced by qualified biogas property (as defined in section 48(c)(7)) if a

credit is allowed under section 48 with respect to such property for the taxable year or any prior taxable year.".

(5) PUBLIC UTILITY PROPERTY.—Paragraph (2) of section 50(d) is amended— 26 USC 50.

(A) by adding after the first sentence the following new sentence: "At the election of a taxpayer, this paragraph shall not apply to any energy storage technology (as defined in section 48(c)(6)), provided—", and

(B) by adding the following new subparagraphs:

"(A) no election under this paragraph shall be permitted if the making of such election is prohibited by a State or political subdivision thereof, by any agency or instrumentality of the United States, or by a public service or public utility commission or other similar body of any State or political subdivision that regulates public utilities as described in section 7701(a)(33)(A),

"(B) an election under this paragraph shall be made separately with respect to each energy storage technology by the due date (including extensions) of the Federal tax return for the taxable year in which the energy storage technology is placed in service by the taxpayer, and once made, may be revoked only with the consent of the Secretary, and

"(C) an election shall not apply with respect to any energy storage technology if such energy storage technology has a maximum capacity equal to or less than 500 kilowatt hours.".

(g) FUEL CELLS USING ELECTROMECHANICAL PROCESSES.—

(1) IN GENERAL.—Section 48(c)(1) is amended—

(A) in subparagraph (A)(i)—

(i) by inserting "or electromechanical" after "electrochemical", and

(ii) by inserting "(1 kilowatt in the case of a fuel cell power plant with a linear generator assembly)" after "0.5 kilowatt", and

(B) in subparagraph (C)—

(i) by inserting ", or linear generator assembly," after "a fuel cell stack assembly", and

(ii) by inserting "or electromechanical" after "electrochemical".

(2) LINEAR GENERATOR ASSEMBLY LIMITATION.—Section 48(c)(1) is amended by redesignating subparagraph (D) as subparagraph (E) and by inserting after subparagraph (C) the following new subparagraph:

"(D) LINEAR GENERATOR ASSEMBLY.—The term 'linear generator assembly' does not include any assembly which contains rotating parts.".

(h) DYNAMIC GLASS.—Section 48(a)(3)(A)(ii) is amended by inserting ", or electrochromic glass which uses electricity to change its light transmittance properties in order to heat or cool a structure," after "sunlight".

(i) COORDINATION WITH LOW INCOME HOUSING TAX CREDIT.—Paragraph (3) of section 50(c) is amended—

(1) by striking "and" at the end of subparagraph (A),

(2) by striking the period at the end of subparagraph (B) and inserting ", and", and

(3) by adding at the end the following new subparagraph:

"(C) paragraph (1) shall not apply for purposes of determining eligible basis under section 42.".

(j) INTERCONNECTION PROPERTY.—Section 48(a), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraph:

26 USC 48.

Definitions.
Determination.

"(8) INTERCONNECTION PROPERTY.—

"(A) IN GENERAL.—For purposes of determining the credit under subsection (a), energy property shall include amounts paid or incurred by the taxpayer for qualified interconnection property in connection with the installation of energy property (as defined in paragraph (3)) which has a maximum net output of not greater than 5 megawatts (as measured in alternating current), to provide for the transmission or distribution of the electricity produced or stored by such property, and which are properly chargeable to the capital account of the taxpayer.

"(B) QUALIFIED INTERCONNECTION PROPERTY.—The term 'qualified interconnection property' means, with respect to an energy project which is not a microgrid controller, any tangible property—

"(i) which is part of an addition, modification, or upgrade to a transmission or distribution system which is required at or beyond the point at which the energy project interconnects to such transmission or distribution system in order to accommodate such interconnection,

"(ii) either—

"(I) which is constructed, reconstructed, or erected by the taxpayer, or

"(II) for which the cost with respect to the construction, reconstruction, or erection of such property is paid or incurred by such taxpayer, and

"(iii) the original use of which, pursuant to an interconnection agreement, commences with a utility.

"(C) INTERCONNECTION AGREEMENT.—The term 'interconnection agreement' means an agreement with a utility for the purposes of interconnecting the energy property owned by such taxpayer to the transmission or distribution system of such utility.

"(D) UTILITY.—For purposes of this paragraph, the term 'utility' means the owner or operator of an electrical transmission or distribution system which is subject to the regulatory authority of a State or political subdivision thereof, any agency or instrumentality of the United States, a public service or public utility commission or other similar body of any State or political subdivision thereof, or the governing or ratemaking body of an electric cooperative.

"(E) SPECIAL RULE FOR INTERCONNECTION PROPERTY.—In the case of expenses paid or incurred for interconnection property, amounts otherwise chargeable to capital account with respect to such expenses shall be reduced under rules similar to the rules of section 50(c).".

(k) ENERGY PROJECTS, WAGE REQUIREMENTS, AND APPRENTICESHIP REQUIREMENTS.—Section 48(a), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraphs:

"(9) INCREASED CREDIT AMOUNT FOR ENERGY PROJECTS.—

"(A) IN GENERAL.—

"(i) RULE.—In the case of any energy project which satisfies the requirements of subparagraph (B), the amount of the credit determined under this subsection (determined after the application of paragraphs (1) through (8) and without regard to this clause) shall be equal to such amount multiplied by 5.

"(ii) ENERGY PROJECT DEFINED.—For purposes of this subsection, the term 'energy project' means a project consisting of one or more energy properties that are part of a single project.

"(B) PROJECT REQUIREMENTS.—A project meets the requirements of this subparagraph if it is one of the following:

"(i) A project with a maximum net output of less than 1 megawatt of electrical (as measured in alternating current) or thermal energy.

"(ii) A project the construction of which begins before the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (10)(A) and (11). Time period. Publication. Guidelines.

"(iii) A project which satisfies the requirements of paragraphs (10)(A) and (11).

"(10) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any energy project are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in—

"(i) the construction of such energy project, and

"(ii) for the 5-year period beginning on the date such project is originally placed in service, the alteration or repair of such project, Time period.

shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such project is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code. Subject to subparagraph (C), for purposes of any determination under paragraph (9)(A)(i) for the taxable year in which the energy project is placed in service, the taxpayer shall be deemed to satisfy the requirement under clause (ii) at the time such project is placed in service.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply. Applicability.

"(C) RECAPTURE.—The Secretary shall, by regulations or other guidance, provide for recapturing the benefit of any increase in the credit allowed under this subsection by reason of this paragraph with respect to any project which does not satisfy the requirements under subparagraph (A) (after application of subparagraph (B)) for the period described in clause (ii) of subparagraph (A) (but which does not cease to be investment credit property within the meaning of section 50(a)). The period and Regulations. Guidelines. Determination.

percentage of such recapture shall be determined under rules similar to the rules of section 50(a).

"(11) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.".

(l) DOMESTIC CONTENT; PHASEOUT FOR ELECTIVE PAYMENT.— 26 USC 48.
Section 48(a), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraphs:

"(12) DOMESTIC CONTENT BONUS CREDIT AMOUNT.—

"(A) IN GENERAL.—In the case of any energy project which satisfies the requirement under subparagraph (B), for purposes of applying paragraph (2) with respect to such property, the energy percentage shall be increased by the applicable credit rate increase.

Applicability. "(B) REQUIREMENT.—Rules similar to the rules of section 45(b)(9)(B) shall apply.

"(C) APPLICABLE CREDIT RATE INCREASE.—For purposes of subparagraph (A), the applicable credit rate increase shall be—

"(i) in the case of an energy project which does not satisfy the requirements of paragraph (9)(B), 2 percentage points, and

"(ii) in the case of an energy project which satisfies the requirements of paragraph (9)(B), 10 percentage points.

Applicability. "(13) PHASEOUT FOR ELECTIVE PAYMENT.—In the case of a taxpayer making an election under section 6417 with respect to a credit under this section, rules similar to the rules of section 45(b)(10) shall apply.".

(m) SPECIAL RULE FOR PROPERTY FINANCED BY TAX-EXEMPT BONDS.—Section 48(a)(4) is amended to read as follows:

Applicability. "(4) SPECIAL RULE FOR PROPERTY FINANCED BY TAX-EXEMPT BONDS.—Rules similar to the rule under section 45(b)(3) shall apply for purposes of this section.".

(n) TREATMENT OF CERTAIN CONTRACTS INVOLVING ENERGY STORAGE.—Section 7701(e) is amended—

(1) in paragraph (3)—

(A) in subparagraph (A)(i), by striking "or" at the end of subclause (II), by striking "and" at the end of subclause (III) and inserting "or", and by adding at the end the following new subclause:

"(IV) the operation of a storage facility, and", and

(B) by adding at the end the following new subparagraph:

Definition. "(F) STORAGE FACILITY.—For purposes of subparagraph (A), the term 'storage facility' means a facility which uses energy storage technology within the meaning of section 48(c)(6).", and

(2) in paragraph (4), by striking "or water treatment works facility" and inserting "water treatment works facility, or storage facility".

(o) INCREASE IN CREDIT RATE FOR ENERGY COMMUNITIES.— Section 48(a), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraph:

"(14) INCREASE IN CREDIT RATE FOR ENERGY COMMUNITIES.—

"(A) IN GENERAL.—In the case of any energy project that is placed in service within an energy community (as defined in section 45(b)(11)(B), as applied by substituting 'energy project' for 'qualified facility' each place it appears), for purposes of applying paragraph (2) with respect to energy property which is part of such project, the energy percentage shall be increased by the applicable credit rate increase.

"(B) APPLICABLE CREDIT RATE INCREASE.—For purposes of subparagraph (A), the applicable credit rate increase shall be equal to—

"(i) in the case of any energy project which does not satisfy the requirements of paragraph (9)(B), 2 percentage points, and

"(ii) in the case of any energy project which satisfies the requirements of paragraph (9)(B), 10 percentage points.".

(p) REGULATIONS.—Section 48(a), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraph: 26 USC 48.

"(15) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.". Determination. Requirements. Records.

(q) EFFECTIVE DATES.— Applicability. 26 USC 45 note.

(1) IN GENERAL.—Except as provided in paragraphs (2) and (3), the amendments made by this section shall apply to property placed in service after December 31, 2021.

(2) OTHER PROPERTY.—The amendments made by subsections (f), (g), (h), (i), (j), (l), (n), and (o) shall apply to property placed in service after December 31, 2022.

(3) SPECIAL RULE FOR PROPERTY FINANCED BY TAX-EXEMPT BONDS.—The amendments made by subsection (m) shall apply to property the construction of which begins after the date of enactment of this Act.

SEC. 13103. INCREASE IN ENERGY CREDIT FOR SOLAR AND WIND FACILITIES PLACED IN SERVICE IN CONNECTION WITH LOW-INCOME COMMUNITIES.

(a) IN GENERAL.—Section 48 is amended by adding at the end the following new subsection:

"(e) SPECIAL RULES FOR CERTAIN SOLAR AND WIND FACILITIES PLACED IN SERVICE IN CONNECTION WITH LOW-INCOME COMMUNITIES.—

"(1) IN GENERAL.—In the case of any qualified solar and wind facility with respect to which the Secretary makes an allocation of environmental justice solar and wind capacity limitation under paragraph (4)—

"(A) the energy percentage otherwise determined under paragraph (2) or (5) of subsection (a) with respect to any eligible property which is part of such facility shall be increased by—

"(i) in the case of a facility described in subclause (I) of paragraph (2)(A)(iii) and not described in subclause (II) of such paragraph, 10 percentage points, and

"(ii) in the case of a facility described in subclause (II) of paragraph (2)(A)(iii), 20 percentage points, and

"(B) the increase in the credit determined under subsection (a) by reason of this subsection for any taxable year with respect to all property which is part of such facility shall not exceed the amount which bears the same ratio to the amount of such increase (determined without regard to this subparagraph) as—

"(i) the environmental justice solar and wind capacity limitation allocated to such facility, bears to

"(ii) the total megawatt nameplate capacity of such facility, as measured in direct current.

"(2) QUALIFIED SOLAR AND WIND FACILITY.—For purposes of this subsection—

Definition.

"(A) IN GENERAL.—The term 'qualified solar and wind facility' means any facility—

"(i) which generates electricity solely from property described in section 45(d)(1) or in clause (i) or (vi) of subsection (a)(3)(A),

"(ii) which has a maximum net output of less than 5 megawatts (as measured in alternating current), and

"(iii) which—

"(I) is located in a low-income community (as defined in section 45D(e)) or on Indian land (as defined in section 2601(2) of the Energy Policy Act of 1992 (25 U.S.C. 3501(2))), or

"(II) is part of a qualified low-income residential building project or a qualified low-income economic benefit project.

"(B) QUALIFIED LOW-INCOME RESIDENTIAL BUILDING PROJECT.—A facility shall be treated as part of a qualified low-income residential building project if—

"(i) such facility is installed on a residential rental building which participates in a covered housing program (as defined in section 41411(a) of the Violence Against Women Act of 1994 (34 U.S.C. 12491(a)(3)), a housing assistance program administered by the Department of Agriculture under title V of the Housing Act of 1949, a housing program administered by a tribally designated housing entity (as defined in section 4(22) of the Native American Housing Assistance and Self-Determination Act of 1996 (25 U.S.C. 4103(22))) or such other affordable housing programs as the Secretary may provide, and

"(ii) the financial benefits of the electricity produced by such facility are allocated equitably among the occupants of the dwelling units of such building.

"(C) QUALIFIED LOW-INCOME ECONOMIC BENEFIT PROJECT.—A facility shall be treated as part of a qualified low-income economic benefit project if at least 50 percent of the financial benefits of the electricity produced by such facility are provided to households with income of—

"(i) less than 200 percent of the poverty line (as defined in section 36B(d)(3)(A)) applicable to a family of the size involved, or

"(ii) less than 80 percent of area median gross income (as determined under section 142(d)(2)(B)).

"(D) FINANCIAL BENEFIT.—For purposes of subparagraphs (B) and (C), electricity acquired at a below-market rate shall not fail to be taken into account as a financial benefit.

"(3) ELIGIBLE PROPERTY.—For purposes of this section, the term 'eligible property' means energy property which— Definition.

"(A) is part of a facility described in section 45(d)(1) for which an election was made under subsection (a)(5), or

"(B) is described in clause (i) or (vi) of subsection (a)(3)(A),

including energy storage technology (as described in subsection (a)(3)(A)(ix)) installed in connection with such energy property.

"(4) ALLOCATIONS.—

"(A) IN GENERAL.—Not later than 180 days after the date of enactment of this subsection, the Secretary shall establish a program to allocate amounts of environmental justice solar and wind capacity limitation to qualified solar and wind facilities. In establishing such program and to carry out the purposes of this subsection, the Secretary shall provide procedures to allow for an efficient allocation process, including, when determined appropriate, consideration of multiple projects in a single application if such projects will be placed in service by a single taxpayer. Deadline. Procedures.

"(B) LIMITATION.—The amount of environmental justice solar and wind capacity limitation allocated by the Secretary under subparagraph (A) during any calendar year shall not exceed the annual capacity limitation with respect to such year.

"(C) ANNUAL CAPACITY LIMITATION.—For purposes of this paragraph, the term 'annual capacity limitation' means 1.8 gigawatts of direct current capacity for each of calendar years 2023 and 2024, and zero thereafter. Definition.

"(D) CARRYOVER OF UNUSED LIMITATION.—If the annual capacity limitation for any calendar year exceeds the aggregate amount allocated for such year under this paragraph, such limitation for the succeeding calendar year shall be increased by the amount of such excess. No amount may be carried under the preceding sentence to any calendar year after 2024 except as provided in section 48E(h)(4)(D)(ii).

"(E) PLACED IN SERVICE DEADLINE.—

"(i) IN GENERAL.—Paragraph (1) shall not apply with respect to any property which is placed in service after the date that is 4 years after the date of the allocation with respect to the facility of which such property is a part. Time period.

"(ii) APPLICATION OF CARRYOVER.—Any amount of environmental justice solar and wind capacity limitation which expires under clause (i) during any calendar year shall be taken into account as an excess described in subparagraph (D) (or as an increase in such excess)

for such calendar year, subject to the limitation imposed by the last sentence of such subparagraph.

Regulations. Guidelines.

"(5) RECAPTURE.—The Secretary shall, by regulations or other guidance, provide for recapturing the benefit of any increase in the credit allowed under subsection (a) by reason of this subsection with respect to any property which ceases to be property eligible for such increase (but which does not cease to be investment credit property within the meaning of section 50(a)). The period and percentage of such recapture shall be determined under rules similar to the rules of section 50(a). To the extent provided by the Secretary, such recapture may not apply with respect to any property if, within 12 months after the date the taxpayer becomes aware (or reasonably should have become aware) of such property ceasing to be property eligible for such increase, the eligibility of such property for such increase is restored. The preceding sentence shall not apply more than once with respect to any facility.".

Determination. Time period.

26 USC 48 note.

(b) EFFECTIVE DATE.—The amendments made by this section shall take effect on January 1, 2023.

SEC. 13104. EXTENSION AND MODIFICATION OF CREDIT FOR CARBON OXIDE SEQUESTRATION.

(a) MODIFICATION OF CARBON OXIDE CAPTURE REQUIREMENTS.—

26 USC 45Q.

(1) IN GENERAL.—Section 45Q(d) is amended to read as follows:

Definition.

"(d) QUALIFIED FACILITY.—For purposes of this section, the term 'qualified facility' means any industrial facility or direct air capture facility—

Effective date.

"(1) the construction of which begins before January 1, 2033, and either—

"(A) construction of carbon capture equipment begins before such date, or

"(B) the original planning and design for such facility includes installation of carbon capture equipment, and

"(2) which—

"(A) in the case of a direct air capture facility, captures not less than 1,000 metric tons of qualified carbon oxide during the taxable year,

"(B) in the case of an electricity generating facility—

"(i) captures not less than 18,750 metric tons of qualified carbon oxide during the taxable year, and

"(ii) with respect to any carbon capture equipment for the applicable electric generating unit at such facility, has a capture design capacity of not less than 75 percent of the baseline carbon oxide production of such unit, or

"(C) in the case of any other facility, captures not less than 12,500 metric tons of qualified carbon oxide during the taxable year.".

(2) DEFINITIONS.—

(A) IN GENERAL.—Section 45Q(e) is amended—

(i) by redesignating paragraphs (1) through (3) as paragraphs (3) through (5), respectively, and

(ii) by inserting after "For purposes of this section—" the following new paragraphs:

"(1) APPLICABLE ELECTRIC GENERATING UNIT.—The term 'applicable electric generating unit' means the principal electric generating unit for which the carbon capture equipment is originally planned and designed.

"(2) BASELINE CARBON OXIDE PRODUCTION.—

"(A) IN GENERAL.—The term 'baseline carbon oxide production' means either of the following: Time periods.

"(i) In the case of an applicable electric generating unit which was originally placed in service more than 1 year prior to the date on which construction of the carbon capture equipment begins, the average annual carbon oxide production, by mass, from such unit during—

"(I) in the case of an applicable electric generating unit which was originally placed in service more than 1 year prior to the date on which construction of the carbon capture equipment begins and on or after the date which is 3 years prior to the date on which construction of such equipment begins, the period beginning on the date such unit was placed in service and ending on the date on which construction of such equipment began, and

"(II) in the case of an applicable electric generating unit which was originally placed in service more than 3 years prior to the date on which construction of the carbon capture equipment begins, the 3 years with the highest annual carbon oxide production during the 12-year period preceding the date on which construction of such equipment began.

"(ii) In the case of an applicable electric generating unit which—

"(I) as of the date on which construction of the carbon capture equipment begins, is not yet placed in service, or

"(II) was placed in service during the 1-year period prior to the date on which construction of the carbon capture equipment begins,

the designed annual carbon oxide production, by mass, as determined based on an assumed capacity factor of 60 percent.

"(B) CAPACITY FACTOR.—The term 'capacity factor' means the ratio (expressed as a percentage) of the actual electric output from the applicable electric generating unit to the potential electric output from such unit.".

(B) CONFORMING AMENDMENT.—Section 142(o)(1)(B) is amended by striking "section 45Q(e)(1)" and inserting "section 45Q(e)(3)". 26 USC 142.

(b) MODIFIED APPLICABLE DOLLAR AMOUNT.—Section 45Q(b)(1)(A) is amended—

(1) in clause (i)—

(A) in subclause (I), by striking "the dollar amount" and all that follows through "such period" and inserting "$17", and

(B) in subclause (II), by striking "the dollar amount" and all that follows through "such period" and inserting "$12", and

(2) in clause (ii)—

(A) in subclause (I), by striking "$50" and inserting "$17", and

(B) in subclause (II), by striking "$35" and inserting "$12".

(c) DETERMINATION OF APPLICABLE DOLLAR AMOUNT.—

Effective dates.
26 USC 45Q.

(1) IN GENERAL.—Section 45Q(b)(1), as amended by the preceding provisions of this Act, is amended—

(A) by redesignating subparagraph (B) as subparagraph (D), and

(B) by inserting after subparagraph (A) the following new subparagraphs:

"(B) SPECIAL RULE FOR DIRECT AIR CAPTURE FACILITIES.—In the case of any qualified facility described in subsection (d)(2)(A) which is placed in service after December 31, 2022, the applicable dollar amount shall be an amount equal to the applicable dollar amount otherwise determined with respect to such qualified facility under subparagraph (A), except that such subparagraph shall be applied—

"(i) by substituting '$36' for '$17' each place it appears, and

"(ii) by substituting '$26' for '$12' each place it appears.

"(C) APPLICABLE DOLLAR AMOUNT FOR ADDITIONAL CARBON CAPTURE EQUIPMENT.—In the case of any qualified facility which is placed in service before January 1, 2023, if any additional carbon capture equipment is installed at such facility and such equipment is placed in service after December 31, 2022, the applicable dollar amount shall be an amount equal to the applicable dollar amount otherwise determined under this paragraph, except that subparagraph (B) shall be applied—

"(i) by substituting 'before January 1, 2023' for 'after December 31, 2022', and

"(ii) by substituting 'the additional carbon capture equipment installed at such qualified facility' for 'such qualified facility'.".

(2) CONFORMING AMENDMENTS.—

(A) Section 45Q(b)(1)(A) is amended by striking "The applicable dollar amount" and inserting "Except as provided in subparagraph (B) or (C), the applicable dollar amount".

(B) Section 45Q(b)(1)(D), as redesignated by paragraph (1)(A), is amended by striking "subparagraph (A)" and inserting "subparagraph (A), (B), or (C)".

(d) WAGE AND APPRENTICESHIP REQUIREMENTS.—Section 45Q is amended by redesignating subsection (h) as subsection (i) and inserting after subsection (g) following new subsection:

"(h) INCREASED CREDIT AMOUNT FOR QUALIFIED FACILITIES AND CARBON CAPTURE EQUIPMENT.—

"(1) IN GENERAL.—In the case of any qualified facility or any carbon capture equipment which satisfy the requirements of paragraph (2), the amount of the credit determined under

subsection (a) shall be equal to such amount (determined without regard to this sentence) multiplied by 5.

"(2) REQUIREMENTS.—The requirements described in this paragraph are that— Time periods. Publication. Guidelines.

"(A) with respect to any qualified facility the construction of which begins on or after the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (3)(A) and (4), as well as any carbon capture equipment placed in service at such facility—

"(i) subject to subparagraph (B) of paragraph (3), the taxpayer satisfies the requirements under subparagraph (A) of such paragraph with respect to such facility and equipment, and

"(ii) the taxpayer satisfies the requirements under paragraph (4) with respect to the construction of such facility and equipment,

"(B) with respect to any carbon capture equipment the construction of which begins on or after the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (3)(A) and (4), and which is installed at a qualified facility the construction of which began prior to such date—

"(i) subject to subparagraph (B) of paragraph (3), the taxpayer satisfies the requirements under subparagraph (A) of such paragraph with respect to such equipment, and

"(ii) the taxpayer satisfies the requirements under paragraph (4) with respect to the construction of such equipment, or

"(C) the construction of carbon capture equipment begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (3)(A) and (4), and such equipment is installed at a qualified facility the construction of which begins prior to such date.

"(3) PREVAILING WAGE REQUIREMENTS.— Applicability.

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any qualified facility and any carbon capture equipment placed in service at such facility are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in—

"(i) the construction of such facility or equipment, and

"(ii) with respect to any taxable year, for any portion of such taxable year which is within the period described in paragraph (3)(A) or (4)(A) of subsection (a), the alteration or repair of such facility or such equipment,

shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such facility and equipment are located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code. For purposes

of determining an increased credit amount under paragraph (1) for a taxable year, the requirement under clause (ii) of this subparagraph is applied to such taxable year in which the alteration or repair of qualified facility occurs.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Applicability.

"(4) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

Determination.
Requirements.
Records.

"(5) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.".

26 USC 45Q.

(e) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—Section 45Q(f) is amended—

(1) by striking the second paragraph (3), as added at the end of such section by section 80402(e) of the Infrastructure Investment and Jobs Act (Public Law 117-58), and

(2) by adding at the end the following new paragraph:

Applicability.

"(8) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—Rules similar to the rule under section 45(b)(3) shall apply for purposes of this section.".

(f) APPLICATION OF SECTION FOR CERTAIN CARBON CAPTURE EQUIPMENT.—Section 45Q(g) is amended by inserting "the earlier of January 1, 2023, and" before "the end of the calendar year".

(g) ELECTION.—Section 45Q(f), as amended by subsection (e), is amended by adding at the end the following new paragraph:

Time period.

"(9) ELECTION.—For purposes of paragraphs (3) and (4) of subsection (a), a person described in paragraph (3)(A)(ii) may elect, at such time and in such manner as the Secretary may prescribe, to have the 12–year period begin on the first day of the first taxable year in which a credit under this section is claimed with respect to carbon capture equipment which is originally placed in service at a qualified facility on or after the date of the enactment of the Bipartisan Budget Act of 2018 (after application of paragraph (6), where applicable) if—

"(A) no taxpayer claimed a credit under this section with respect to such carbon capture equipment for any prior taxable year,

"(B) the qualified facility at which such carbon capture equipment is placed in service is located in an area affected by a federally-declared disaster (as defined by section 165(i)(5)(A)) after the carbon capture equipment is originally placed in service, and

"(C) such federally-declared disaster results in a cessation of the operation of the qualified facility or the carbon capture equipment after such equipment is originally placed in service.".

(h) REGULATIONS FOR BASELINE CARBON OXIDE PRODUCTION.—Subsection (i) of section 45Q, as redesignated by subsection (d), is amended—

(1) in paragraph (1), by striking "and",

(2) in paragraph (2), by striking the period at the end and inserting ", and", and

(3) by adding at the end the following new paragraph:

"(3) for purposes of subsection (d)(2)(B)(ii), adjust the baseline carbon oxide production with respect to any applicable electric generating unit at any electricity generating facility if, after the date on which the carbon capture equipment is placed in service, modifications which are chargeable to capital account are made to such unit which result in a significant increase or decrease in carbon oxide production.".

(i) EFFECTIVE DATES.—

Applicability. 26 USC 45Q note.

(1) IN GENERAL.—Except as provided in paragraphs (2), (3), and (4), the amendments made by this section shall apply to facilities or equipment placed in service after December 31, 2022.

(2) MODIFICATION OF CARBON OXIDE CAPTURE REQUIREMENTS.—The amendments made by subsection (a) shall apply to facilities or equipment the construction of which begins after the date of enactment of this Act.

(3) APPLICATION OF SECTION FOR CERTAIN CARBON CAPTURE EQUIPMENT.—The amendments made by subsection (f) shall take effect on the date of enactment of this Act.

(4) ELECTION.—The amendments made by subsection (g) shall apply to carbon oxide captured and disposed of after December 31, 2021.

SEC. 13105. ZERO-EMISSION NUCLEAR POWER PRODUCTION CREDIT.

(a) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1 is amended by adding at the end the following new section:

"SEC. 45U. ZERO-EMISSION NUCLEAR POWER PRODUCTION CREDIT. 26 USC 45U.

"(a) AMOUNT OF CREDIT.—For purposes of section 38, the zero-emission nuclear power production credit for any taxable year is an amount equal to the amount by which—

"(1) the product of—

"(A) 0.3 cents, multiplied by

"(B) the kilowatt hours of electricity—

"(i) produced by the taxpayer at a qualified nuclear power facility, and

"(ii) sold by the taxpayer to an unrelated person during the taxable year, exceeds

"(2) the reduction amount for such taxable year.

"(b) DEFINITIONS.—

"(1) QUALIFIED NUCLEAR POWER FACILITY.—For purposes of this section, the term 'qualified nuclear power facility' means any nuclear facility—

"(A) which is owned by the taxpayer and which uses nuclear energy to produce electricity,

"(B) which is not an advanced nuclear power facility as defined in subsection (d)(1) of section 45J, and

"(C) which is placed in service before the date of the enactment of this section.

"(2) REDUCTION AMOUNT.—

"(A) IN GENERAL.—For purposes of this section, the term 'reduction amount' means, with respect to any qualified nuclear power facility for any taxable year, the amount equal to the lesser of—

"(i) the amount determined under subsection (a)(1), or

"(ii) the amount equal to 16 percent of the excess of—

"(I) subject to subparagraph (B), the gross receipts from any electricity produced by such facility (including any electricity services or products provided in conjunction with the electricity produced by such facility) and sold to an unrelated person during such taxable year, over

"(II) the amount equal to the product of—

"(aa) 2.5 cents, multiplied by

"(bb) the amount determined under subsection (a)(1)(B).

"(B) TREATMENT OF CERTAIN RECEIPTS.—

"(i) IN GENERAL.—Subject to clause (iii), the amount determined under subparagraph (A)(ii)(I) shall include any amount received by the taxpayer during the taxable year with respect to the qualified nuclear power facility from a zero-emission credit program. For purposes of determining the amount received during such taxable year, the taxpayer shall take into account any reductions required under such program.

Determination.

"(ii) ZERO-EMISSION CREDIT PROGRAM.—For purposes of this subparagraph, the term 'zero-emission credit program' means any payments with respect to a qualified nuclear power facility as a result of any Federal, State or local government program for, in whole or in part, the zero-emission, zero-carbon, or air quality attributes of any portion of the electricity produced by such facility.

"(iii) EXCLUSION.—For purposes of clause (i), any amount received by the taxpayer from a zero-emission credit program shall be excluded from the amount determined under subparagraph (A)(ii)(I) if the full amount of the credit calculated pursuant to subsection (a) (determined without regard to this subparagraph) is used to reduce payments from such zero-emission credit program.

"(3) ELECTRICITY.—For purposes of this section, the term 'electricity' means the energy produced by a qualified nuclear power facility from the conversion of nuclear fuel into electric power.

"(c) OTHER RULES.—

"(1) INFLATION ADJUSTMENT.—The 0.3 cent amount in subsection (a)(1)(A) and the 2.5 cent amount in subsection (b)(2)(A)(ii)(II)(aa) shall each be adjusted by multiplying such amount by the inflation adjustment factor (as determined under section 45(e)(2), as applied by substituting 'calendar year 2023' for 'calendar year 1992' in subparagraph (B) thereof) for the calendar year in which the sale occurs. If the 0.3 cent amount as increased under this paragraph is not a multiple of 0.05 cent, such amount shall be rounded to the nearest multiple of 0.05 cent. If the 2.5 cent amount as increased under this paragraph is not a multiple of 0.1 cent, such amount shall be rounded to the nearest multiple of 0.1 cent.

Applicability.

"(2) SPECIAL RULES.—Rules similar to the rules of paragraphs (1), (3), (4), and (5) of section 45(e) shall apply for purposes of this section.

"(d) WAGE REQUIREMENTS.—

"(1) INCREASED CREDIT AMOUNT FOR QUALIFIED NUCLEAR POWER FACILITIES.—In the case of any qualified nuclear power facility which satisfies the requirements of paragraph (2)(A), the amount of the credit determined under subsection (a) shall be equal to such amount (as determined without regard to this sentence) multiplied by 5.

"(2) PREVAILING WAGE REQUIREMENTS.—

Determination.

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any qualified nuclear power facility are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in the alteration or repair of such facility shall be paid wages at rates not less than the prevailing rates for alteration or repair of a similar character in the locality in which such facility is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code.

Applicability.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Determination. Requirements. Records.

"(3) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.

"(e) TERMINATION.—This section shall not apply to taxable years beginning after December 31, 2032.".

(b) CONFORMING AMENDMENTS.—

26 USC 38.

(1) Section 38(b) is amended—

(A) in paragraph (32), by striking "plus" at the end,

(B) in paragraph (33), by striking the period at the end and inserting ", plus", and

(C) by adding at the end the following new paragraph:

"(34) the zero-emission nuclear power production credit determined under section 45U(a).".

26 USC 38 prec.

(2) The table of sections for subpart D of part IV of subchapter A of chapter 1 is amended by adding at the end the following new item:

"Sec. 45U. Zero-emission nuclear power production credit.".

26 USC 45U note.

(c) EFFECTIVE DATE.—This section shall apply to electricity produced and sold after December 31, 2023, in taxable years beginning after such date.

PART 2—CLEAN FUELS

SEC. 13201. EXTENSION OF INCENTIVES FOR BIODIESEL, RENEWABLE DIESEL AND ALTERNATIVE FUELS.

(a) BIODIESEL AND RENEWABLE DIESEL CREDIT.—Section 40A(g) is amended by striking "December 31, 2022" and inserting "December 31, 2024".

(b) BIODIESEL MIXTURE CREDIT.—

(1) IN GENERAL.—Section 6426(c)(6) is amended by striking "December 31, 2022" and inserting "December 31, 2024".

26 USC 6427.

(2) FUELS NOT USED FOR TAXABLE PURPOSES.—Section 6427(e)(6)(B) is amended by striking "December 31, 2022" and inserting "December 31, 2024".

(c) ALTERNATIVE FUEL CREDIT.—Section 6426(d)(5) is amended by striking "December 31, 2021" and inserting "December 31, 2024".

(d) ALTERNATIVE FUEL MIXTURE CREDIT.—Section 6426(e)(3) is amended by striking "December 31, 2021" and inserting "December 31, 2024".

(e) PAYMENTS FOR ALTERNATIVE FUELS.—Section 6427(e)(6)(C) is amended by striking "December 31, 2021" and inserting "December 31, 2024".

26 USC 40A note.

(f) EFFECTIVE DATE.—The amendments made by this section shall apply to fuel sold or used after December 31, 2021.

Effective date.
Deadlines.
Claims.
26 USC 6426 note.

(g) SPECIAL RULE.—In the case of any alternative fuel credit properly determined under section 6426(d) of the Internal Revenue Code of 1986 for the period beginning on January 1, 2022, and ending with the close of the last calendar quarter beginning before the date of the enactment of this Act, such credit shall be allowed, and any refund or payment attributable to such credit (including any payment under section 6427(e) of such Code) shall be made, only in such manner as the Secretary of the Treasury (or the Secretary's delegate) shall provide. Such Secretary shall issue guidance within 30 days after the date of the enactment of this Act providing for a one-time submission of claims covering periods described in the preceding sentence. Such guidance shall provide for a 180-day period for the submission of such claims (in such manner as prescribed by such Secretary) to begin not later than 30 days after such guidance is issued. Such claims shall be paid by such Secretary not later than 60 days after receipt. If such Secretary has not paid pursuant to a claim filed under this subsection within 60 days after the date of the filing of such claim, the claim shall be paid with interest from such date determined by using the overpayment rate and method under section 6621 of such Code.

Guidelines.

Guidelines.

Determination.

SEC. 13202. EXTENSION OF SECOND GENERATION BIOFUEL INCENTIVES.

(a) IN GENERAL.—Section 40(b)(6)(J)(i) is amended by striking "2022" and inserting "2025".

26 USC 40 note.

(b) EFFECTIVE DATE.—The amendment made by subsection (a) shall apply to qualified second generation biofuel production after December 31, 2021.

SEC. 13203. SUSTAINABLE AVIATION FUEL CREDIT.

(a) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1 is amended by inserting after section 40A the following new section:

Definitions.
26 USC 40B.

"SEC. 40B. SUSTAINABLE AVIATION FUEL CREDIT.

"(a) IN GENERAL.—For purposes of section 38, the sustainable aviation fuel credit determined under this section for the taxable year is, with respect to any sale or use of a qualified mixture which occurs during such taxable year, an amount equal to the product of—

"(1) the number of gallons of sustainable aviation fuel in such mixture, multiplied by

"(2) the sum of—

"(A) $1.25, plus

"(B) the applicable supplementary amount with respect to such sustainable aviation fuel. Applicability.

"(b) APPLICABLE SUPPLEMENTARY AMOUNT.—For purposes of this section, the term 'applicable supplementary amount' means, with respect to any sustainable aviation fuel, an amount equal to $0.01 for each percentage point by which the lifecycle greenhouse gas emissions reduction percentage with respect to such fuel exceeds 50 percent. In no event shall the applicable supplementary amount determined under this subsection exceed $0.50.

"(c) QUALIFIED MIXTURE.—For purposes of this section, the term 'qualified mixture' means a mixture of sustainable aviation fuel and kerosene if—

"(1) such mixture is produced by the taxpayer in the United States,

"(2) such mixture is used by the taxpayer (or sold by the taxpayer for use) in an aircraft,

"(3) such sale or use is in the ordinary course of a trade or business of the taxpayer, and

"(4) the transfer of such mixture to the fuel tank of such aircraft occurs in the United States.

"(d) SUSTAINABLE AVIATION FUEL.—

"(1) IN GENERAL.—For purposes of this section, the term 'sustainable aviation fuel' means liquid fuel, the portion of which is not kerosene, which—

"(A) meets the requirements of—

"(i) ASTM International Standard D7566, or

"(ii) the Fischer Tropsch provisions of ASTM International Standard D1655, Annex A1,

"(B) is not derived from coprocessing an applicable material (or materials derived from an applicable material) with a feedstock which is not biomass,

"(C) is not derived from palm fatty acid distillates or petroleum, and

"(D) has been certified in accordance with subsection (e) as having a lifecycle greenhouse gas emissions reduction percentage of at least 50 percent.

"(2) DEFINITIONS.—In this subsection—

"(A) APPLICABLE MATERIAL.—The term 'applicable material' means—

"(i) monoglycerides, diglycerides, and triglycerides,

"(ii) free fatty acids, and

"(iii) fatty acid esters.

"(B) BIOMASS.—The term 'biomass' has the same meaning given such term in section 45K(c)(3).

"(e) LIFECYCLE GREENHOUSE GAS EMISSIONS REDUCTION PERCENTAGE.—For purposes of this section, the term 'lifecycle greenhouse gas emissions reduction percentage' means, with respect to any sustainable aviation fuel, the percentage reduction in lifecycle greenhouse gas emissions achieved by such fuel as compared with petroleum-based jet fuel, as defined in accordance with—

"(1) the most recent Carbon Offsetting and Reduction Scheme for International Aviation which has been adopted by the International Civil Aviation Organization with the agreement of the United States, or

"(2) any similar methodology which satisfies the criteria under section 211(o)(1)(H) of the Clean Air Act (42 U.S.C.

7545(o)(1)(H)), as in effect on the date of enactment of this section.

"(f) REGISTRATION OF SUSTAINABLE AVIATION FUEL PRODUCERS.—No credit shall be allowed under this section with respect to any sustainable aviation fuel unless the producer or importer of such fuel—

"(1) is registered with the Secretary under section 4101, and

"(2) provides—

Certification. Compliance. Requirements.

"(A) certification (in such form and manner as the Secretary shall prescribe) from an unrelated party demonstrating compliance with—

"(i) any general requirements, supply chain traceability requirements, and information transmission requirements established under the Carbon Offsetting and Reduction Scheme for International Aviation described in paragraph (1) of subsection (e), or

"(ii) in the case of any methodology established under paragraph (2) of such subsection, requirements similar to the requirements described in clause (i), and

"(B) such other information with respect to such fuel as the Secretary may require for purposes of carrying out this section.

"(g) COORDINATION WITH CREDIT AGAINST EXCISE TAX.—The amount of the credit determined under this section with respect to any sustainable aviation fuel shall, under rules prescribed by the Secretary, be properly reduced to take into account any benefit provided with respect to such sustainable aviation fuel solely by reason of the application of section 6426 or 6427(e).

"(h) TERMINATION.—This section shall not apply to any sale or use after December 31, 2024.".

(b) CREDIT MADE PART OF GENERAL BUSINESS CREDIT.— Section 38(b), as amended by the preceding provisions of this Act, is amended by striking "plus" at the end of paragraph (33), by striking the period at the end of paragraph (34) and inserting ", plus", and by inserting after paragraph (34) the following new paragraph:

26 USC 38.

"(35) the sustainable aviation fuel credit determined under section 40B.".

(c) COORDINATION WITH BIODIESEL INCENTIVES.—

(1) IN GENERAL.—Section 40A(d)(1) is amended by inserting "or 40B" after "determined under section 40".

(2) CONFORMING AMENDMENT.—Section 40A(f) is amended by striking paragraph (4).

(d) SUSTAINABLE AVIATION FUEL ADDED TO CREDIT FOR ALCOHOL FUEL, BIODIESEL, AND ALTERNATIVE FUEL MIXTURES.—

(1) IN GENERAL.—Section 6426 is amended by adding at the end the following new subsection:

"(k) SUSTAINABLE AVIATION FUEL CREDIT.—

"(1) IN GENERAL.—For purposes of this section, the sustainable aviation fuel credit for the taxable year is, with respect to any sale or use of a qualified mixture, an amount equal to the product of—

"(A) the number of gallons of sustainable aviation fuel in such mixture, multiplied by

"(B) the sum of—

"(i) $1.25, plus

"(ii) the applicable supplementary amount with respect to such sustainable aviation fuel. Applicability.

"(2) DEFINITIONS.—Any term used in this subsection which is also used in section 40B shall have the meaning given such term by section 40B.

"(3) REGISTRATION REQUIREMENT.—For purposes of this subsection, rules similar to the rules of section 40B(f) shall apply.". Applicability.

(2) CONFORMING AMENDMENTS.—

(A) Section 6426 is amended— 26 USC 6426.

(i) in subsection (a)(1), by striking "and (e)" and inserting "(e), and (k)", and

(ii) in subsection (h), by striking "under section 40 or 40A" and inserting "under section 40, 40A, or 40B".

(B) Section 6427(e) is amended—

(i) in the heading, by striking "OR ALTERNATIVE FUEL" and inserting, "ALTERNATIVE FUEL, OR SUSTAINABLE AVIATION FUEL",

(ii) in paragraph (1), by inserting "or the sustainable aviation fuel mixture credit" after "alternative fuel mixture credit", and

(iii) in paragraph (6)—

(I) in subparagraph (C), by striking "and" at the end,

(II) in subparagraph (D), by striking the period at the end and inserting ", and", and

(III) by adding at the end the following new subparagraph:

"(E) any qualified mixture of sustainable aviation fuel (as defined in section 6426(k)(3)) sold or used after December 31, 2024.".

(C) Section 4101(a)(1) is amended by inserting "every person producing or importing sustainable aviation fuel (as defined in section 40B)," before "and every person producing second generation biofuel".

(D) The table of sections for subpart D of subchapter A of chapter 1 is amended by inserting after the item relating to section 40A the following new item: 26 USC 38 prec.

"Sec. 40B. Sustainable aviation fuel credit.".

(e) AMOUNT OF CREDIT INCLUDED IN GROSS INCOME.—Section 87 is amended by striking "and" in paragraph (1), by striking the period at the end of paragraph (2) and inserting ", and", and by adding at the end the following new paragraph:

"(3) the sustainable aviation fuel credit determined with respect to the taxpayer for the taxable year under section 40B(a).".

(f) EFFECTIVE DATE.—The amendments made by this section shall apply to fuel sold or used after December 31, 2022. 26 USC 40B note.

SEC. 13204. CLEAN HYDROGEN.

(a) CREDIT FOR PRODUCTION OF CLEAN HYDROGEN.—

(1) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new section:

26 USC 45V.

"SEC. 45V. CREDIT FOR PRODUCTION OF CLEAN HYDROGEN.

"(a) AMOUNT OF CREDIT.—For purposes of section 38, the clean hydrogen production credit for any taxable year is an amount equal to the product of—

Time period.

"(1) the kilograms of qualified clean hydrogen produced by the taxpayer during such taxable year at a qualified clean hydrogen production facility during the 10-year period beginning on the date such facility was originally placed in service, multiplied by

"(2) the applicable amount (as determined under subsection (b)) with respect to such hydrogen.

"(b) APPLICABLE AMOUNT.—

"(1) IN GENERAL.—For purposes of subsection (a)(2), the applicable amount shall be an amount equal to the applicable percentage of $0.60. If any amount as determined under the preceding sentence is not a multiple of 0.1 cent, such amount shall be rounded to the nearest multiple of 0.1 cent.

Determination.

"(2) APPLICABLE PERCENTAGE.—For purposes of paragraph (1), the applicable percentage shall be determined as follows:

"(A) In the case of any qualified clean hydrogen which is produced through a process that results in a lifecycle greenhouse gas emissions rate of—

"(i) not greater than 4 kilograms of CO2e per kilogram of hydrogen, and

"(ii) not less than 2.5 kilograms of CO2e per kilogram of hydrogen,

the applicable percentage shall be 20 percent.

"(B) In the case of any qualified clean hydrogen which is produced through a process that results in a lifecycle greenhouse gas emissions rate of—

"(i) less than 2.5 kilograms of CO2e per kilogram of hydrogen, and

"(ii) not less than 1.5 kilograms of CO2e per kilogram of hydrogen,

the applicable percentage shall be 25 percent.

"(C) In the case of any qualified clean hydrogen which is produced through a process that results in a lifecycle greenhouse gas emissions rate of—

"(i) less than 1.5 kilograms of CO2e per kilogram of hydrogen, and

"(ii) not less than 0.45 kilograms of CO2e per kilogram of hydrogen,

the applicable percentage shall be 33.4 percent.

"(D) In the case of any qualified clean hydrogen which is produced through a process that results in a lifecycle greenhouse gas emissions rate of less than 0.45 kilograms of CO2e per kilogram of hydrogen, the applicable percentage shall be 100 percent.

"(3) INFLATION ADJUSTMENT.—The $0.60 amount in paragraph (1) shall be adjusted by multiplying such amount by the inflation adjustment factor (as determined under section 45(e)(2), determined by substituting '2022' for '1992' in subparagraph (B) thereof) for the calendar year in which the qualified clean hydrogen is produced. If any amount as increased under the preceding sentence is not a multiple of 0.1 cent, such amount shall be rounded to the nearest multiple of 0.1 cent.

"(c) DEFINITIONS.—For purposes of this section—

"(1) LIFECYCLE GREENHOUSE GAS EMISSIONS.—

"(A) IN GENERAL.—Subject to subparagraph (B), the term 'lifecycle greenhouse gas emissions' has the same meaning given such term under subparagraph (H) of section 211(o)(1) of the Clean Air Act (42 U.S.C. 7545(o)(1)), as in effect on the date of enactment of this section.

"(B) GREET MODEL.—The term 'lifecycle greenhouse gas emissions' shall only include emissions through the point of production (well-to-gate), as determined under the most recent Greenhouse gases, Regulated Emissions, and Energy use in Transportation model (commonly referred to as the 'GREET model') developed by Argonne National Laboratory, or a successor model (as determined by the Secretary).

"(2) QUALIFIED CLEAN HYDROGEN.—

"(A) IN GENERAL.—The term 'qualified clean hydrogen' means hydrogen which is produced through a process that results in a lifecycle greenhouse gas emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen.

"(B) ADDITIONAL REQUIREMENTS.—Such term shall not include any hydrogen unless—

"(i) such hydrogen is produced—

"(I) in the United States (as defined in section 638(1)) or a possession of the United States (as defined in section 638(2)),

"(II) in the ordinary course of a trade or business of the taxpayer, and

"(III) for sale or use, and

"(ii) the production and sale or use of such hydrogen is verified by an unrelated party.

"(C) PROVISIONAL EMISSIONS RATE.—In the case of any hydrogen for which a lifecycle greenhouse gas emissions rate has not been determined for purposes of this section, a taxpayer producing such hydrogen may file a petition with the Secretary for determination of the lifecycle greenhouse gas emissions rate with respect to such hydrogen. Determination.

"(3) QUALIFIED CLEAN HYDROGEN PRODUCTION FACILITY.—The term 'qualified clean hydrogen production facility' means a facility—

"(A) owned by the taxpayer,

"(B) which produces qualified clean hydrogen, and

"(C) the construction of which begins before January 1, 2033. Effective date.

"(d) SPECIAL RULES.—

"(1) TREATMENT OF FACILITIES OWNED BY MORE THAN 1 TAXPAYER.—Rules similar to the rules section 45(e)(3) shall apply for purposes of this section. Applicability.

"(2) COORDINATION WITH CREDIT FOR CARBON OXIDE SEQUESTRATION.—No credit shall be allowed under this section with respect to any qualified clean hydrogen produced at a facility which includes carbon capture equipment for which a credit is allowed to any taxpayer under section 45Q for the taxable year or any prior taxable year.

"(e) INCREASED CREDIT AMOUNT FOR QUALIFIED CLEAN HYDROGEN PRODUCTION FACILITIES.—

"(1) IN GENERAL.—In the case of any qualified clean hydrogen production facility which satisfies the requirements

of paragraph (2), the amount of the credit determined under subsection (a) with respect to qualified clean hydrogen described in subsection (b)(2) shall be equal to such amount (determined without regard to this sentence) multiplied by 5.

"(2) REQUIREMENTS.—A facility meets the requirements of this paragraph if it is one of the following:

"(A) A facility—

Effective date.
Time period.
Publication.
Guidelines.

"(i) the construction of which begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (3)(A) and (4), and

"(ii) which meets the requirements of paragraph (3)(A) with respect to alteration or repair of such facility which occurs after such date.

"(B) A facility which satisfies the requirements of paragraphs (3)(A) and (4).

Applicability.
Determination.

"(3) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any qualified clean hydrogen production facility are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in—

"(i) the construction of such facility, and

"(ii) with respect to any taxable year, for any portion of such taxable year which is within the period described in subsection (a)(2), the alteration or repair of such facility,

shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such facility is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code. For purposes of determining an increased credit amount under paragraph (1) for a taxable year, the requirement under clause (ii) of this subparagraph is applied to such taxable year in which the alteration or repair of qualified facility occurs.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Applicability.

"(4) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

Determination.
Requirements.
Records.

"(5) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.

Deadline.
Guidelines.
Determinations.

"(f) REGULATIONS.—Not later than 1 year after the date of enactment of this section, the Secretary shall issue regulations or other guidance to carry out the purposes of this section, including regulations or other guidance for determining lifecycle greenhouse gas emissions.".

26 USC 45V.

(2) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—Section 45V(d), as added by this section, is amended by adding at the end the following new paragraph:

"(3) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—Rules similar to the rule under section 45(b)(3) shall apply for purposes of this section.". Applicability.

(3) MODIFICATION OF EXISTING FACILITIES.—Section 45V(d), as added and amended by the preceding provisions of this section, is amended by adding at the end the following new paragraph: 26 USC 45V.

"(4) MODIFICATION OF EXISTING FACILITIES.—For purposes of subsection (a)(1), in the case of any facility which—

"(A) was originally placed in service before January 1, 2023, and, prior to the modification described in subparagraph (B), did not produce qualified clean hydrogen, and Effective date.

"(B) after the date such facility was originally placed in service—

"(i) is modified to produce qualified clean hydrogen, and

"(ii) amounts paid or incurred with respect to such modification are properly chargeable to capital account of the taxpayer,

such facility shall be deemed to have been originally placed in service as of the date that the property required to complete the modification described in subparagraph (B) is placed in service.".

(4) CONFORMING AMENDMENTS.—

(A) Section 38(b), as amended by the preceding provisions of this Act, is amended—

(i) in paragraph (34), by striking "plus" at the end,

(ii) in paragraph (35), by striking the period at the end and inserting ", plus", and

(iii) by adding at the end the following new paragraph:

"(36) the clean hydrogen production credit determined under section 45V(a).".

(B) The table of sections for subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new item: 26 USC 38 prec.

"Sec. 45V. Credit for production of clean hydrogen.".

(5) EFFECTIVE DATES.— Applicability. 26 USC 45V note.

(A) IN GENERAL.—The amendments made by paragraphs (1) and (4) of this subsection shall apply to hydrogen produced after December 31, 2022.

(B) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—The amendment made by paragraph (2) shall apply to facilities the construction of which begins after the date of enactment of this Act.

(C) MODIFICATION OF EXISTING FACILITIES.—The amendment made by paragraph (3) shall apply to modifications made after December 31, 2022.

(b) CREDIT FOR ELECTRICITY PRODUCED FROM RENEWABLE RESOURCES ALLOWED IF ELECTRICITY IS USED TO PRODUCE CLEAN HYDROGEN.—

(1) IN GENERAL.—Section 45(e), as amended by the preceding provisions of this Act, is amended by adding at the end the following new paragraph:

"(13) SPECIAL RULE FOR ELECTRICITY USED AT A QUALIFIED CLEAN HYDROGEN PRODUCTION FACILITY.—Electricity produced by the taxpayer shall be treated as sold by such taxpayer to an unrelated person during the taxable year if—

"(A) such electricity is used during such taxable year by the taxpayer or a person related to the taxpayer at a qualified clean hydrogen production facility (as defined in section 45V(c)(3)) to produce qualified clean hydrogen (as defined in section 45V(c)(2)), and

"(B) such use and production is verified (in such form or manner as the Secretary may prescribe) by an unrelated third party.".

(2) SIMILAR RULE FOR ZERO-EMISSION NUCLEAR POWER PRODUCTION CREDIT.—Subsection (c)(2) of section 45U, as added by section 13105 of this Act, is amended by striking "and (5)" and inserting "(5), and (13)".

26 USC 45U.

26 USC 45 note.

(3) EFFECTIVE DATE.—The amendments made by this subsection shall apply to electricity produced after December 31, 2022.

(c) ELECTION TO TREAT CLEAN HYDROGEN PRODUCTION FACILITIES AS ENERGY PROPERTY.—

(1) IN GENERAL.—Section 48(a), as amended by the preceding provisions of this Act, is amended—

(A) by redesignating paragraph (15) as paragraph (16), and

(B) by inserting after paragraph (14) the following new paragraph:

"(15) ELECTION TO TREAT CLEAN HYDROGEN PRODUCTION FACILITIES AS ENERGY PROPERTY.—

"(A) IN GENERAL.—In the case of any qualified property (as defined in paragraph (5)(D)) which is part of a specified clean hydrogen production facility—

"(i) such property shall be treated as energy property for purposes of this section, and

"(ii) the energy percentage with respect to such property is—

"(I) in the case of a facility which is designed and reasonably expected to produce qualified clean hydrogen which is described in a subparagraph (A) of section 45V(b)(2), 1.2 percent,

"(II) in the case of a facility which is designed and reasonably expected to produce qualified clean hydrogen which is described in a subparagraph (B) of such section, 1.5 percent,

"(III) in the case of a facility which is designed and reasonably expected to produce qualified clean hydrogen which is described in a subparagraph (C) of such section, 2 percent, and

"(IV) in the case of a facility which is designed and reasonably expected to produce qualified clean hydrogen which is described in subparagraph (D) of such section, 6 percent.

"(B) DENIAL OF PRODUCTION CREDIT.—No credit shall be allowed under section 45V or section 45Q for any taxable year with respect to any specified clean hydrogen production facility or any carbon capture equipment included at such facility.

"(C) SPECIFIED CLEAN HYDROGEN PRODUCTION FACILITY.—For purposes of this paragraph, the term 'specified clean hydrogen production facility' means any qualified clean hydrogen production facility (as defined in section 45V(c)(3))— Definition.

"(i) which is placed in service after December 31, 2022, Effective date.

"(ii) with respect to which—

"(I) no credit has been allowed under section 45V or 45Q, and

"(II) the taxpayer makes an irrevocable election to have this paragraph apply, and

"(iii) for which an unrelated third party has verified (in such form or manner as the Secretary may prescribe) that such facility produces hydrogen through a process which results in lifecycle greenhouse gas emissions which are consistent with the hydrogen that such facility was designed and expected to produce under subparagraph (A)(ii). Verification.

"(D) QUALIFIED CLEAN HYDROGEN.—For purposes of this paragraph, the term 'qualified clean hydrogen' has the meaning given such term by section 45V(c)(2). Definition.

"(E) REGULATIONS.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this section, including regulations or other guidance which recaptures so much of any credit allowed under this section as exceeds the amount of the credit which would have been allowed if the expected production were consistent with the actual verified production (or all of the credit so allowed in the absence of such verification).". Guidelines. Determination.

(2) CONFORMING AMENDMENT.—Paragraph (9)(A)(i) of section 48(a), as added by section 13102, is amended by inserting "and paragraph (15)" after "paragraphs (1) through (8)". 26 USC 48.

(3) EFFECTIVE DATE.—The amendments made by this subsection shall apply to property placed in service after December 31, 2022, and, for any property the construction of which begins prior to January 1, 2023, only to the extent of the basis thereof attributable to the construction, reconstruction, or erection after December 31, 2022. Applicability. 26 USC 48 note.

(d) TERMINATION OF EXCISE TAX CREDIT FOR HYDROGEN.—

(1) IN GENERAL.—Section 6426(d)(2) is amended by striking subparagraph (D) and by redesignating subparagraphs (E), (F), and (G) as subparagraphs (D), (E), and (F), respectively.

(2) CONFORMING AMENDMENT.—Section 6426(e)(2) is amended by striking "(F)" and inserting "(E)".

(3) EFFECTIVE DATE.—The amendments made by this subsection shall apply to fuel sold or used after December 31, 2022. 26 USC 6426 note.

PART 3—CLEAN ENERGY AND EFFICIENCY INCENTIVES FOR INDIVIDUALS

SEC. 13301. EXTENSION, INCREASE, AND MODIFICATIONS OF NONBUSINESS ENERGY PROPERTY CREDIT.

(a) EXTENSION OF CREDIT.—Section 25C(g)(2) is amended by striking "December 31, 2021" and inserting "December 31, 2032".

26 USC 25C.

(b) ALLOWANCE OF CREDIT.—Section 25C(a) is amended to read as follows:

"(a) ALLOWANCE OF CREDIT.—In the case of an individual, there shall be allowed as a credit against the tax imposed by this chapter for the taxable year an amount equal to 30 percent of the sum of—

"(1) the amount paid or incurred by the taxpayer for qualified energy efficiency improvements installed during such taxable year, and

"(2) the amount of the residential energy property expenditures paid or incurred by the taxpayer during such taxable year.".

(c) APPLICATION OF ANNUAL LIMITATION IN LIEU OF LIFETIME LIMITATION.—Section 25C(b) is amended to read as follows:

"(b) LIMITATIONS.—

"(1) IN GENERAL.—The credit allowed under this section with respect to any taxpayer for any taxable year shall not exceed $1,200.

"(2) ENERGY PROPERTY.—The credit allowed under this section by reason of subsection (a)(2) with respect to any taxpayer for any taxable year shall not exceed, with respect to any item of qualified energy property, $600.

"(3) WINDOWS.—The credit allowed under this section by reason of subsection (a)(1) with respect to any taxpayer for any taxable year shall not exceed, in the aggregate with respect to all exterior windows and skylights, $600.

"(4) DOORS.—The credit allowed under this section by reason of subsection (a)(1) with respect to any taxpayer for any taxable year shall not exceed—

"(A) $250 in the case of any exterior door, and

"(B) $500 in the aggregate with respect to all exterior doors.

"(5) HEAT PUMP AND HEAT PUMP WATER HEATERS; BIOMASS STOVES AND BOILERS.—Notwithstanding paragraphs (1) and (2), the credit allowed under this section by reason of subsection (a)(2) with respect to any taxpayer for any taxable year shall not, in the aggregate, exceed $2,000 with respect to amounts paid or incurred for property described in clauses (i) and (ii) of subsection (d)(2)(A) and in subsection (d)(2)(B).".

(d) MODIFICATIONS RELATED TO QUALIFIED ENERGY EFFICIENCY IMPROVEMENTS.—

(1) STANDARDS FOR ENERGY EFFICIENT BUILDING ENVELOPE COMPONENTS.—Section 25C(c)(2) is amended by striking "meets—" and all that follows through the period at the end and inserting the following: "meets—

"(A) in the case of an exterior window or skylight, Energy Star most efficient certification requirements,

"(B) in the case of an exterior door, applicable Energy Star requirements, and

Effective date.

"(C) in the case of any other component, the prescriptive criteria for such component established by the most recent International Energy Conservation Code standard in effect as of the beginning of the calendar year which is 2 years prior to the calendar year in which such component is placed in service.".

(2) ROOFS NOT TREATED AS BUILDING ENVELOPE COMPONENTS.—Section 25C(c)(3) is amended by adding "and" at the

end of subparagraph (B), by striking ", and" at the end of subparagraph (C) and inserting a period, and by striking subparagraph (D).

(3) AIR SEALING INSULATION ADDED TO DEFINITION OF BUILDING ENVELOPE COMPONENT.—Section 25C(c)(3)(A) is amended by inserting ", including air sealing material or system," after "material or system". 26 USC 25C.

(e) MODIFICATION OF RESIDENTIAL ENERGY PROPERTY EXPENDITURES.—Section 25C(d) is amended to read as follows:

"(d) RESIDENTIAL ENERGY PROPERTY EXPENDITURES.—For purposes of this section— Definitions.

"(1) IN GENERAL.—The term 'residential energy property expenditures' means expenditures made by the taxpayer for qualified energy property which is—

"(A) installed on or in connection with a dwelling unit located in the United States and used as a residence by the taxpayer, and

"(B) originally placed in service by the taxpayer.

Such term includes expenditures for labor costs properly allocable to the onsite preparation, assembly, or original installation of the property.

"(2) QUALIFIED ENERGY PROPERTY.—The term 'qualified energy property' means any of the following: Effective dates.

"(A) Any of the following which meet or exceed the highest efficiency tier (not including any advanced tier) established by the Consortium for Energy Efficiency which is in effect as of the beginning of the calendar year in which the property is placed in service:

"(i) An electric or natural gas heat pump water heater.

"(ii) An electric or natural gas heat pump.

"(iii) A central air conditioner.

"(iv) A natural gas, propane, or oil water heater.

"(v) A natural gas, propane, or oil furnace or hot water boiler.

"(B) A biomass stove or boiler which—

"(i) uses the burning of biomass fuel to heat a dwelling unit located in the United States and used as a residence by the taxpayer, or to heat water for use in such a dwelling unit, and

"(ii) has a thermal efficiency rating of at least 75 percent (measured by the higher heating value of the fuel).

"(C) Any oil furnace or hot water boiler which—

"(i) is placed in service after December 31, 2022, and before January 1, 2027, and—

"(I) meets or exceeds 2021 Energy Star efficiency criteria, and

"(II) is rated by the manufacturer for use with fuel blends at least 20 percent of the volume of which consists of an eligible fuel, or

"(ii) is placed in service after December 31, 2026, and—

"(I) achieves an annual fuel utilization efficiency rate of not less than 90, and

"(II) is rated by the manufacturer for use with fuel blends at least 50 percent of the volume of which consists of an eligible fuel.

"(D) Any improvement to, or replacement of, a panelboard, sub-panelboard, branch circuits, or feeders which—

"(i) is installed in a manner consistent with the National Electric Code,

"(ii) has a load capacity of not less than 200 amps,

"(iii) is installed in conjunction with—

"(I) any qualified energy efficiency improvements, or

"(II) any qualified energy property described in subparagraphs (A) through (C) for which a credit is allowed under this section for expenditures with respect to such property, and

"(iv) enables the installation and use of any property described in subclause (I) or (II) of clause (iii).

"(3) ELIGIBLE FUEL.—For purposes of paragraph (2), the term 'eligible fuel' means—

"(A) biodiesel and renewable diesel (within the meaning of section 40A), and

"(B) second generation biofuel (within the meaning of section 40).".

(f) HOME ENERGY AUDITS.—

26 USC 25C.

(1) IN GENERAL.—Section 25C(a), as amended by subsection (b), is amended by striking "and" at the end of paragraph (1), by striking the period at the end of paragraph (2) and inserting ", and", and by adding at the end the following new paragraph:

"(3) the amount paid or incurred by the taxpayer during the taxable year for home energy audits.".

(2) LIMITATION.—Section 25C(b), as amended by subsection (c), is amended adding at the end the following new paragraph:

"(6) HOME ENERGY AUDITS.—

"(A) DOLLAR LIMITATION.—The amount of the credit allowed under this section by reason of subsection (a)(3) shall not exceed $150.

"(B) SUBSTANTIATION REQUIREMENT.—No credit shall be allowed under this section by reason of subsection (a)(3) unless the taxpayer includes with the taxpayer's return of tax such information or documentation as the Secretary may require.".

(3) HOME ENERGY AUDITS.—

(A) IN GENERAL.—Section 25C is amended by redesignating subsections (e), (f), and (g), as subsections (f), (g), and (h), respectively, and by inserting after subsection (d) the following new subsection:

Definition.

"(e) HOME ENERGY AUDITS.—For purposes of this section, the term 'home energy audit' means an inspection and written report with respect to a dwelling unit located in the United States and owned or used by the taxpayer as the taxpayer's principal residence (within the meaning of section 121) which—

Cost estimates.

"(1) identifies the most significant and cost-effective energy efficiency improvements with respect to such dwelling unit, including an estimate of the energy and cost savings with respect to each such improvement, and

"(2) is conducted and prepared by a home energy auditor that meets the certification or other requirements specified by the Secretary in regulations or other guidance (as prescribed by the Secretary not later than 365 days after the date of the enactment of this subsection).". Requirements. Regulations. Guidelines. Deadline.

(B) CONFORMING AMENDMENT.—Section 1016(a)(33) is amended by striking "section 25C(f)" and inserting "section 25C(g)". 26 USC 1016.

(4) LACK OF SUBSTANTIATION TREATED AS MATHEMATICAL OR CLERICAL ERROR.—Section 6213(g)(2) is amended—

(A) in subparagraph (P), by striking "and" at the end,

(B) in subparagraph (Q), by striking the period at the end and inserting ", and", and

(C) by inserting after subparagraph (Q) the following:

"(R) an omission of information or documentation required under section 25C(b)(6)(B) (relating to home energy audits) to be included on a return.".

(g) IDENTIFICATION NUMBER REQUIREMENT.—

(1) IN GENERAL.—Section 25C, as amended by this section, is amended by redesignating subsection (h) as subsection (i) and by inserting after subsection (g) the following new subsection:

"(h) PRODUCT IDENTIFICATION NUMBER REQUIREMENT.— Definitions.

"(1) IN GENERAL.—No credit shall be allowed under subsection (a) with respect to any item of specified property placed in service after December 31, 2024, unless— Effective date.

"(A) such item is produced by a qualified manufacturer, and

"(B) the taxpayer includes the qualified product identification number of such item on the return of tax for the taxable year.

"(2) QUALIFIED PRODUCT IDENTIFICATION NUMBER.—For purposes of this section, the term 'qualified product identification number' means, with respect to any item of specified property, the product identification number assigned to such item by the qualified manufacturer pursuant to the methodology referred to in paragraph (3).

"(3) QUALIFIED MANUFACTURER.—For purposes of this section, the term 'qualified manufacturer' means any manufacturer of specified property which enters into an agreement with the Secretary which provides that such manufacturer will—

"(A) assign a product identification number to each item of specified property produced by such manufacturer utilizing a methodology that will ensure that such number (including any alphanumeric) is unique to each such item (by utilizing numbers or letters which are unique to such manufacturer or by such other method as the Secretary may provide),

"(B) label such item with such number in such manner as the Secretary may provide, and

"(C) make periodic written reports to the Secretary (at such times and in such manner as the Secretary may provide) of the product identification numbers so assigned and including such information as the Secretary may require with respect to the item of specified property to which such number was so assigned. Reports.

"(4) SPECIFIED PROPERTY.—For purposes of this subsection, the term 'specified property' means any qualified energy property and any property described in subparagraph (B) or (C) of subsection (c)(3).".

(2) OMISSION OF CORRECT PRODUCT IDENTIFICATION NUMBER TREATED AS MATHEMATICAL OR CLERICAL ERROR.—Section 6213(g)(2), as amended by the preceding provisions of this Act, is amended— 26 USC 6213.

(A) in subparagraph (Q), by striking "and" at the end,

(B) in subparagraph (R), by striking the period at the end and inserting ", and", and

(C) by inserting after subparagraph (R) the following:

"(S) an omission of a correct product identification number required under section 25C(h) (relating to credit for nonbusiness energy property) to be included on a return.".

(h) ENERGY EFFICIENT HOME IMPROVEMENT CREDIT.—

(1) IN GENERAL.—The heading for section 25C is amended by striking "**NONBUSINESS ENERGY PROPERTY**" and inserting "**ENERGY EFFICIENT HOME IMPROVEMENT CREDIT**".

(2) CLERICAL AMENDMENT.—The table of sections for subpart A of part IV of subchapter A of chapter 1 is amended by striking the item relating to section 25C and inserting after the item relating to section 25B the following item: 26 USC 21 prec.

"Sec. 25C. Energy efficient home improvement credit.".

(i) EFFECTIVE DATES.— Applicability. 26 USC 25C note.

(1) IN GENERAL.—Except as otherwise provided by this subsection, the amendments made by this section shall apply to property placed in service after December 31, 2022.

(2) EXTENSION OF CREDIT.—The amendments made by subsection (a) shall apply to property placed in service after December 31, 2021.

(3) IDENTIFICATION NUMBER REQUIREMENT.—The amendments made by subsection (g) shall apply to property placed in service after December 31, 2024.

SEC. 13302. RESIDENTIAL CLEAN ENERGY CREDIT.

(a) EXTENSION OF CREDIT.—

(1) IN GENERAL.—Section 25D(h) is amended by striking "December 31, 2023" and inserting "December 31, 2034".

(2) APPLICATION OF PHASEOUT.—Section 25D(g) is amended—

(A) in paragraph (2), by striking "before January 1, 2023, 26 percent, and" and inserting "before January 1, 2022, 26 percent,", and

(B) by striking paragraph (3) and by inserting after paragraph (2) the following new paragraphs:

"(3) in the case of property placed in service after December 31, 2021, and before January 1, 2033, 30 percent,

"(4) in the case of property placed in service after December 31, 2032, and before January 1, 2034, 26 percent, and

"(5) in the case of property placed in service after December 31, 2033, and before January 1, 2035, 22 percent.".

(b) RESIDENTIAL CLEAN ENERGY CREDIT FOR BATTERY STORAGE TECHNOLOGY; CERTAIN EXPENDITURES DISALLOWED.—

(1) ALLOWANCE OF CREDIT.—Paragraph (6) of section 25D(a) is amended to read as follows:

"(6) the qualified battery storage technology expenditures,".

(2) DEFINITION OF QUALIFIED BATTERY STORAGE TECHNOLOGY EXPENDITURE.—Paragraph (6) of section 25D(d) is amended to read as follows: 26 USC 25D.

"(6) QUALIFIED BATTERY STORAGE TECHNOLOGY EXPENDITURE.—The term 'qualified battery storage technology expenditure' means an expenditure for battery storage technology which— Definition.

"(A) is installed in connection with a dwelling unit located in the United States and used as a residence by the taxpayer, and

"(B) has a capacity of not less than 3 kilowatt hours.".

(c) CONFORMING AMENDMENTS.—

(1) Section 25D(d)(3) is amended by inserting ", without regard to subparagraph (D) thereof" after "section 48(c)(1)".

(2) The heading for section 25D is amended by striking "**ENERGY EFFICIENT PROPERTY**" and inserting "**CLEAN ENERGY CREDIT**".

(3) The table of sections for subpart A of part IV of subchapter A of chapter 1 is amended by striking the item relating to section 25D and inserting the following: 26 USC 21 prec.

"Sec. 25D. Residential clean energy credit.".

(d) EFFECTIVE DATES.— Applicability. 26 USC 25D note.

(1) IN GENERAL.—Except as provided in paragraph (2), the amendments made by this section shall apply to expenditures made after December 31, 2021.

(2) RESIDENTIAL CLEAN ENERGY CREDIT FOR BATTERY STORAGE TECHNOLOGY; CERTAIN EXPENDITURES DISALLOWED.—The amendments made by subsection (b) shall apply to expenditures made after December 31, 2022.

SEC. 13303. ENERGY EFFICIENT COMMERCIAL BUILDINGS DEDUCTION.

(a) IN GENERAL.—

(1) MAXIMUM AMOUNT OF DEDUCTION.—Subsection (b) of section 179D is amended to read as follows:

"(b) MAXIMUM AMOUNT OF DEDUCTION.—

"(1) IN GENERAL.—The deduction under subsection (a) with respect to any building for any taxable year shall not exceed the excess (if any) of—

"(A) the product of—

"(i) the applicable dollar value, and

"(ii) the square footage of the building, over

"(B) the aggregate amount of the deductions under subsections (a) and (f) with respect to the building for the 3 taxable years immediately preceding such taxable year (or, in the case of any such deduction allowable to a person other than the taxpayer, for any taxable year ending during the 4-taxable-year period ending with such taxable year). Time periods.

"(2) APPLICABLE DOLLAR VALUE.—For purposes of paragraph (1)(A)(i), the applicable dollar value shall be an amount equal to $0.50 increased (but not above $1.00) by $0.02 for each percentage point by which the total annual energy and power costs for the building are certified to be reduced by a percentage greater than 25 percent.

"(3) INCREASED DEDUCTION AMOUNT FOR CERTAIN PROPERTY.—

Applicability.

"(A) IN GENERAL.—In the case of any property which satisfies the requirements of subparagraph (B), paragraph (2) shall be applied by substituting '$2.50' for '$0.50', '$.10' for '$.02', and '$5.00' for '$1.00'.

"(B) PROPERTY REQUIREMENTS.—In the case of any energy efficient commercial building property, energy efficient building retrofit property, or property installed pursuant to a qualified retrofit plan, such property shall meet the requirements of this subparagraph if —

Time period.
Publication.
Guidelines.

"(i) installation of such property begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (4)(A) and (5), or

"(ii) installation of such property satisfies the requirements of paragraphs (4)(A) and (5).

"(4) PREVAILING WAGE REQUIREMENTS.—

Determination.

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any property are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in the installation of any property shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such property is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code.

Applicability.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Applicability.

"(5) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

Guidelines.
Determination.
Requirements.
Records.

"(6) REGULATIONS.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.".

26 USC 179D.

(2) MODIFICATION OF EFFICIENCY STANDARD.—Section 179D(c)(1)(D) is amended by striking "50 percent" and inserting "25 percent".

(3) REFERENCE STANDARD.—Section 179D(c)(2) is amended by striking "the most recent" and inserting the following: "the more recent of—

"(A) Standard 90.1-2007 published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers and the Illuminating Engineering Society of North America, or

"(B) the most recent".

(4) FINAL DETERMINATION; EXTENSION OF PERIOD; PLACED IN SERVICE DEADLINE.—Subparagraph (B) of section 179D(c)(2), as amended by paragraph (3), is amended—

(A) by inserting "for which the Department of Energy has issued a final determination and" before "which has been affirmed",

(B) by striking "2 years" and inserting "4 years", and

(C) by striking "that construction of such property begins" and inserting "such property is placed in service".

(5) ELIMINATION OF PARTIAL ALLOWANCE.—

(A) IN GENERAL.—Section 179D(d) is amended— 26 USC 179D.

(i) by striking paragraph (1), and

(ii) by redesignating paragraphs (2) through (6) as paragraphs (1) through (5), respectively.

(B) CONFORMING AMENDMENTS.—

(i) Section 179D(c)(1)(D) is amended—

(I) by striking "subsection (d)(6)" and inserting "subsection (d)(5)", and

(II) by striking "subsection (d)(2)" and inserting "subsection (d)(1)".

(ii) Paragraph (2)(A) of section 179D(d), as redesignated by subparagraph (A), is amended by striking "paragraph (2)" and inserting "paragraph (1)".

(iii) Paragraph (4) of section 179D(d), as redesignated by subparagraph (A), is amended by striking "paragraph (3)(B)(iii)" and inserting "paragraph (2)(B)(iii)".

(iv) Section 179D is amended by striking subsection (f).

(v) Section 179D(h) is amended by striking "or (d)(1)(A)".

(6) ALLOCATION OF DEDUCTION BY CERTAIN TAX-EXEMPT ENTITIES.—Paragraph (3) of section 179D(d), as redesignated by paragraph (5)(A), is amended to read as follows:

"(3) ALLOCATION OF DEDUCTION BY CERTAIN TAX-EXEMPT ENTITIES.—

"(A) IN GENERAL.—In the case of energy efficient commercial building property installed on or in property owned by a specified tax-exempt entity, the Secretary shall promulgate regulations or guidance to allow the allocation of the deduction to the person primarily responsible for designing the property in lieu of the owner of such property. Such person shall be treated as the taxpayer for purposes of this section. Regulations. Guidelines.

"(B) SPECIFIED TAX-EXEMPT ENTITY.—For purposes of this paragraph, the term 'specified tax-exempt entity' means— Definition.

"(i) the United States, any State or political subdivision thereof, any possession of the United States, or any agency or instrumentality of any of the foregoing,

"(ii) an Indian tribal government (as defined in section 30D(g)(9)) or Alaska Native Corporation (as defined in section 3 of the Alaska Native Claims Settlement Act (43 U.S.C. 1602(m)), and

"(iii) any organization exempt from tax imposed by this chapter.".

(7) ALTERNATIVE DEDUCTION FOR ENERGY EFFICIENT BUILDING RETROFIT PROPERTY.—Section 179D, as amended by the preceding provisions of this section, is amended by inserting after subsection (e) the following new subsection:

"(f) ALTERNATIVE DEDUCTION FOR ENERGY EFFICIENT BUILDING RETROFIT PROPERTY.— Definitions.

Determinations.

"(1) IN GENERAL.—In the case of a taxpayer which elects (at such time and in such manner as the Secretary may provide) the application of this subsection with respect to any qualified building, there shall be allowed as a deduction for the taxable year which includes the date of the qualifying final certification with respect to the qualified retrofit plan of such building, an amount equal to the lesser of—

"(A) the excess described in subsection (b) (determined by substituting 'energy use intensity' for 'total annual energy and power costs' in paragraph (2) thereof), or

"(B) the aggregate adjusted basis (determined after taking into account all adjustments with respect to such taxable year other than the reduction under subsection (e)) of energy efficient building retrofit property placed in service by the taxpayer pursuant to such qualified retrofit plan.

Certifications.

"(2) QUALIFIED RETROFIT PLAN.—For purposes of this subsection, the term 'qualified retrofit plan' means a written plan prepared by a qualified professional which specifies modifications to a building which, in the aggregate, are expected to reduce such building's energy use intensity by 25 percent or more in comparison to the baseline energy use intensity of such building. Such plan shall provide for a qualified professional to—

Time period.

"(A) as of any date during the 1-year period ending on the date on which the property installed pursuant to such plan is placed in service, certify the energy use intensity of such building as of such date,

"(B) certify the status of property installed pursuant to such plan as meeting the requirements of subparagraphs (B) and (C) of paragraph (3), and

"(C) as of any date that is more than 1 year after the date on which the property installed pursuant to such plan is placed in service, certify the energy use intensity of such building as of such date.

"(3) ENERGY EFFICIENT BUILDING RETROFIT PROPERTY.—For purposes of this subsection, the term 'energy efficient building retrofit property' means property—

"(A) with respect to which depreciation (or amortization in lieu of depreciation) is allowable,

"(B) which is installed on or in any qualified building,

"(C) which is installed as part of—

"(i) the interior lighting systems,

"(ii) the heating, cooling, ventilation, and hot water systems, or

"(iii) the building envelope, and

Certification.

"(D) which is certified in accordance with paragraph (2)(B) as meeting the requirements of subparagraphs (B) and (C).

"(4) QUALIFIED BUILDING.—For purposes of this subsection, the term 'qualified building' means any building which—

"(A) is located in the United States, and

Time period.

"(B) was originally placed in service not less than 5 years before the establishment of the qualified retrofit plan with respect to such building.

"(5) QUALIFYING FINAL CERTIFICATION.—For purposes of this subsection, the term 'qualifying final certification' means,

with respect to any qualified retrofit plan, the certification described in paragraph (2)(C) if the energy use intensity certified in such certification is not more than 75 percent of the baseline energy use intensity of the building.

"(6) BASELINE ENERGY USE INTENSITY.—

"(A) IN GENERAL.—For purposes of this subsection, the term 'baseline energy use intensity' means the energy use intensity certified under paragraph (2)(A), as adjusted to take into account weather.

"(B) DETERMINATION OF ADJUSTMENT.—For purposes of subparagraph (A), the adjustments described in such subparagraph shall be determined in such manner as the Secretary may provide.

"(7) OTHER DEFINITIONS.—For purposes of this subsection—

"(A) ENERGY USE INTENSITY.—The term 'energy use intensity' means the annualized, measured site energy use intensity determined in accordance with such regulations or other guidance as the Secretary may provide and measured in British thermal units. Determination.

"(B) QUALIFIED PROFESSIONAL.—The term 'qualified professional' means an individual who is a licensed architect or a licensed engineer and meets such other requirements as the Secretary may provide.

"(8) COORDINATION WITH DEDUCTION OTHERWISE ALLOWED UNDER SUBSECTION (a).—

"(A) IN GENERAL.—In the case of any building with respect to which an election is made under paragraph (1), the term 'energy efficient commercial building property' shall not include any energy efficient building retrofit property with respect to which a deduction is allowable under this subsection.

"(B) CERTAIN RULES NOT APPLICABLE.—

"(i) IN GENERAL.—Except as provided in clause (ii), subsection (d) shall not apply for purposes of this subsection.

"(ii) ALLOCATION OF DEDUCTION BY CERTAIN TAX-EXEMPT ENTITIES.—Rules similar to subsection (d)(3) shall apply for purposes of this subsection.". Applicability.

(8) INFLATION ADJUSTMENT.—Section 179D(g) is amended— 26 USC 179D.

(A) by striking "2020" and inserting "2022",

(B) by striking "or subsection (d)(1)(A)", and

(C) by striking "2019" and inserting "2021".

(b) APPLICATION TO REAL ESTATE INVESTMENT TRUST EARNINGS AND PROFITS.—Section 312(k)(3)(B) is amended—

(1) by striking "For purposes of computing the earnings and profits of a corporation" and inserting the following:

"(i) IN GENERAL.—For purposes of computing the earnings and profits of a corporation, except as provided in clause (ii)", and

(2) by adding at the end the following new clause:

"(ii) SPECIAL RULE.—In the case of a corporation that is a real estate investment trust, any amount deductible under section 179D shall be allowed in the year in which the property giving rise to such deduction is placed in service (or, in the case of energy efficient building retrofit property, the year in which the qualifying final certification is made).".

Deadlines.
26 USC 179D.

(c) CONFORMING AMENDMENT.—Paragraph (1) of section 179D(d), as redesignated by subsection (a)(5)(A), is amended by striking "not later than the date that is 2 years before the date that construction of such property begins" and inserting "not later than the date that is 4 years before the date such property is placed in service".

Applicability.
26 USC 179D note.

(d) EFFECTIVE DATE.—

(1) IN GENERAL.—Except as otherwise provided in this subsection, the amendments made by this section shall apply to taxable years beginning after December 31, 2022.

(2) ALTERNATIVE DEDUCTION FOR ENERGY EFFICIENT BUILDING RETROFIT PROPERTY.—Subsection (f) of section 179D of the Internal Revenue Code of 1986 (as amended by this section), and any other provision of such section solely for purposes of applying such subsection, shall apply to property placed in service after December 31, 2022 (in taxable years ending after such date) if such property is placed in service pursuant to qualified retrofit plan (within the meaning of such section) established after such date.

SEC. 13304. EXTENSION, INCREASE, AND MODIFICATIONS OF NEW ENERGY EFFICIENT HOME CREDIT.

(a) EXTENSION OF CREDIT.—Section 45L(g) is amended by striking "December 31, 2021" and inserting "December 31, 2032".

(b) INCREASE IN CREDIT AMOUNTS.—Paragraph (2) of section 45L(a) is amended to read as follows:

Requirements.

"(2) APPLICABLE AMOUNT.—For purposes of paragraph (1), the applicable amount is an amount equal to—

"(A) in the case of a dwelling unit which is eligible to participate in the Energy Star Residential New Construction Program or the Energy Star Manufactured New Homes program—

"(i) which meets the requirements of subsection (c)(1)(A) (and which does not meet the requirements of subsection (c)(1)(B)), $2,500, and

"(ii) which meets the requirements of subsection (c)(1)(B), $5,000, and

"(B) in the case of a dwelling unit which is part of a building eligible to participate in the Energy Star Multifamily New Construction Program—

"(i) which meets the requirements of subsection (c)(1)(A) (and which does not meet the requirements of subsection (c)(1)(B)), $500, and

"(ii) which meets the requirements of subsection (c)(1)(B), $1,000.".

(c) MODIFICATION OF ENERGY SAVING REQUIREMENTS.—Section 45L(c) is amended to read as follows:

Effective dates.
Time periods.

"(c) ENERGY SAVING REQUIREMENTS.—

"(1) IN GENERAL.—

"(A) IN GENERAL.—A dwelling unit meets the requirements of this subparagraph if such dwelling unit meets the requirements of paragraph (2) or (3) (whichever is applicable).

Certification.

"(B) ZERO ENERGY READY HOME PROGRAM.—A dwelling unit meets the requirements of this subparagraph if such dwelling unit is certified as a zero energy ready home

under the zero energy ready home program of the Department of Energy as in effect on January 1, 2023 (or any successor program determined by the Secretary).

"(2) SINGLE-FAMILY HOME REQUIREMENTS.—A dwelling unit meets the requirements of this paragraph if—

"(A) such dwelling unit meets—

"(i)(I) in the case of a dwelling unit acquired before January 1, 2025, the Energy Star Single-Family New Homes National Program Requirements 3.1, or

"(II) in the case of a dwelling unit acquired after December 31, 2024, the Energy Star Single-Family New Homes National Program Requirements 3.2, and

"(ii) the most recent Energy Star Single-Family New Homes Program Requirements applicable to the location of such dwelling unit (as in effect on the latter of January 1, 2023, or January 1 of two calendar years prior to the date the dwelling unit was acquired), or

"(B) such dwelling unit meets the most recent Energy Star Manufactured Home National program requirements as in effect on the latter of January 1, 2023, or January 1 of two calendar years prior to the date such dwelling unit is acquired.

"(3) MULTI-FAMILY HOME REQUIREMENTS.—A dwelling unit meets the requirements of this paragraph if—

"(A) such dwelling unit meets the most recent Energy Star Multifamily New Construction National Program Requirements (as in effect on either January 1, 2023, or January 1 of three calendar years prior to the date the dwelling was acquired, whichever is later), and

"(B) such dwelling unit meets the most recent Energy Star Multifamily New Construction Regional Program Requirements applicable to the location of such dwelling unit (as in effect on either January 1, 2023, or January 1 of three calendar years prior to the date the dwelling was acquired, whichever is later).".

(d) PREVAILING WAGE REQUIREMENT.—Section 45L is amended by redesignating subsection (g) as subsection (h) and by inserting after subsection (f) the following new subsection: 26 USC 45L.

"(g) PREVAILING WAGE REQUIREMENT.—

"(1) IN GENERAL.—In the case of a qualifying residence described in subsection (a)(2)(B) meeting the prevailing wage requirements of paragraph (2)(A), the credit amount allowed with respect to such residence shall be—

"(A) $2,500 in the case of a residence which meets the requirements of subparagraph (A) of subsection (c)(1) (and which does not meet the requirements of subparagraph (B) of such subsection), and

"(B) $5,000 in the case of a residence which meets the requirements of subsection (c)(1)(B).

"(2) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any qualified residence are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in the construction of such residence shall be paid wages at rates not less than the prevailing rates Determination.

for construction, alteration, or repair of a similar character in the locality in which such residence is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code.

Applicability.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Determination. Requirements. Records.

"(3) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.".

26 USC 45L.

(e) BASIS ADJUSTMENT.—Section 45L(e) is amended by inserting after the first sentence the following: "This subsection shall not apply for purposes of determining the adjusted basis of any building under section 42.".

Applicability. 26 USC 45L note.

(f) EFFECTIVE DATES.—

(1) IN GENERAL.—Except as provided in paragraph (2), the amendments made by this section shall apply to dwelling units acquired after December 31, 2022.

(2) EXTENSION OF CREDIT.—The amendments made by subsection (a) shall apply to dwelling units acquired after December 31, 2021.

PART 4—CLEAN VEHICLES

SEC. 13401. CLEAN VEHICLE CREDIT.

Determinations.

(a) PER VEHICLE DOLLAR LIMITATION.—Section 30D(b) is amended by striking paragraphs (2) and (3) and inserting the following:

"(2) CRITICAL MINERALS.—In the case of a vehicle with respect to which the requirement described in subsection (e)(1)(A) is satisfied, the amount determined under this paragraph is $3,750.

"(3) BATTERY COMPONENTS.—In the case of a vehicle with respect to which the requirement described in subsection (e)(2)(A) is satisfied, the amount determined under this paragraph is $3,750.".

(b) FINAL ASSEMBLY.—Section 30D(d) is amended—

(1) in paragraph (1)—

(A) in subparagraph (E), by striking "and" at the end,

(B) in subparagraph (F)(ii), by striking the period at the end and inserting ", and", and

(C) by adding at the end the following:

"(G) the final assembly of which occurs within North America.",

(2) by adding at the end the following:

Definition.

"(5) FINAL ASSEMBLY.—For purposes of paragraph (1)(G), the term 'final assembly' means the process by which a manufacturer produces a new clean vehicle at, or through the use of, a plant, factory, or other place from which the vehicle is delivered to a dealer or importer with all component parts necessary for the mechanical operation of the vehicle included with the vehicle, whether or not the component parts are permanently installed in or on the vehicle.".

(c) DEFINITION OF NEW CLEAN VEHICLE.—

(1) IN GENERAL.—Section 30D(d), as amended by the preceding provisions of this section, is amended— 26 USC 30D.

(A) in the heading, by striking "QUALIFIED PLUG-IN ELECTRIC DRIVE MOTOR" and inserting "CLEAN",

(B) in paragraph (1)—

(i) in the matter preceding subparagraph (A), by striking "qualified plug-in electric drive motor" and inserting "clean",

(ii) in subparagraph (C), by inserting "qualified" before "manufacturer",

(iii) in subparagraph (F)—

(I) in clause (i), by striking "4" and inserting "7", and

(II) in clause (ii), by striking "and" at the end,

(iv) in subparagraph (G), by striking the period at the end and inserting ", and", and

(v) by adding at the end the following:

"(H) for which the person who sells any vehicle to the taxpayer furnishes a report to the taxpayer and to the Secretary, at such time and in such manner as the Secretary shall provide, containing—

"(i) the name and taxpayer identification number of the taxpayer,

"(ii) the vehicle identification number of the vehicle, unless, in accordance with any applicable rules promulgated by the Secretary of Transportation, the vehicle is not assigned such a number,

"(iii) the battery capacity of the vehicle,

"(iv) verification that original use of the vehicle commences with the taxpayer, and

"(v) the maximum credit under this section allowable to the taxpayer with respect to the vehicle.",

(C) in paragraph (3)—

(i) in the heading, by striking "MANUFACTURER" and inserting "QUALIFIED MANUFACTURER",

(ii) by striking "The term 'manufacturer' has the meaning given such term in" and inserting "The term 'qualified manufacturer' means any manufacturer (within the meaning of the", and

(iii) by inserting ") which enters into a written agreement with the Secretary under which such manufacturer agrees to make periodic written reports to the Secretary (at such times and in such manner as the Secretary may provide) providing vehicle identification numbers and such other information related to each vehicle manufactured by such manufacturer as the Secretary may require" before the period at the end, and

(D) by adding at the end the following:

"(6) NEW QUALIFIED FUEL CELL MOTOR VEHICLE.—For purposes of this section, the term 'new clean vehicle' shall include any new qualified fuel cell motor vehicle (as defined in section 30B(b)(3)) which meets the requirements under subparagraphs (G) and (H) of paragraph (1).".

(2) CONFORMING AMENDMENTS.—Section 30D is amended—

(A) in subsection (a), by striking "new qualified plug-in electric drive motor vehicle" and inserting "new clean vehicle", and

(B) in subsection (b)(1), by striking "new qualified plug-in electric drive motor vehicle" and inserting "new clean vehicle".

(d) ELIMINATION OF LIMITATION ON NUMBER OF VEHICLES ELIGIBLE FOR CREDIT.—Section 30D is amended by striking subsection (e). 26 USC 30D.

(e) CRITICAL MINERAL AND BATTERY COMPONENT REQUIREMENTS.—

(1) IN GENERAL.—Section 30D, as amended by the preceding provisions of this section, is amended by inserting after subsection (d) the following:

"(e) CRITICAL MINERAL AND BATTERY COMPONENT REQUIREMENTS.— Effective dates. Time periods.

"(1) CRITICAL MINERALS REQUIREMENT.—

"(A) IN GENERAL.—The requirement described in this subparagraph with respect to a vehicle is that, with respect to the battery from which the electric motor of such vehicle draws electricity, the percentage of the value of the applicable critical minerals (as defined in section 45X(c)(6)) contained in such battery that were—

"(i) extracted or processed—

"(I) in the United States, or

"(II) in any country with which the United States has a free trade agreement in effect, or

"(ii) recycled in North America,

is equal to or greater than the applicable percentage (as certified by the qualified manufacturer, in such form or manner as prescribed by the Secretary).

"(B) APPLICABLE PERCENTAGE.—For purposes of subparagraph (A), the applicable percentage shall be—

"(i) in the case of a vehicle placed in service after the date on which the proposed guidance described in paragraph (3)(B) is issued by the Secretary and before January 1, 2024, 40 percent,

"(ii) in the case of a vehicle placed in service during calendar year 2024, 50 percent,

"(iii) in the case of a vehicle placed in service during calendar year 2025, 60 percent,

"(iv) in the case of a vehicle placed in service during calendar year 2026, 70 percent, and

"(v) in the case of a vehicle placed in service after December 31, 2026, 80 percent.

"(2) BATTERY COMPONENTS.—

"(A) IN GENERAL.—The requirement described in this subparagraph with respect to a vehicle is that, with respect to the battery from which the electric motor of such vehicle draws electricity, the percentage of the value of the components contained in such battery that were manufactured or assembled in North America is equal to or greater than the applicable percentage (as certified by the qualified manufacturer, in such form or manner as prescribed by the Secretary).

"(B) APPLICABLE PERCENTAGE.—For purposes of subparagraph (A), the applicable percentage shall be—

"(i) in the case of a vehicle placed in service after the date on which the proposed guidance described in paragraph (3)(B) is issued by the Secretary and before January 1, 2024, 50 percent,

"(ii) in the case of a vehicle placed in service during calendar year 2024 or 2025, 60 percent,

"(iii) in the case of a vehicle placed in service during calendar year 2026, 70 percent,

"(iv) in the case of a vehicle placed in service during calendar year 2027, 80 percent,

"(v) in the case of a vehicle placed in service during calendar year 2028, 90 percent,

"(vi) in the case of a vehicle placed in service after December 31, 2028, 100 percent.

"(3) REGULATIONS AND GUIDANCE.—

"(A) IN GENERAL.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection. Determination.

"(B) DEADLINE FOR PROPOSED GUIDANCE.—Not later than December 31, 2022, the Secretary shall issue proposed guidance with respect to the requirements under this subsection.".

(2) EXCLUDED ENTITIES.—Section 30D(d), as amended by the preceding provisions of this section, is amended by adding at the end the following: 26 USC 30D.

"(7) EXCLUDED ENTITIES.—For purposes of this section, the term 'new clean vehicle' shall not include— Effective dates.

"(A) any vehicle placed in service after December 31, 2024, with respect to which any of the applicable critical minerals contained in the battery of such vehicle (as described in subsection (e)(1)(A)) were extracted, processed, or recycled by a foreign entity of concern (as defined in section 40207(a)(5) of the Infrastructure Investment and Jobs Act (42 U.S.C. 18741(a)(5))), or

"(B) any vehicle placed in service after December 31, 2023, with respect to which any of the components contained in the battery of such vehicle (as described in subsection (e)(2)(A)) were manufactured or assembled by a foreign entity of concern (as so defined).".

(f) SPECIAL RULES.—Section 30D(f) is amended by adding at the end the following:

"(8) ONE CREDIT PER VEHICLE.—In the case of any vehicle, the credit described in subsection (a) shall only be allowed once with respect to such vehicle, as determined based upon the vehicle identification number of such vehicle.

"(9) VIN REQUIREMENT.—No credit shall be allowed under this section with respect to any vehicle unless the taxpayer includes the vehicle identification number of such vehicle on the return of tax for the taxable year.

"(10) LIMITATION BASED ON MODIFIED ADJUSTED GROSS INCOME.—

"(A) IN GENERAL.—No credit shall be allowed under subsection (a) for any taxable year if—

"(i) the lesser of—

"(I) the modified adjusted gross income of the taxpayer for such taxable year, or

"(II) the modified adjusted gross income of the taxpayer for the preceding taxable year, exceeds

"(ii) the threshold amount.

"(B) THRESHOLD AMOUNT.—For purposes of subparagraph (A)(ii), the threshold amount shall be—

"(i) in the case of a joint return or a surviving spouse (as defined in section 2(a)), $300,000,

"(ii) in the case of a head of household (as defined in section 2(b)), $225,000, and

"(iii) in the case of a taxpayer not described in clause (i) or (ii), $150,000.

Definition.

"(C) MODIFIED ADJUSTED GROSS INCOME.—For purposes of this paragraph, the term 'modified adjusted gross income' means adjusted gross income increased by any amount excluded from gross income under section 911, 931, or 933.

"(11) MANUFACTURER'S SUGGESTED RETAIL PRICE LIMITATION.—

"(A) IN GENERAL.—No credit shall be allowed under subsection (a) for a vehicle with a manufacturer's suggested retail price in excess of the applicable limitation.

"(B) APPLICABLE LIMITATION.—For purposes of subparagraph (A), the applicable limitation for each vehicle classification is as follows:

"(i) VANS.—In the case of a van, $80,000.

"(ii) SPORT UTILITY VEHICLES.—In the case of a sport utility vehicle, $80,000.

"(iii) PICKUP TRUCKS.—In the case of a pickup truck, $80,000.

"(iv) OTHER.—In the case of any other vehicle, $55,000.

Determination.

"(C) REGULATIONS AND GUIDANCE.—For purposes of this paragraph, the Secretary shall prescribe such regulations or other guidance as the Secretary determines necessary for determining vehicle classifications using criteria similar to that employed by the Environmental Protection Agency and the Department of the Energy to determine size and class of vehicles.".

(g) TRANSFER OF CREDIT.—

26 USC 30D.

(1) IN GENERAL.—Section 30D is amended by striking subsection (g) and inserting the following:

"(g) TRANSFER OF CREDIT.—

Determination.

"(1) IN GENERAL.—Subject to such regulations or other guidance as the Secretary determines necessary, if the taxpayer who acquires a new clean vehicle elects the application of this subsection with respect to such vehicle, the credit which would (but for this subsection) be allowed to such taxpayer with respect to such vehicle shall be allowed to the eligible entity specified in such election (and not to such taxpayer).

Definition.

"(2) ELIGIBLE ENTITY.—For purposes of this subsection, the term 'eligible entity' means, with respect to the vehicle for which the credit is allowed under subsection (a), the dealer which sold such vehicle to the taxpayer and has—

"(A) subject to paragraph (4), registered with the Secretary for purposes of this paragraph, at such time, and in such form and manner, as the Secretary may prescribe,

"(B) prior to the election described in paragraph (1) and not later than at the time of such sale, disclosed to the taxpayer purchasing such vehicle—

"(i) the manufacturer's suggested retail price,

"(ii) the value of the credit allowed and any other incentive available for the purchase of such vehicle, and

"(iii) the amount provided by the dealer to such taxpayer as a condition of the election described in paragraph (1),

"(C) not later than at the time of such sale, made payment to such taxpayer (whether in cash or in the form of a partial payment or down payment for the purchase of such vehicle) in an amount equal to the credit otherwise allowable to such taxpayer, and Deadline.

"(D) with respect to any incentive otherwise available for the purchase of a vehicle for which a credit is allowed under this section, including any incentive in the form of a rebate or discount provided by the dealer or manufacturer, ensured that—

"(i) the availability or use of such incentive shall not limit the ability of a taxpayer to make an election described in paragraph (1), and

"(ii) such election shall not limit the value or use of such incentive.

"(3) TIMING.—An election described in paragraph (1) shall be made by the taxpayer not later than the date on which the vehicle for which the credit is allowed under subsection (a) is purchased.

"(4) REVOCATION OF REGISTRATION.—Upon determination by the Secretary that a dealer has failed to comply with the requirements described in paragraph (2), the Secretary may revoke the registration (as described in subparagraph (A) of such paragraph) of such dealer. Determination.

"(5) TAX TREATMENT OF PAYMENTS.—With respect to any payment described in paragraph (2)(C), such payment—

"(A) shall not be includible in the gross income of the taxpayer, and

"(B) with respect to the dealer, shall not be deductible under this title.

"(6) APPLICATION OF CERTAIN OTHER REQUIREMENTS.—In the case of any election under paragraph (1) with respect to any vehicle—

"(A) the requirements of paragraphs (1) and (2) of subsection (f) shall apply to the taxpayer who acquired the vehicle in the same manner as if the credit determined under this section with respect to such vehicle were allowed to such taxpayer,

"(B) paragraph (6) of such subsection shall not apply, and

"(C) the requirement of paragraph (9) of such subsection (f) shall be treated as satisfied if the eligible entity provides the vehicle identification number of such vehicle

to the Secretary in such manner as the Secretary may provide.

"(7) ADVANCE PAYMENT TO REGISTERED DEALERS.—

"(A) IN GENERAL.—The Secretary shall establish a program to make advance payments to any eligible entity in an amount equal to the cumulative amount of the credits allowed under subsection (a) with respect to any vehicles sold by such entity for which an election described in paragraph (1) has been made.

Applicability.

"(B) EXCESSIVE PAYMENTS.—Rules similar to the rules of section 6417(d)(6) shall apply for purposes of this paragraph.

"(C) TREATMENT OF ADVANCE PAYMENTS.—For purposes of section 1324 of title 31, United States Code, the payments under subparagraph (A) shall be treated in the same manner as a refund due from a credit provision referred to in subsection (b)(2) of such section.

Definition.

"(8) DEALER.—For purposes of this subsection, the term 'dealer' means a person licensed by a State, the District of Columbia, the Commonwealth of Puerto Rico, any other territory or possession of the United States, an Indian tribal government, or any Alaska Native Corporation (as defined in section 3 of the Alaska Native Claims Settlement Act (43 U.S.C. 1602(m)) to engage in the sale of vehicles.

Definition.

"(9) INDIAN TRIBAL GOVERNMENT.—For purposes of this subsection, the term 'Indian tribal government' means the recognized governing body of any Indian or Alaska Native tribe, band, nation, pueblo, village, community, component band, or component reservation, individually identified (including parenthetically) in the list published most recently as of the date of enactment of this subsection pursuant to section 104 of the Federally Recognized Indian Tribe List Act of 1994 (25 U.S.C. 5131).

"(10) RECAPTURE.—In the case of any taxpayer who has made an election described in paragraph (1) with respect to a new clean vehicle and received a payment described in paragraph (2)(C) from an eligible entity, if the credit under subsection (a) would otherwise (but for this subsection) not be allowable to such taxpayer pursuant to the application of subsection (f)(10), the tax imposed on such taxpayer under this chapter for the taxable year in which such vehicle was placed in service shall be increased by the amount of the payment received by such taxpayer.".

(2) CONFORMING AMENDMENTS.—Section 30D, as amended by the preceding provisions of this section, is amended—

26 USC 30D.

(A) in subsection (d)(1)(H) of such section—

(i) in clause (iv), by striking "and" at the end,

(ii) in clause (v), by striking the period at the end and inserting ", and", and

(iii) by adding at the end the following:

"(vi) in the case of a taxpayer who makes an election under subsection (g)(1), any amount described in subsection (g)(2)(C) which has been provided to such taxpayer.", and

(B) in subsection (f)—

(i) by striking paragraph (3), and

(ii) in paragraph (8), by inserting ", including any vehicle with respect to which the taxpayer elects the application of subsection (g)" before the period at the end.

(h) TERMINATION.—Section 30D is amended by adding at the end the following: 26 USC 30D.

"(h) TERMINATION.—No credit shall be allowed under this section with respect to any vehicle placed in service after December 31, 2032.".

(i) ADDITIONAL CONFORMING AMENDMENTS.—

(1) The heading of section 30D is amended by striking "**NEW QUALIFIED PLUG-IN ELECTRIC DRIVE MOTOR VEHICLES**" and inserting "**CLEAN VEHICLE CREDIT**".

(2) Section 30B is amended—

(A) in subsection (h)(8), by striking ", except that no benefit shall be recaptured if such property ceases to be eligible for such credit by reason of conversion to a qualified plug-in electric drive motor vehicle", and

(B) by striking subsection (i).

(3) Section 38(b)(30) is amended by striking "qualified plug-in electric drive motor" and inserting "clean".

(4) Section 6213(g)(2), as amended by the preceding provisions of this Act, is amended—

(A) in subparagraph (R), by striking "and" at the end,

(B) in subparagraph (S), by striking the period at the end and inserting ", and", and

(C) by inserting after subparagraph (S) the following:

"(T) an omission of a correct vehicle identification number required under section 30D(f)(9) (relating to credit for new clean vehicles) to be included on a return.".

(5) Section 6501(m) is amended by striking "30D(e)(4)" and inserting "30D(f)(6)".

(6) The table of sections for subpart B of part IV of subchapter A of chapter 1 is amended by striking the item relating to section 30D and inserting after the item relating to section 30C the following item: 26 USC 27 prec.

"Sec. 30D. Clean vehicle credit.".

(j) GROSS-UP OF DIRECT SPENDING.—Beginning in fiscal year 2023 and each fiscal year thereafter, the portion of any credit allowed to an eligible entity (as defined in section 30D(g)(2) of the Internal Revenue Code of 1986) pursuant to an election made under section 30D(g) of the Internal Revenue Code of 1986 that is direct spending shall be increased by 6.0445 percent. Effective dates. Time periods. 26 USC 30D note.

(k) EFFECTIVE DATES.—

(1) IN GENERAL.—Except as provided in paragraphs (2), (3), (4), and (5), the amendments made by this section shall apply to vehicles placed in service after December 31, 2022. Applicability. 26 USC 30D note.

(2) FINAL ASSEMBLY.—The amendments made by subsection (b) shall apply to vehicles sold after the date of enactment of this Act.

(3) PER VEHICLE DOLLAR LIMITATION AND RELATED REQUIREMENTS.—The amendments made by subsections (a) and (e) shall apply to vehicles placed in service after the date on which the proposed guidance described in paragraph (3)(B) of section 30D(e) of the Internal Revenue Code of 1986 (as added by subsection (e)) is issued by the Secretary of the Treasury (or the Secretary's delegate).

(4) TRANSFER OF CREDIT.—The amendments made by subsection (g) shall apply to vehicles placed in service after December 31, 2023.

(5) ELIMINATION OF MANUFACTURER LIMITATION.—The amendment made by subsection (d) shall apply to vehicles sold after December 31, 2022.

Applicability. Effective dates. 26 USC 30D note.

(l) TRANSITION RULE.—Solely for purposes of the application of section 30D of the Internal Revenue Code of 1986, in the case of a taxpayer that—

(1) after December 31, 2021, and before the date of enactment of this Act, purchased, or entered into a written binding contract to purchase, a new qualified plug-in electric drive motor vehicle (as defined in section 30D(d)(1) of the Internal Revenue Code of 1986, as in effect on the day before the date of enactment of this Act), and

(2) placed such vehicle in service on or after the date of enactment of this Act,

such taxpayer may elect (at such time, and in such form and manner, as the Secretary of the Treasury, or the Secretary's delegate, may prescribe) to treat such vehicle as having been placed in service on the day before the date of enactment of this Act.

SEC. 13402. CREDIT FOR PREVIOUSLY-OWNED CLEAN VEHICLES.

(a) IN GENERAL.—Subpart A of part IV of subchapter A of chapter 1 is amended by inserting after section 25D the following new section:

26 USC 25E.

"SEC. 25E. PREVIOUSLY-OWNED CLEAN VEHICLES.

"(a) ALLOWANCE OF CREDIT.—In the case of a qualified buyer who during a taxable year places in service a previously-owned clean vehicle, there shall be allowed as a credit against the tax imposed by this chapter for the taxable year an amount equal to the lesser of—

"(1) $4,000, or

"(2) the amount equal to 30 percent of the sale price with respect to such vehicle.

"(b) LIMITATION BASED ON MODIFIED ADJUSTED GROSS INCOME.—

"(1) IN GENERAL.—No credit shall be allowed under subsection (a) for any taxable year if—

"(A) the lesser of—

"(i) the modified adjusted gross income of the taxpayer for such taxable year, or

"(ii) the modified adjusted gross income of the taxpayer for the preceding taxable year, exceeds

"(B) the threshold amount.

"(2) THRESHOLD AMOUNT.—For purposes of paragraph (1)(B), the threshold amount shall be—

"(A) in the case of a joint return or a surviving spouse (as defined in section 2(a)), $150,000,

"(B) in the case of a head of household (as defined in section 2(b)), $112,500, and

"(C) in the case of a taxpayer not described in subparagraph (A) or (B), $75,000.

Definition.

"(3) MODIFIED ADJUSTED GROSS INCOME.—For purposes of this subsection, the term 'modified adjusted gross income' means adjusted gross income increased by any amount excluded from gross income under section 911, 931, or 933.

"(c) DEFINITIONS.—For purposes of this section—

"(1) PREVIOUSLY-OWNED CLEAN VEHICLE.—The term 'previously-owned clean vehicle' means, with respect to a taxpayer, a motor vehicle—

"(A) the model year of which is at least 2 years earlier than the calendar year in which the taxpayer acquires such vehicle,

"(B) the original use of which commences with a person other than the taxpayer,

"(C) which is acquired by the taxpayer in a qualified sale, and

"(D) which—

"(i) meets the requirements of subparagraphs (C), (D), (E), (F), and (H) (except for clause (iv) thereof) of section 30D(d)(1), or

"(ii) is a motor vehicle which—

"(I) satisfies the requirements under subparagraphs (A) and (B) of section 30B(b)(3), and

"(II) has a gross vehicle weight rating of less than 14,000 pounds.

"(2) QUALIFIED SALE.—The term 'qualified sale' means a sale of a motor vehicle—

"(A) by a dealer (as defined in section 30D(g)(8)),

"(B) for a sale price which does not exceed $25,000, and

"(C) which is the first transfer since the date of the enactment of this section to a qualified buyer other than the person with whom the original use of such vehicle commenced.

"(3) QUALIFIED BUYER.—The term 'qualified buyer' means, with respect to a sale of a motor vehicle, a taxpayer—

"(A) who is an individual,

"(B) who purchases such vehicle for use and not for resale,

"(C) with respect to whom no deduction is allowable with respect to another taxpayer under section 151, and

"(D) who has not been allowed a credit under this section for any sale during the 3-year period ending on the date of the sale of such vehicle.

"(4) MOTOR VEHICLE; CAPACITY.—The terms 'motor vehicle' and 'capacity' have the meaning given such terms in paragraphs (2) and (4) of section 30D(d), respectively.

"(d) VIN NUMBER REQUIREMENT.—No credit shall be allowed under subsection (a) with respect to any vehicle unless the taxpayer includes the vehicle identification number of such vehicle on the return of tax for the taxable year.

"(e) APPLICATION OF CERTAIN RULES.—For purposes of this section, rules similar to the rules of section 30D(f) (without regard to paragraph (10) or (11) thereof) shall apply for purposes of this section.

"(f) TERMINATION.—No credit shall be allowed under this section with respect to any vehicle acquired after December 31, 2032.".

(b) TRANSFER OF CREDIT.—Section 25E, as added by subsection (a), is amended—

(1) by redesignating subsection (f) as subsection (g), and

(2) by inserting after subsection (e) the following:

Applicability.

"(f) TRANSFER OF CREDIT.—Rules similar to the rules of section 30D(g) shall apply.".

(c) CONFORMING AMENDMENTS.—Section 6213(g)(2), as amended by the preceding provisions of this Act, is amended—

(1) in subparagraph (S), by striking "and" at the end,

(2) in subparagraph (T), by striking the period at the end and inserting ", and", and

(3) by inserting after subparagraph (T) the following:

"(U) an omission of a correct vehicle identification number required under section 25E(d) (relating to credit for previously-owned clean vehicles) to be included on a return.".

(d) CLERICAL AMENDMENT.—The table of sections for subpart A of part IV of subchapter A of chapter 1 is amended by inserting after the item relating to section 25D the following new item:

26 USC 21 prec.

"Sec. 25E. Previously-owned clean vehicles.".

Applicability.
26 USC 25E note.

(e) EFFECTIVE DATE.—

(1) IN GENERAL.—Except as provided in paragraph (2), the amendments made by this section shall apply to vehicles acquired after December 31, 2022.

(2) TRANSFER OF CREDIT.—The amendments made by subsection (b) shall apply to vehicles acquired after December 31, 2023.

SEC. 13403. QUALIFIED COMMERCIAL CLEAN VEHICLES.

(a) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new section:

26 USC 45W.

"SEC. 45W. CREDIT FOR QUALIFIED COMMERCIAL CLEAN VEHICLES.

"(a) IN GENERAL.—For purposes of section 38, the qualified commercial clean vehicle credit for any taxable year is an amount equal to the sum of the credit amounts determined under subsection (b) with respect to each qualified commercial clean vehicle placed in service by the taxpayer during the taxable year.

"(b) PER VEHICLE AMOUNT.—

"(1) IN GENERAL.—Subject to paragraph (4), the amount determined under this subsection with respect to any qualified commercial clean vehicle shall be equal to the lesser of—

"(A) 15 percent of the basis of such vehicle (30 percent in the case of a vehicle not powered by a gasoline or diesel internal combustion engine), or

"(B) the incremental cost of such vehicle.

"(2) INCREMENTAL COST.—For purposes of paragraph (1)(B), the incremental cost of any qualified commercial clean vehicle is an amount equal to the excess of the purchase price for such vehicle over such price of a comparable vehicle.

Definition.

"(3) COMPARABLE VEHICLE.—For purposes of this subsection, the term 'comparable vehicle' means, with respect to any qualified commercial clean vehicle, any vehicle which is powered solely by a gasoline or diesel internal combustion engine and which is comparable in size and use to such vehicle.

"(4) LIMITATION.—The amount determined under this subsection with respect to any qualified commercial clean vehicle shall not exceed—

"(A) in the case of a vehicle which has a gross vehicle weight rating of less than 14,000 pounds, $7,500, and

"(B) in the case of a vehicle not described in subparagraph (A), $40,000.

"(c) QUALIFIED COMMERCIAL CLEAN VEHICLE.—For purposes of this section, the term 'qualified commercial clean vehicle' means any vehicle which— Definition.

"(1) meets the requirements of section 30D(d)(1)(C) and is acquired for use or lease by the taxpayer and not for resale,

"(2) either—

"(A) meets the requirements of subparagraph (D) of section 30D(d)(1) and is manufactured primarily for use on public streets, roads, and highways (not including a vehicle operated exclusively on a rail or rails), or

"(B) is mobile machinery, as defined in section 4053(8) (including vehicles that are not designed to perform a function of transporting a load over the public highways),

"(3) either—

"(A) is propelled to a significant extent by an electric motor which draws electricity from a battery which has a capacity of not less than 15 kilowatt hours (or, in the case of a vehicle which has a gross vehicle weight rating of less than 14,000 pounds, 7 kilowatt hours) and is capable of being recharged from an external source of electricity, or

"(B) is a motor vehicle which satisfies the requirements under subparagraphs (A) and (B) of section 30B(b)(3), and

"(4) is of a character subject to the allowance for depreciation.

"(d) SPECIAL RULES.—

"(1) IN GENERAL.—Rules similar to the rules under subsection (f) of section 30D (without regard to paragraph (10) or (11) thereof) shall apply for purposes of this section. Applicability.

"(2) VEHICLES PLACED IN SERVICE BY TAX-EXEMPT ENTITIES.—Subsection (c)(4) shall not apply to any vehicle which is not subject to a lease and which is placed in service by a tax-exempt entity described in clause (i), (ii), or (iv) of section 168(h)(2)(A).

"(3) NO DOUBLE BENEFIT.—No credit shall be allowed under this section with respect to any vehicle for which a credit was allowed under section 30D.

"(e) VIN NUMBER REQUIREMENT.—No credit shall be determined under subsection (a) with respect to any vehicle unless the taxpayer includes the vehicle identification number of such vehicle on the return of tax for the taxable year.

"(f) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this section, including regulations or other guidance relating to determination of the incremental cost of any qualified commercial clean vehicle. Determination.

"(g) TERMINATION.—No credit shall be determined under this section with respect to any vehicle acquired after December 31, 2032.".

(b) CONFORMING AMENDMENTS.—

(1) Section 38(b), as amended by the preceding provisions of this Act, is amended— 26 USC 38.

(A) in paragraph (35), by striking "plus" at the end,

(B) in paragraph (36), by striking the period at the end and inserting ", plus", and

(C) by adding at the end the following new paragraph:

"(37) the qualified commercial clean vehicle credit determined under section 45W.".

(2) Section 6213(g)(2), as amended by the preceding provisions of this Act, is amended— 26 USC 6213.

(A) in subparagraph (T), by striking "and" at the end,

(B) in subparagraph (U), by striking the period at the end and inserting ", and", and

(C) by inserting after subparagraph (U) the following:

"(V) an omission of a correct vehicle identification number required under section 45W(e) (relating to commercial clean vehicle credit) to be included on a return.".

(3) The table of sections for subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new item: 26 USC 38 prec.

"Sec. 45W. Qualified commercial clean vehicle credit.".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to vehicles acquired after December 31, 2022. 26 USC 45W note.

SEC. 13404. ALTERNATIVE FUEL REFUELING PROPERTY CREDIT.

(a) IN GENERAL.—Section 30C(g) is amended by striking "December 31, 2021" and inserting "December 31, 2032".

(b) CREDIT FOR PROPERTY OF A CHARACTER SUBJECT TO DEPRECIATION.—

(1) IN GENERAL.—Section 30C(a) is amended by inserting "(6 percent in the case of property of a character subject to depreciation)" after "30 percent".

(2) MODIFICATION OF CREDIT LIMITATION.—Subsection (b) of section 30C is amended—

(A) in the matter preceding paragraph (1)—

(i) by striking "with respect to all" and inserting "with respect to any single item of", and

(ii) by striking "at a location", and

(B) in paragraph (1), by striking "$30,000 in the case of a property" and inserting "$100,000 in the case of any such item of property".

(3) BIDIRECTIONAL CHARGING EQUIPMENT INCLUDED AS QUALIFIED ALTERNATIVE FUEL VEHICLE REFUELING PROPERTY.—Section 30C(c) is amended to read as follows:

"(c) QUALIFIED ALTERNATIVE FUEL VEHICLE REFUELING PROPERTY.—For purposes of this section—

"(1) IN GENERAL.—The term 'qualified alternative fuel vehicle refueling property' has the same meaning as the term 'qualified clean-fuel vehicle refueling property' would have under section 179A if— Definition.

"(A) paragraph (1) of section 179A(d) did not apply to property installed on property which is used as the principal residence (within the meaning of section 121) of the taxpayer, and

"(B) only the following were treated as clean-burning fuels for purposes of section 179A(d):

"(i) Any fuel at least 85 percent of the volume of which consists of one or more of the following: ethanol, natural gas, compressed natural gas, liquified natural gas, liquefied petroleum gas, or hydrogen.

"(ii) Any mixture—

"(I) which consists of two or more of the following: biodiesel (as defined in section 40A(d)(1)), diesel fuel (as defined in section 4083(a)(3)), or kerosene, and

"(II) at least 20 percent of the volume of which consists of biodiesel (as so defined) determined without regard to any kerosene in such mixture. "(iii) Electricity.

"(2) BIDIRECTIONAL CHARGING EQUIPMENT.—Property shall not fail to be treated as qualified alternative fuel vehicle refueling property solely because such property—

"(A) is capable of charging the battery of a motor vehicle propelled by electricity, and

"(B) allows discharging electricity from such battery to an electric load external to such motor vehicle.".

(c) CERTAIN ELECTRIC CHARGING STATIONS INCLUDED AS QUALIFIED ALTERNATIVE FUEL VEHICLE REFUELING PROPERTY.—Section 30C is amended by redesignating subsections (f) and (g) as subsections (g) and (h), respectively, and by inserting after subsection (e) the following: 26 USC 30C.

"(f) SPECIAL RULE FOR ELECTRIC CHARGING STATIONS FOR CERTAIN VEHICLES WITH 2 OR 3 WHEELS.—For purposes of this section—

"(1) IN GENERAL.—The term 'qualified alternative fuel vehicle refueling property' includes any property described in subsection (c) for the recharging of a motor vehicle described in paragraph (2), but only if such property— Definition.

"(A) meets the requirements of subsection (a)(2), and

"(B) is of a character subject to depreciation.

"(2) MOTOR VEHICLE.—A motor vehicle is described in this paragraph if the motor vehicle—

"(A) is manufactured primarily for use on public streets, roads, or highways (not including a vehicle operated exclusively on a rail or rails),

"(B) has 2 or 3 wheels, and

"(C) is propelled by electricity.".

(d) WAGE AND APPRENTICESHIP REQUIREMENTS.—Section 30C, as amended by this section, is further amended by redesignating subsections (g) and (h) as subsections (h) and (i) and by inserting after subsection (f) the following new subsection:

"(g) WAGE AND APPRENTICESHIP REQUIREMENTS.—

"(1) INCREASED CREDIT AMOUNT.—

"(A) IN GENERAL.—In the case of any qualified alternative fuel vehicle refueling project which satisfies the requirements of subparagraph (C), the amount of the credit determined under subsection (a) for any qualified alternative fuel vehicle refueling property of a character subject to an allowance for depreciation which is part of such project shall be equal to such amount (determined without regard to this sentence) multiplied by 5.

"(B) QUALIFIED ALTERNATIVE FUEL VEHICLE REFUELING PROJECT.—For purposes of this subsection, the term 'qualified alternative fuel vehicle refueling project' means a project consisting of one or more properties that are part of a single project. Definition.

"(C) PROJECT REQUIREMENTS.—A project meets the requirements of this subparagraph if it is one of the following:

Time period. Publication. Guidelines.

"(i) A project the construction of which begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (2)(A) and (3).

"(ii) A project which satisfies the requirements of paragraphs (2)(A) and (3).

"(2) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to any qualified alternative fuel vehicle refueling project are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in the construction of any qualified alternative fuel vehicle refueling property which is part of such project shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such project is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code.

Applicability.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Applicability.

"(3) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

Determination. Requirements. Records.

"(4) REGULATIONS AND GUIDANCE.—The Secretary shall issue such regulations or other guidance as the Secretary determines necessary to carry out the purposes of this subsection, including regulations or other guidance which provides for requirements for recordkeeping or information reporting for purposes of administering the requirements of this subsection.".

(e) ELIGIBLE CENSUS TRACTS.—Subsection (c) of section 30C, as amended by subsection (b)(3), is amended by adding at the end the following:

26 USC 30C.

"(3) PROPERTY REQUIRED TO BE LOCATED IN ELIGIBLE CENSUS TRACTS.—

"(A) IN GENERAL.—Property shall not be treated as qualified alternative fuel vehicle refueling property unless such property is placed in service in an eligible census tract.

Definitions.

"(B) ELIGIBLE CENSUS TRACT.—

"(i) IN GENERAL.—For purposes of this paragraph, the term 'eligible census tract' means any population census tract which—

"(I) is described in section 45D(e), or

"(II) is not an urban area.

"(ii) URBAN AREA.—For purposes of clause (i)(II), the term 'urban area' means a census tract (as defined by the Bureau of the Census) which, according to the most recent decennial census, has been designated as an urban area by the Secretary of Commerce.".

Applicability. 26 USC 30C note.

(f) EFFECTIVE DATE.—

(1) IN GENERAL.—Except as provided in paragraph (2), the amendments made by this section shall apply to property placed in service after December 31, 2022.

(2) EXTENSION.—The amendments made by subsection (a) shall apply to property placed in service after December 31, 2021.

PART 5—INVESTMENT IN CLEAN ENERGY MANUFACTURING AND ENERGY SECURITY

SEC. 13501. EXTENSION OF THE ADVANCED ENERGY PROJECT CREDIT.

(a) EXTENSION OF CREDIT.—Section 48C is amended by redesignating subsection (e) as subsection (f) and by inserting after subsection (d) the following new subsection: 26 USC 48C.

"(e) ADDITIONAL ALLOCATIONS.—

"(1) IN GENERAL.—Not later than 180 days after the date of enactment of this subsection, the Secretary shall establish a program to consider and award certifications for qualified investments eligible for credits under this section to qualifying advanced energy project sponsors. Deadline.

"(2) LIMITATION.—The total amount of credits which may be allocated under the program established under paragraph (1) shall not exceed $10,000,000,000, of which not greater than $6,000,000,000 may be allocated to qualified investments which are not located within a census tract which—

"(A) is described in clause (iii) of section 45(b)(11)(B), and

"(B) prior to the date of enactment of this subsection, had no project which received a certification and allocation of credits under subsection (d).

"(3) CERTIFICATIONS.— Time period.

"(A) APPLICATION REQUIREMENT.—Each applicant for certification under this subsection shall submit an application at such time and containing such information as the Secretary may require.

"(B) TIME TO MEET CRITERIA FOR CERTIFICATION.—Each applicant for certification shall have 2 years from the date of acceptance by the Secretary of the application during which to provide to the Secretary evidence that the requirements of the certification have been met. Notification.

"(C) PERIOD OF ISSUANCE.—An applicant which receives a certification shall have 2 years from the date of issuance of the certification in order to place the project in service and to notify the Secretary that such project has been so placed in service, and if such project is not placed in service by that time period, then the certification shall no longer be valid. If any certification is revoked under this subparagraph, the amount of the limitation under paragraph (2) shall be increased by the amount of the credit with respect to such revoked certification.

"(D) LOCATION OF PROJECT.—In the case of an applicant which receives a certification, if the Secretary determines that the project has been placed in service at a location which is materially different than the location specified in the application for such project, the certification shall no longer be valid. Determination.

"(4) CREDIT RATE CONDITIONED UPON WAGE AND APPRENTICESHIP REQUIREMENTS.—

"(A) BASE RATE.—For purposes of allocations under this subsection, the amount of the credit determined under Determination.

subsection (a) shall be determined by substituting '6 percent' for '30 percent'.

"(B) ALTERNATIVE RATE.—In the case of any project which satisfies the requirements of paragraphs (5)(A) and (6), subparagraph (A) shall not apply.

"(5) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—The requirements described in this subparagraph with respect to a project are that the taxpayer shall ensure that any laborers and mechanics employed by the taxpayer or any contractor or subcontractor in the re-equipping, expansion, or establishment of a manufacturing facility shall be paid wages at rates not less than the prevailing rates for construction, alteration, or repair of a similar character in the locality in which such project is located as most recently determined by the Secretary of Labor, in accordance with subchapter IV of chapter 31 of title 40, United States Code.

Applicability.

"(B) CORRECTION AND PENALTY RELATED TO FAILURE TO SATISFY WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7)(B) shall apply.

Applicability.

"(6) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

Certification. Public information.

"(7) DISCLOSURE OF ALLOCATIONS.—The Secretary shall, upon making a certification under this subsection, publicly disclose the identity of the applicant and the amount of the credit with respect to such applicant.".

26 USC 48C.

(b) MODIFICATION OF QUALIFYING ADVANCED ENERGY PROJECTS.—Section 48C(c)(1)(A) is amended—

(1) by inserting ", any portion of the qualified investment of which is certified by the Secretary under subsection (e) as eligible for a credit under this section" after "means a project",

(2) in clause (i)—

(A) by striking "a manufacturing facility for the production of" and inserting "an industrial or manufacturing facility for the production or recycling of",

(B) in clause (I), by inserting "water," after "sun,",

(C) in clause (II), by striking "an energy storage system for use with electric or hybrid-electric motor vehicles" and inserting "energy storage systems and components",

(D) in clause (III), by striking "grids to support the transmission of intermittent sources of renewable energy, including storage of such energy" and inserting "grid modernization equipment or components",

(E) in subclause (IV), by striking "and sequester carbon dioxide emissions" and inserting ", remove, use, or sequester carbon oxide emissions",

(F) by striking subclause (V) and inserting the following:

"(V) equipment designed to refine, electrolyze, or blend any fuel, chemical, or product which is—

"(aa) renewable, or

"(bb) low-carbon and low-emission,",

(G) by striking subclause (VI),

(H) by redesignating subclause (VII) as subclause (IX),

(I) by inserting after subclause (V) the following new subclauses:

"(VI) property designed to produce energy conservation technologies (including residential, commercial, and industrial applications),

"(VII) light-, medium-, or heavy-duty electric or fuel cell vehicles, as well as—

"(aa) technologies, components, or materials for such vehicles, and

"(bb) associated charging or refueling infrastructure,

"(VIII) hybrid vehicles with a gross vehicle weight rating of not less than 14,000 pounds, as well as technologies, components, or materials for such vehicles, or", and

(J) in subclause (IX), as so redesignated, by striking "and" at the end, and

(3) by striking clause (ii) and inserting the following:

"(ii) which re-equips an industrial or manufacturing facility with equipment designed to reduce greenhouse gas emissions by at least 20 percent through the installation of—

"(I) low- or zero-carbon process heat systems,

"(II) carbon capture, transport, utilization and storage systems,

"(III) energy efficiency and reduction in waste from industrial processes, or

"(IV) any other industrial technology designed to reduce greenhouse gas emissions, as determined by the Secretary, or

"(iii) which re-equips, expands, or establishes an industrial facility for the processing, refining, or recycling of critical materials (as defined in section 7002(a) of the Energy Act of 2020 (30 U.S.C. 1606(a)).".

(c) CONFORMING AMENDMENT.—Subparagraph (A) of section 48C(c)(2) is amended to read as follows: 26 USC 48C.

"(A) which is necessary for—

"(i) the production or recycling of property described in clause (i) of paragraph (1)(A),

"(ii) re-equipping an industrial or manufacturing facility described in clause (ii) of such paragraph, or

"(iii) re-equipping, expanding, or establishing an industrial facility described in clause (iii) of such paragraph,".

(d) DENIAL OF DOUBLE BENEFIT.—48C(f), as redesignated by this section, is amended by striking "or 48B" and inserting "48B, 48E, 45Q, or 45V".

(e) EFFECTIVE DATE.—The amendments made by this section shall take effect on January 1, 2023. 26 USC 48C note.

SEC. 13502. ADVANCED MANUFACTURING PRODUCTION CREDIT.

(a) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new section:

"SEC. 45X. ADVANCED MANUFACTURING PRODUCTION CREDIT. 26 USC 45X.

"(a) IN GENERAL.—

"(1) ALLOWANCE OF CREDIT.—For purposes of section 38, the advanced manufacturing production credit for any taxable year is an amount equal to the sum of the credit amounts

determined under subsection (b) with respect to each eligible component which is—

"(A) produced by the taxpayer, and

"(B) during the taxable year, sold by such taxpayer to an unrelated person.

"(2) PRODUCTION AND SALE MUST BE IN TRADE OR BUSINESS.—Any eligible component produced and sold by the taxpayer shall be taken into account only if the production and sale described in paragraph (1) is in a trade or business of the taxpayer.

"(3) UNRELATED PERSON.—

"(A) IN GENERAL.—For purposes of this subsection, a taxpayer shall be treated as selling components to an unrelated person if such component is sold to such person by a person related to the taxpayer.

"(B) ELECTION.—

"(i) IN GENERAL.—At the election of the taxpayer (in such form and manner as the Secretary may prescribe), a sale of components by such taxpayer to a related person shall be deemed to have been made to an unrelated person.

"(ii) REQUIREMENT.—As a condition of, and prior to, any election described in clause (i), the Secretary may require such information or registration as the Secretary deems necessary for purposes of preventing duplication, fraud, or any improper or excessive amount determined under paragraph (1).

"(b) CREDIT AMOUNT.—

"(1) IN GENERAL.—Subject to paragraph (3), the amount determined under this subsection with respect to any eligible component, including any eligible component it incorporates, shall be equal to—

"(A) in the case of a thin film photovoltaic cell or a crystalline photovoltaic cell, an amount equal to the product of—

"(i) 4 cents, multiplied by

"(ii) the capacity of such cell (expressed on a per direct current watt basis),

"(B) in the case of a photovoltaic wafer, $12 per square meter,

"(C) in the case of solar grade polysilicon, $3 per kilogram,

"(D) in the case of a polymeric backsheet, 40 cents per square meter,

"(E) in the case of a solar module, an amount equal to the product of—

"(i) 7 cents, multiplied by

"(ii) the capacity of such module (expressed on a per direct current watt basis),

"(F) in the case of a wind energy component—

"(i) if such component is a related offshore wind vessel, an amount equal to 10 percent of the sales price of such vessel, and

"(ii) if such component is not described in clause (i), an amount equal to the product of—

"(I) the applicable amount with respect to such component (as determined under paragraph (2)(A)), multiplied by

"(II) the total rated capacity (expressed on a per watt basis) of the completed wind turbine for which such component is designed,

"(G) in the case of a torque tube, 87 cents per kilogram,

"(H) in the case of a structural fastener, $2.28 per kilogram,

"(I) in the case of an inverter, an amount equal to the product of—

"(i) the applicable amount with respect to such inverter (as determined under paragraph (2)(B)), multiplied by

"(ii) the capacity of such inverter (expressed on a per alternating current watt basis),

"(J) in the case of electrode active materials, an amount equal to 10 percent of the costs incurred by the taxpayer with respect to production of such materials,

"(K) in the case of a battery cell, an amount equal to the product of—

"(i) $35, multiplied by

"(ii) subject to paragraph (4), the capacity of such battery cell (expressed on a kilowatt-hour basis),

"(L) in the case of a battery module, an amount equal to the product of—

"(i) $10 (or, in the case of a battery module which does not use battery cells, $45), multiplied by

"(ii) subject to paragraph (4), the capacity of such battery module (expressed on a kilowatt-hour basis), and

"(M) in the case of any applicable critical mineral, an amount equal to 10 percent of the costs incurred by the taxpayer with respect to production of such mineral.

"(2) APPLICABLE AMOUNTS.—

"(A) WIND ENERGY COMPONENTS.—For purposes of paragraph (1)(F)(ii), the applicable amount with respect to any wind energy component shall be—

"(i) in the case of a blade, 2 cents,

"(ii) in the case of a nacelle, 5 cents,

"(iii) in the case of a tower, 3 cents, and

"(iv) in the case of an offshore wind foundation—

"(I) which uses a fixed platform, 2 cents, or

"(II) which uses a floating platform, 4 cents.

"(B) INVERTERS.—For purposes of paragraph (1)(I), the applicable amount with respect to any inverter shall be—

"(i) in the case of a central inverter, 0.25 cents,

"(ii) in the case of a utility inverter, 1.5 cents,

"(iii) in the case of a commercial inverter, 2 cents,

"(iv) in the case of a residential inverter, 6.5 cents, and

"(v) in the case of a microinverter or a distributed wind inverter, 11 cents.

"(3) PHASE OUT.—

Time periods. Effective date.

"(A) IN GENERAL.—Subject to subparagraph (C), in the case of any eligible component sold after December 31, 2029, the amount determined under this subsection with

respect to such component shall be equal to the product of—

"(i) the amount determined under paragraph (1) with respect to such component, as determined without regard to this paragraph, multiplied by

"(ii) the phase out percentage under subparagraph (B).

"(B) PHASE OUT PERCENTAGE.—The phase out percentage under this subparagraph is equal to—

"(i) in the case of an eligible component sold during calendar year 2030, 75 percent,

"(ii) in the case of an eligible component sold during calendar year 2031, 50 percent,

"(iii) in the case of an eligible component sold during calendar year 2032, 25 percent,

"(iv) in the case of an eligible component sold after December 31, 2032, 0 percent.

Determination.

"(C) EXCEPTION.—For purposes of determining the amount under this subsection with respect to any applicable critical mineral, this paragraph shall not apply.

"(4) LIMITATION ON CAPACITY OF BATTERY CELLS AND BATTERY MODULES.—

"(A) IN GENERAL.—For purposes of subparagraph (K)(ii) or (L)(ii) of paragraph (1), the capacity determined under either subparagraph with respect to a battery cell or battery module shall not exceed a capacity-to-power ratio of 100:1.

Definition.

"(B) CAPACITY-TO-POWER RATIO.—For purposes of this paragraph, the term 'capacity-to-power ratio' means, with respect to a battery cell or battery module, the ratio of the capacity of such cell or module to the maximum discharge amount of such cell or module.

"(c) DEFINITIONS.—For purposes of this section—

"(1) ELIGIBLE COMPONENT.—

"(A) IN GENERAL.—The term 'eligible component' means—

"(i) any solar energy component,

"(ii) any wind energy component,

"(iii) any inverter described in subparagraphs (B) through (G) of paragraph (2),

"(iv) any qualifying battery component, and

"(v) any applicable critical mineral.

"(B) APPLICATION WITH OTHER CREDITS.—The term 'eligible component' shall not include any property which is produced at a facility if the basis of any property which is part of such facility is taken into account for purposes of the credit allowed under section 48C after the date of the enactment of this section.

"(2) INVERTERS.—

"(A) IN GENERAL.—The term 'inverter' means an end product which is suitable to convert direct current electricity from 1 or more solar modules or certified distributed wind energy systems into alternating current electricity.

"(B) CENTRAL INVERTER.—The term 'central inverter' means an inverter which is suitable for large utility-scale systems and has a capacity which is greater than 1,000

kilowatts (expressed on a per alternating current watt basis).

"(C) COMMERCIAL INVERTER.—The term 'commercial inverter' means an inverter which—

"(i) is suitable for commercial or utility-scale applications,

"(ii) has a rated output of 208, 480, 600, or 800 volt three-phase power, and

"(iii) has a capacity which is not less than 20 kilowatts and not greater than 125 kilowatts (expressed on a per alternating current watt basis).

"(D) DISTRIBUTED WIND INVERTER.—

"(i) IN GENERAL.—The term 'distributed wind inverter' means an inverter which—

"(I) is used in a residential or non-residential system which utilizes 1 or more certified distributed wind energy systems, and

"(II) has a rated output of not greater than 150 kilowatts.

"(ii) CERTIFIED DISTRIBUTED WIND ENERGY SYSTEM.—The term 'certified distributed wind energy system' means a wind energy system which is certified by an accredited certification agency to meet Standard 9.1-2009 of the American Wind Energy Association (including any subsequent revisions to or modifications of such Standard which have been approved by the American National Standards Institute).

"(E) MICROINVERTER.—The term 'microinverter' means an inverter which—

"(i) is suitable to connect with one solar module,

"(ii) has a rated output of—

"(I) 120 or 240 volt single-phase power, or

"(II) 208 or 480 volt three-phase power, and

"(iii) has a capacity which is not greater than 650 watts (expressed on a per alternating current watt basis).

"(F) RESIDENTIAL INVERTER.—The term 'residential inverter' means an inverter which—

"(i) is suitable for a residence,

"(ii) has a rated output of 120 or 240 volt single-phase power, and

"(iii) has a capacity which is not greater than 20 kilowatts (expressed on a per alternating current watt basis).

"(G) UTILITY INVERTER.—The term 'utility inverter' means an inverter which—

"(i) is suitable for commercial or utility-scale systems,

"(ii) has a rated output of not less than 600 volt three-phase power, and

"(iii) has a capacity which is greater than 125 kilowatts and not greater than 1000 kilowatts (expressed on a per alternating current watt basis)

"(3) SOLAR ENERGY COMPONENT.—

"(A) IN GENERAL.—The term 'solar energy component' means any of the following:

"(i) Solar modules.

"(ii) Photovoltaic cells.
"(iii) Photovoltaic wafers.
"(iv) Solar grade polysilicon.
"(v) Torque tubes or structural fasteners.
"(vi) Polymeric backsheets.
"(B) ASSOCIATED DEFINITIONS.—
"(i) PHOTOVOLTAIC CELL.—The term 'photovoltaic cell' means the smallest semiconductor element of a solar module which performs the immediate conversion of light into electricity.
"(ii) PHOTOVOLTAIC WAFER.—The term 'photovoltaic wafer' means a thin slice, sheet, or layer of semiconductor material of at least 240 square centimeters—
"(I) produced by a single manufacturer either—
"(aa) directly from molten or evaporated solar grade polysilicon or deposition of solar grade thin film semiconductor photon absorber layer, or
"(bb) through formation of an ingot from molten polysilicon and subsequent slicing, and
"(II) which comprises the substrate or absorber layer of one or more photovoltaic cells.
"(iii) POLYMERIC BACKSHEET.—The term 'polymeric backsheet' means a sheet on the back of a solar module which acts as an electric insulator and protects the inner components of such module from the surrounding environment.
"(iv) SOLAR GRADE POLYSILICON.—The term 'solar grade polysilicon' means silicon which is—
"(I) suitable for use in photovoltaic manufacturing, and
"(II) purified to a minimum purity of 99.999999 percent silicon by mass.
"(v) SOLAR MODULE.—The term 'solar module' means the connection and lamination of photovoltaic cells into an environmentally protected final assembly which is—
"(I) suitable to generate electricity when exposed to sunlight, and
"(II) ready for installation without an additional manufacturing process.
"(vi) SOLAR TRACKER.—The term 'solar tracker' means a mechanical system that moves solar modules according to the position of the sun and to increase energy output.
"(vii) SOLAR TRACKER COMPONENTS.—
"(I) TORQUE TUBE.—The term 'torque tube' means a structural steel support element (including longitudinal purlins) which—
"(aa) is part of a solar tracker,
"(bb) is of any cross-sectional shape,
"(cc) may be assembled from individually manufactured segments,
"(dd) spans longitudinally between foundation posts,

"(ee) supports solar panels and is connected to a mounting attachment for solar panels (with or without separate module interface rails), and

"(ff) is rotated by means of a drive system.

"(II) STRUCTURAL FASTENER.—The term 'structural fastener' means a component which is used—

"(aa) to connect the mechanical and drive system components of a solar tracker to the foundation of such solar tracker,

"(bb) to connect torque tubes to drive assemblies, or

"(cc) to connect segments of torque tubes to one another.

"(4) WIND ENERGY COMPONENT.—

"(A) IN GENERAL.—The term 'wind energy component' means any of the following:

"(i) Blades.

"(ii) Nacelles.

"(iii) Towers.

"(iv) Offshore wind foundations.

"(v) Related offshore wind vessels.

"(B) ASSOCIATED DEFINITIONS.—

"(i) BLADE.—The term 'blade' means an airfoil-shaped blade which is responsible for converting wind energy to low-speed rotational energy.

"(ii) OFFSHORE WIND FOUNDATION.—The term 'offshore wind foundation' means the component (including transition piece) which secures an offshore wind tower and any above-water turbine components to the seafloor using—

"(I) fixed platforms, such as offshore wind monopiles, jackets, or gravity-based foundations, or

"(II) floating platforms and associated mooring systems.

"(iii) NACELLE.—The term 'nacelle' means the assembly of the drivetrain and other tower-top components of a wind turbine (with the exception of the blades and the hub) within their cover housing.

"(iv) RELATED OFFSHORE WIND VESSEL.—The term 'related offshore wind vessel' means any vessel which is purpose-built or retrofitted for purposes of the development, transport, installation, operation, or maintenance of offshore wind energy components.

"(v) TOWER.—The term 'tower' means a tubular or lattice structure which supports the nacelle and rotor of a wind turbine.

"(5) QUALIFYING BATTERY COMPONENT.—

"(A) IN GENERAL.—The term 'qualifying battery component' means any of the following:

"(i) Electrode active materials.

"(ii) Battery cells.

"(iii) Battery modules.

"(B) ASSOCIATED DEFINITIONS.—

"(i) ELECTRODE ACTIVE MATERIAL.—The term 'electrode active material' means cathode materials, anode

materials, anode foils, and electrochemically active materials, including solvents, additives, and electrolyte salts that contribute to the electrochemical processes necessary for energy storage .

"(ii) BATTERY CELL.—The term 'battery cell' means an electrochemical cell—

"(I) comprised of 1 or more positive electrodes and 1 or more negative electrodes,

"(II) with an energy density of not less than 100 watt-hours per liter, and

"(III) capable of storing at least 12 watt-hours of energy.

"(iii) BATTERY MODULE.—The term 'battery module' means a module—

"(I)(aa) in the case of a module using battery cells, with 2 or more battery cells which are configured electrically, in series or parallel, to create voltage or current, as appropriate, to a specified end use, or

"(bb) with no battery cells, and

"(II) with an aggregate capacity of not less than 7 kilowatt-hours (or, in the case of a module for a hydrogen fuel cell vehicle, not less than 1 kilowatt-hour).

"(6) APPLICABLE CRITICAL MINERALS.—The term 'applicable critical mineral' means any of the following:

"(A) ALUMINUM.—Aluminum which is—

"(i) converted from bauxite to a minimum purity of 99 percent alumina by mass, or

"(ii) purified to a minimum purity of 99.9 percent aluminum by mass.

"(B) ANTIMONY.—Antimony which is—

"(i) converted to antimony trisulfide concentrate with a minimum purity of 90 percent antimony trisulfide by mass, or

"(ii) purified to a minimum purity of 99.65 percent antimony by mass.

"(C) BARITE.—Barite which is barium sulfate purified to a minimum purity of 80 percent barite by mass.

"(D) BERYLLIUM.—Beryllium which is—

"(i) converted to copper-beryllium master alloy, or

"(ii) purified to a minimum purity of 99 percent beryllium by mass.

"(E) CERIUM.—Cerium which is—

"(i) converted to cerium oxide which is purified to a minimum purity of 99.9 percent cerium oxide by mass, or

"(ii) purified to a minimum purity of 99 percent cerium by mass.

"(F) CESIUM.—Cesium which is—

"(i) converted to cesium formate or cesium carbonate, or

"(ii) purified to a minimum purity of 99 percent cesium by mass.

"(G) CHROMIUM.—Chromium which is—

"(i) converted to ferrochromium consisting of not less than 60 percent chromium by mass, or

"(ii) purified to a minimum purity of 99 percent chromium by mass.

"(H) COBALT.—Cobalt which is—

"(i) converted to cobalt sulfate, or

"(ii) purified to a minimum purity of 99.6 percent cobalt by mass.

"(I) DYSPROSIUM.—Dysprosium which is—

"(i) converted to not less than 99 percent pure dysprosium iron alloy by mass, or

"(ii) purified to a minimum purity of 99 percent dysprosium by mass.

"(J) EUROPIUM.—Europium which is—

"(i) converted to europium oxide which is purified to a minimum purity of 99.9 percent europium oxide by mass, or

"(ii) purified to a minimum purity of 99 percent by mass.

"(K) FLUORSPAR.—Fluorspar which is—

"(i) converted to fluorspar which is purified to a minimum purity of 97 percent calcium fluoride by mass, or

"(ii) purified to a minimum purity of 99 percent fluorspar by mass.

"(L) GADOLINIUM.—Gadolinium which is—

"(i) converted to gadolinium oxide which is purified to a minimum purity of 99.9 percent gadolinium oxide by mass, or

"(ii) purified to a minimum purity of 99 percent gadolinium by mass.

"(M) GERMANIUM.—Germanium which is—

"(i) converted to germanium tetrachloride, or

"(ii) purified to a minimum purity of 99.99 percent germanium by mass.

"(N) GRAPHITE.—Graphite which is purified to a minimum purity of 99.9 percent graphitic carbon by mass.

"(O) INDIUM.—Indium which is—

"(i) converted to—

"(I) indium tin oxide, or

"(II) indium oxide which is purified to a minimum purity of 99.9 percent indium oxide by mass, or

"(ii) purified to a minimum purity of 99 percent indium by mass.

"(P) LITHIUM.—Lithium which is—

"(i) converted to lithium carbonate or lithium hydroxide, or

"(ii) purified to a minimum purity of 99.9 percent lithium by mass.

"(Q) MANGANESE.—Manganese which is—

"(i) converted to manganese sulphate, or

"(ii) purified to a minimum purity of 99.7 percent manganese by mass.

"(R) NEODYMIUM.—Neodymium which is—

"(i) converted to neodymium-praseodymium oxide which is purified to a minimum purity of 99 percent neodymium-praseodymium oxide by mass,

"(ii) converted to neodymium oxide which is purified to a minimum purity of 99.5 percent neodymium oxide by mass

"(iii) purified to a minimum purity of 99.9 percent neodymium by mass.

"(S) NICKEL.—Nickel which is—

"(i) converted to nickel sulphate, or

"(ii) purified to a minimum purity of 99 percent nickel by mass.

"(T) NIOBIUM.—Niobium which is—

"(i) converted to ferronibium, or

"(ii) purified to a minimum purity of 99 percent niobium by mass.

"(U) TELLURIUM.—Tellurium which is—

"(i) converted to cadmium telluride, or

"(ii) purified to a minimum purity of 99 percent tellurium by mass.

"(V) TIN.—Tin which is purified to low alpha emitting tin which—

"(i) has a purity of greater than 99.99 percent by mass, and

"(ii) possesses an alpha emission rate of not greater than 0.01 counts per hour per centimeter square.

"(W) TUNGSTEN.—Tungsten which is converted to ammonium paratungstate or ferrotungsten.

"(X) VANADIUM.—Vanadium which is converted to ferrovanadium or vanadium pentoxide.

"(Y) YTTRIUM.—Yttrium which is—

"(i) converted to yttrium oxide which is purified to a minimum purity of 99.999 percent yttrium oxide by mass, or

"(ii) purified to a minimum purity of 99.9 percent yttrium by mass.

"(Z) OTHER MINERALS.—Any of the following minerals, provided that such mineral is purified to a minimum purity of 99 percent by mass:

"(i) Arsenic.
"(ii) Bismuth.
"(iii) Erbium.
"(iv) Gallium.
"(v) Hafnium.
"(vi) Holmium.
"(vii) Iridium.
"(viii) Lanthanum.
"(ix) Lutetium.
"(x) Magnesium.
"(xi) Palladium.
"(xii) Platinum.
"(xiii) Praseodymium.
"(xiv) Rhodium.
"(xv) Rubidium.
"(xvi) Ruthenium.
"(xvii) Samarium.
"(xviii) Scandium.
"(xix) Tantalum.
"(xx) Terbium.
"(xxi) Thulium.

"(xxii) Titanium.
"(xxiii) Ytterbium.
"(xxiv) Zinc.
"(xxv) Zirconium.

"(d) SPECIAL RULES.—In this section—

"(1) RELATED PERSONS.—Persons shall be treated as related to each other if such persons would be treated as a single employer under the regulations prescribed under section 52(b).

"(2) ONLY PRODUCTION IN THE UNITED STATES TAKEN INTO ACCOUNT.—Sales shall be taken into account under this section only with respect to eligible components the production of which is within—

"(A) the United States (within the meaning of section 638(1)), or

"(B) a possession of the United States (within the meaning of section 638(2)).

"(3) PASS-THRU IN THE CASE OF ESTATES AND TRUSTS.—Under regulations prescribed by the Secretary, rules similar to the rules of subsection (d) of section 52 shall apply. Regulations. Applicability.

"(4) SALE OF INTEGRATED COMPONENTS.—For purposes of this section, a person shall be treated as having sold an eligible component to an unrelated person if such component is integrated, incorporated, or assembled into another eligible component which is sold to an unrelated person.".

(b) CONFORMING AMENDMENTS.—

(1) Section 38(b) of the Internal Revenue Code of 1986, as amended by the preceding provisions of this Act, is amended— 26 USC 38.

(A) in paragraph (36), by striking "plus" at the end,

(B) in paragraph (37), by striking the period at the end and inserting ", plus", and

(C) by adding at the end the following new paragraph:

"(38) the advanced manufacturing production credit determined under section 45X(a).".

(2) The table of sections for subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new item: 26 USC 38 prec.

"Sec. 45X. Advanced manufacturing production credit.".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to components produced and sold after December 31, 2022. 26 USC 45X note.

PART 6—SUPERFUND

SEC. 13601. REINSTATEMENT OF SUPERFUND.

(a) HAZARDOUS SUBSTANCE SUPERFUND FINANCING RATE.—

(1) EXTENSION.—Section 4611 is amended by striking subsection (e).

(2) ADJUSTMENT FOR INFLATION.—

(A) Section 4611(c)(2)(A) is amended by striking "9.7 cents" and inserting "16.4 cents".

(B) Section 4611(c) is amended by adding at the end the following:

"(3) ADJUSTMENT FOR INFLATION.—

Effective date.

"(A) IN GENERAL.—In the case of a year beginning after 2023, the amount in paragraph (2)(A) shall be increased by an amount equal to—

"(i) such amount, multiplied by

"(ii) the cost-of-living adjustment determined under section 1(f)(3) for the calendar year, determined by substituting 'calendar year 2022' for 'calendar year 2016' in subparagraph (A)(ii) thereof.

"(B) ROUNDING.—If any amount as adjusted under subparagraph (A) is not a multiple of $0.01, such amount shall be rounded to the next lowest multiple of $0.01.".

26 USC 9507.

(b) AUTHORITY FOR ADVANCES.—Section 9507(d)(3)(B) is amended by striking "December 31, 1995" and inserting "December 31, 2032".

26 USC 4611 note.

(c) EFFECTIVE DATE.—The amendments made by this section shall take effect on January 1, 2023.

PART 7—INCENTIVES FOR CLEAN ELECTRICITY AND CLEAN TRANSPORTATION

SEC. 13701. CLEAN ELECTRICITY PRODUCTION CREDIT.

(a) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new section:

26 USC 45Y.

"SEC. 45Y. CLEAN ELECTRICITY PRODUCTION CREDIT.

"(a) AMOUNT OF CREDIT.—

"(1) IN GENERAL.—For purposes of section 38, the clean electricity production credit for any taxable year is an amount equal to the product of—

"(A) the kilowatt hours of electricity—

"(i) produced by the taxpayer at a qualified facility, and

"(ii)(I) sold by the taxpayer to an unrelated person during the taxable year, or

"(II) in the case of a qualified facility which is equipped with a metering device which is owned and operated by an unrelated person, sold, consumed, or stored by the taxpayer during the taxable year, multiplied by

"(B) the applicable amount with respect to such qualified facility.

"(2) APPLICABLE AMOUNT.—

"(A) BASE AMOUNT.—Subject to subsection (g)(7), in the case of any qualified facility which is not described in clause (i) or (ii) of subparagraph (B) and does not satisfy the requirements described in clause (iii) of such subparagraph, the applicable amount shall be 0.3 cents.

"(B) ALTERNATIVE AMOUNT.—Subject to subsection (g)(7), in the case of any qualified facility—

"(i) with a maximum net output of less than 1 megawatt (as measured in alternating current),

Time period. Publication. Guidelines.

"(ii) the construction of which begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (9) and (10) of subsection (g), or

"(iii) which—

"(I) satisfies the requirements under paragraph (9) of subsection (g), and

"(II) with respect to the construction of such facility, satisfies the requirements under paragraph (10) of subsection (g),

the applicable amount shall be 1.5 cents.

"(b) QUALIFIED FACILITY.—

"(1) IN GENERAL.—

"(A) DEFINITION.—Subject to subparagraphs (B), (C), and (D), the term 'qualified facility' means a facility owned by the taxpayer—

"(i) which is used for the generation of electricity,

"(ii) which is placed in service after December 31, 2024, and

"(iii) for which the greenhouse gas emissions rate (as determined under paragraph (2)) is not greater than zero.

"(B) 10-YEAR PRODUCTION CREDIT.—For purposes of this section, a facility shall only be treated as a qualified facility during the 10-year period beginning on the date the facility was originally placed in service.

"(C) EXPANSION OF FACILITY; INCREMENTAL PRODUCTION.—The term 'qualified facility' shall include either of the following in connection with a facility described in subparagraph (A) (without regard to clause (ii) of such subparagraph) which was placed in service before January 1, 2025, but only to the extent of the increased amount of electricity produced at the facility by reason of the following: Definition. Effective dates.

"(i) A new unit which is placed in service after December 31, 2024.

"(ii) Any additions of capacity which are placed in service after December 31, 2024.

"(D) COORDINATION WITH OTHER CREDITS.—The term 'qualified facility' shall not include any facility for which a credit determined under section 45, 45J, 45Q, 45U, 48, 48A, or 48E is allowed under section 38 for the taxable year or any prior taxable year.

"(2) GREENHOUSE GAS EMISSIONS RATE.—

"(A) IN GENERAL.—For purposes of this section, the term 'greenhouse gas emissions rate' means the amount of greenhouse gases emitted into the atmosphere by a facility in the production of electricity, expressed as grams of CO_2e per KWh. Definition.

"(B) FUEL COMBUSTION AND GASIFICATION.—In the case of a facility which produces electricity through combustion or gasification, the greenhouse gas emissions rate for such facility shall be equal to the net rate of greenhouse gases emitted into the atmosphere by such facility (taking into account lifecycle greenhouse gas emissions, as described in section 211(o)(1)(H) of the Clean Air Act (42 U.S.C. 7545(o)(1)(H))) in the production of electricity, expressed as grams of CO_2e per KWh.

"(C) ESTABLISHMENT OF EMISSIONS RATES FOR FACILITIES.—

Deadline.

"(i) PUBLISHING EMISSIONS RATES.—The Secretary shall annually publish a table that sets forth the greenhouse gas emissions rates for types or categories of facilities, which a taxpayer shall use for purposes of this section.

Petition.
Determination.

"(ii) PROVISIONAL EMISSIONS RATE.—In the case of any facility for which an emissions rate has not been established by the Secretary, a taxpayer which owns such facility may file a petition with the Secretary for determination of the emissions rate with respect to such facility.

"(D) CARBON CAPTURE AND SEQUESTRATION EQUIPMENT.—For purposes of this subsection, the amount of greenhouse gases emitted into the atmosphere by a facility in the production of electricity shall not include any qualified carbon dioxide that is captured by the taxpayer and—

"(i) pursuant to any regulations established under paragraph (2) of section 45Q(f), disposed of by the taxpayer in secure geological storage, or

"(ii) utilized by the taxpayer in a manner described in paragraph (5) of such section.

"(c) INFLATION ADJUSTMENT.—

Effective date.

"(1) IN GENERAL.—In the case of a calendar year beginning after 2024, the 0.3 cent amount in paragraph (2)(A) of subsection (a) and the 1.5 cent amount in paragraph (2)(B) of such subsection shall each be adjusted by multiplying such amount by the inflation adjustment factor for the calendar year in which the sale, consumption, or storage of the electricity occurs. If the 0.3 cent amount as increased under this paragraph is not a multiple of 0.05 cent, such amount shall be rounded to the nearest multiple of 0.05 cent. If the 1.5 cent amount as increased under this paragraph is not a multiple of 0.1 cent, such amount shall be rounded to the nearest multiple of 0.1 cent.

Deadline.
Determination.
Federal Register, publication.

"(2) ANNUAL COMPUTATION.—The Secretary shall, not later than April 1 of each calendar year, determine and publish in the Federal Register the inflation adjustment factor for such calendar year in accordance with this subsection.

Definitions.

"(3) INFLATION ADJUSTMENT FACTOR.—The term 'inflation adjustment factor' means, with respect to a calendar year, a fraction the numerator of which is the GDP implicit price deflator for the preceding calendar year and the denominator of which is the GDP implicit price deflator for the calendar year 1992. The term 'GDP implicit price deflator' means the most recent revision of the implicit price deflator for the gross domestic product as computed and published by the Department of Commerce before March 15 of the calendar year.

"(d) CREDIT PHASE-OUT.—

"(1) IN GENERAL.—The amount of the clean electricity production credit under subsection (a) for any qualified facility the construction of which begins during a calendar year described in paragraph (2) shall be equal to the product of—

"(A) the amount of the credit determined under subsection (a) without regard to this subsection, multiplied by

"(B) the phase-out percentage under paragraph (2).

"(2) PHASE-OUT PERCENTAGE.—The phase-out percentage under this paragraph is equal to—

"(A) for a facility the construction of which begins during the first calendar year following the applicable year, 100 percent,

"(B) for a facility the construction of which begins during the second calendar year following the applicable year, 75 percent,

"(C) for a facility the construction of which begins during the third calendar year following the applicable year, 50 percent, and

"(D) for a facility the construction of which begins during any calendar year subsequent to the calendar year described in subparagraph (C), 0 percent.

"(3) APPLICABLE YEAR.—For purposes of this subsection, the term 'applicable year' means the later of— Definition.

"(A) the calendar year in which the Secretary determines that the annual greenhouse gas emissions from the production of electricity in the United States are equal to or less than 25 percent of the annual greenhouse gas emissions from the production of electricity in the United States for calendar year 2022, or Determination.

"(B) 2032.

"(e) DEFINITIONS.—For purposes of this section:

"(1) CO_2e PER KWh.—The term 'CO_2e per KWh' means, with respect to any greenhouse gas, the equivalent carbon dioxide (as determined based on global warming potential) per kilowatt hour of electricity produced.

"(2) GREENHOUSE GAS.—The term 'greenhouse gas' has the same meaning given such term under section 211(o)(1)(G) of the Clean Air Act (42 U.S.C. 7545(o)(1)(G)), as in effect on the date of the enactment of this section.

"(3) QUALIFIED CARBON DIOXIDE.—The term 'qualified carbon dioxide' means carbon dioxide captured from an industrial source which—

"(A) would otherwise be released into the atmosphere as industrial emission of greenhouse gas,

"(B) is measured at the source of capture and verified at the point of disposal or utilization, and

"(C) is captured and disposed or utilized within the United States (within the meaning of section 638(1)) or a possession of the United States (within the meaning of section 638(2)).

"(f) GUIDANCE.—Not later than January 1, 2025, the Secretary shall issue guidance regarding implementation of this section, including calculation of greenhouse gas emission rates for qualified facilities and determination of clean electricity production credits under this section. Deadline. Determination.

"(g) SPECIAL RULES.—

"(1) ONLY PRODUCTION IN THE UNITED STATES TAKEN INTO ACCOUNT.—Consumption, sales, or storage shall be taken into account under this section only with respect to electricity the production of which is within—

"(A) the United States (within the meaning of section 638(1)), or

"(B) a possession of the United States (within the meaning of section 638(2)).

"(2) COMBINED HEAT AND POWER SYSTEM PROPERTY.—

"(A) IN GENERAL.—For purposes of subsection (a)—

"(i) the kilowatt hours of electricity produced by a taxpayer at a qualified facility shall include any production in the form of useful thermal energy by any combined heat and power system property within such facility, and

"(ii) the amount of greenhouse gases emitted into the atmosphere by such facility in the production of such useful thermal energy shall be included for purposes of determining the greenhouse gas emissions rate for such facility.

Definition.

"(B) COMBINED HEAT AND POWER SYSTEM PROPERTY.—For purposes of this paragraph, the term 'combined heat and power system property' has the same meaning given such term by section 48(c)(3) (without regard to subparagraphs (A)(iv), (B), and (D) thereof).

"(C) CONVERSION FROM BTU TO KWH.—

"(i) IN GENERAL.—For purposes of subparagraph (A)(i), the amount of kilowatt hours of electricity produced in the form of useful thermal energy shall be equal to the quotient of—

"(I) the total useful thermal energy produced by the combined heat and power system property within the qualified facility, divided by

"(II) the heat rate for such facility.

Definition.

"(ii) HEAT RATE.—For purposes of this subparagraph, the term 'heat rate' means the amount of energy used by the qualified facility to generate 1 kilowatt hour of electricity, expressed as British thermal units per net kilowatt hour generated.

Regulations.

"(3) PRODUCTION ATTRIBUTABLE TO THE TAXPAYER.—In the case of a qualified facility in which more than 1 person has an ownership interest, except to the extent provided in regulations prescribed by the Secretary, production from the facility shall be allocated among such persons in proportion to their respective ownership interests in the gross sales from such facility.

"(4) RELATED PERSONS.—Persons shall be treated as related to each other if such persons would be treated as a single employer under the regulations prescribed under section 52(b). In the case of a corporation which is a member of an affiliated group of corporations filing a consolidated return, such corporation shall be treated as selling electricity to an unrelated person if such electricity is sold to such a person by another member of such group.

Regulations.
Applicability.

"(5) PASS-THRU IN THE CASE OF ESTATES AND TRUSTS.—Under regulations prescribed by the Secretary, rules similar to the rules of subsection (d) of section 52 shall apply.

"(6) ALLOCATION OF CREDIT TO PATRONS OF AGRICULTURAL COOPERATIVE.—

"(A) ELECTION TO ALLOCATE.—

"(i) IN GENERAL.—In the case of an eligible cooperative organization, any portion of the credit determined under subsection (a) for the taxable year may, at the election of the organization, be apportioned among patrons of the organization on the basis of the amount

of business done by the patrons during the taxable year.

"(ii) FORM AND EFFECT OF ELECTION.—An election under clause (i) for any taxable year shall be made on a timely filed return for such year. Such election, once made, shall be irrevocable for such taxable year. Such election shall not take effect unless the organization designates the apportionment as such in a written notice mailed to its patrons during the payment period described in section 1382(d). Notice.

"(B) TREATMENT OF ORGANIZATIONS AND PATRONS.—The amount of the credit apportioned to any patrons under subparagraph (A)—

"(i) shall not be included in the amount determined under subsection (a) with respect to the organization for the taxable year, and

"(ii) shall be included in the amount determined under subsection (a) for the first taxable year of each patron ending on or after the last day of the payment period (as defined in section 1382(d)) for the taxable year of the organization or, if earlier, for the taxable year of each patron ending on or after the date on which the patron receives notice from the cooperative of the apportionment.

"(C) SPECIAL RULES FOR DECREASE IN CREDITS FOR TAXABLE YEAR.—If the amount of the credit of a cooperative organization determined under subsection (a) for a taxable year is less than the amount of such credit shown on the return of the cooperative organization for such year, an amount equal to the excess of—

"(i) such reduction, over

"(ii) the amount not apportioned to such patrons under subparagraph (A) for the taxable year,

shall be treated as an increase in tax imposed by this chapter on the organization. Such increase shall not be treated as tax imposed by this chapter for purposes of determining the amount of any credit under this chapter.

"(D) ELIGIBLE COOPERATIVE DEFINED.—For purposes of this section, the term 'eligible cooperative' means a cooperative organization described in section 1381(a) which is owned more than 50 percent by agricultural producers or by entities owned by agricultural producers. For this purpose an entity owned by an agricultural producer is one that is more than 50 percent owned by agricultural producers.

"(7) INCREASE IN CREDIT IN ENERGY COMMUNITIES.—In the case of any qualified facility which is located in an energy community (as defined in section 45(b)(11)(B)), for purposes of determining the amount of the credit under subsection (a) with respect to any electricity produced by the taxpayer at such facility during the taxable year, the applicable amount under paragraph (2) of such subsection shall be increased by an amount equal to 10 percent of the amount otherwise in effect under such paragraph. Determination.

"(8) CREDIT REDUCED FOR TAX-EXEMPT BONDS.—Rules similar to the rules of section 45(b)(3) shall apply. Applicability.

Applicability.

"(9) WAGE REQUIREMENTS.—Rules similar to the rules of section 45(b)(7) shall apply.

Applicability.

"(10) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

"(11) DOMESTIC CONTENT BONUS CREDIT AMOUNT.—

"(A) IN GENERAL.—In the case of any qualified facility which satisfies the requirement under subparagraph (B)(i), the amount of the credit determined under subsection (a) shall be increased by an amount equal to 10 percent of the amount so determined (as determined without application of paragraph (7)).

"(B) REQUIREMENT.—

Certification.

"(i) IN GENERAL.—The requirement described in this subclause is satisfied with respect to any qualified facility if the taxpayer certifies to the Secretary (at such time, and in such form and manner, as the Secretary may prescribe) that any steel, iron, or manufactured product which is a component of such facility (upon completion of construction) was produced in the United States (as determined under section 661 of title 49, Code of Federal Regulations).

Applicability.

"(ii) STEEL AND IRON.—In the case of steel or iron, clause (i) shall be applied in a manner consistent with section 661.5 of title 49, Code of Federal Regulations.

"(iii) MANUFACTURED PRODUCT.—For purposes of clause (i), the manufactured products which are components of a qualified facility upon completion of construction shall be deemed to have been produced in the United States if not less than the adjusted percentage (as determined under subparagraph (C)) of the total costs of all such manufactured products of such facility are attributable to manufactured products (including components) which are mined, produced, or manufactured in the United States.

Effective dates.

"(C) ADJUSTED PERCENTAGE.—

"(i) IN GENERAL.—Subject to subclause (ii), for purposes of subparagraph (B)(iii), the adjusted percentage shall be—

"(I) in the case of a facility the construction of which begins before January 1, 2025, 40 percent,

"(II) in the case of a facility the construction of which begins after December 31, 2024, and before January 1, 2026, 45 percent,

"(III) in the case of a facility the construction of which begins after December 31, 2025, and before January 1, 2027, 50 percent, and

"(IV) in the case of a facility the construction of which begins after December 31, 2026, 55 percent.

"(ii) OFFSHORE WIND FACILITY.—For purposes of subparagraph (B)(iii), in the case of a qualified facility which is an offshore wind facility, the adjusted percentage shall be—

"(I) in the case of a facility the construction of which begins before January 1, 2025, 20 percent,

"(II) in the case of a facility the construction of which begins after December 31, 2024, and before January 1, 2026, 27.5 percent,

"(III) in the case of a facility the construction of which begins after December 31, 2025, and before January 1, 2027, 35 percent,

"(IV) in the case of a facility the construction of which begins after December 31, 2026, and before January 1, 2028, 45 percent, and

"(V) in the case of a facility the construction of which begins after December 31, 2027, 55 percent.

"(12) PHASEOUT FOR ELECTIVE PAYMENT.—

"(A) IN GENERAL.—In the case of a taxpayer making an election under section 6417 with respect to a credit under this section, the amount of such credit shall be replaced with—

"(i) the value of such credit (determined without regard to this paragraph), multiplied by

"(ii) the applicable percentage.

"(B) 100 PERCENT APPLICABLE PERCENTAGE FOR CERTAIN QUALIFIED FACILITIES.—In the case of any qualified facility—

"(i) which satisfies the requirements under paragraph (11)(B), or

"(ii) with a maximum net output of less than 1 megawatt (as measured in alternating current),

the applicable percentage shall be 100 percent.

"(C) PHASED DOMESTIC CONTENT REQUIREMENT.—Subject to subparagraph (D), in the case of any qualified facility which is not described in subparagraph (B), the applicable percentage shall be— Effective dates. Time periods.

"(i) if construction of such facility began before January 1, 2024, 100 percent,

"(ii) if construction of such facility began in calendar year 2024, 90 percent,

"(iii) if construction of such facility began in calendar year 2025, 85 percent, and

"(iv) if construction of such facility began after December 31, 2025, 0 percent.

"(D) EXCEPTION.—

"(i) IN GENERAL.—For purposes of this paragraph, the Secretary shall provide exceptions to the requirements under this paragraph if—

"(I) the inclusion of steel, iron, or manufactured products which are produced in the United States increases the overall costs of construction of qualified facilities by more than 25 percent, or

"(II) relevant steel, iron, or manufactured products are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality.

"(ii) APPLICABLE PERCENTAGE.—In any case in which the Secretary provides an exception pursuant to clause (i), the applicable percentage shall be 100 percent.".

(b) CONFORMING AMENDMENTS.—

(1) Section 38(b), as amended by the preceding provisions of this Act, is amended— 26 USC 38.

(A) in paragraph (37), by striking "plus" at the end,

(B) in paragraph (38), by striking the period at the end and inserting ", plus", and

(C) by adding at the end the following new paragraph:

"(39) the clean electricity production credit determined under section 45Y(a).".

(2) The table of sections for subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new item: 26 USC 38 prec.

"Sec. 45Y. Clean electricity production credit.".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to facilities placed in service after December 31, 2024. 26 USC 45Y note.

SEC. 13702. CLEAN ELECTRICITY INVESTMENT CREDIT.

(a) IN GENERAL.—Subpart E of part IV of subchapter A of chapter 1, as amended by section 107(a) of the CHIPS Act of 2022, is amended by inserting after section 48D the following new section:

"SEC. 48E. CLEAN ELECTRICITY INVESTMENT CREDIT. 26 USC 48E.

"(a) INVESTMENT CREDIT FOR QUALIFIED PROPERTY.—

"(1) IN GENERAL.—For purposes of section 46, the clean electricity investment credit for any taxable year is an amount equal to the applicable percentage of the qualified investment for such taxable year with respect to—

"(A) any qualified facility, and

"(B) any energy storage technology.

"(2) APPLICABLE PERCENTAGE.—

"(A) QUALIFIED FACILITIES.—Subject to paragraph (3)—

"(i) BASE RATE.—In the case of any qualified facility which is not described in subclause (I) or (II) of clause (ii) and does not satisfy the requirements described in subclause (III) of such clause, the applicable percentage shall be 6 percent.

"(ii) ALTERNATIVE RATE.—In the case of any qualified facility—

"(I) with a maximum net output of less than 1 megawatt (as measured in alternating current),

"(II) the construction of which begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (3) and (4) of subsection (d), or Time period. Publication. Guidelines.

"(III) which—

"(aa) satisfies the requirements of subsection (d)(3), and

"(bb) with respect to the construction of such facility, satisfies the requirements of subsection (d)(4),

the applicable percentage shall be 30 percent.

"(B) ENERGY STORAGE TECHNOLOGY.—Subject to paragraph (3)—

"(i) BASE RATE.—In the case of any energy storage technology which is not described in subclause (I) or (II) of clause (ii) and does not satisfy the requirements described in subclause (III) of such clause, the applicable percentage shall be 6 percent.

"(ii) ALTERNATIVE RATE.—In the case of any energy storage technology—

"(I) with a capacity of less than 1 megawatt,

"(II) the construction of which begins prior to the date that is 60 days after the Secretary publishes guidance with respect to the requirements of paragraphs (3) and (4) of subsection (d), or

Time period. Publication. Guidelines.

"(III) which—

"(aa) satisfies the requirements of subsection (d)(3), and

"(bb) with respect to the construction of such property, satisfies the requirements of subsection (d)(4),

the applicable percentage shall be 30 percent.

"(3) INCREASE IN CREDIT RATE IN CERTAIN CASES.—

"(A) ENERGY COMMUNITIES.—

"(i) IN GENERAL.—In the case of any qualified investment with respect to a qualified facility or with respect to energy storage technology which is placed in service within an energy community (as defined in section 45(b)(11)(B)), for purposes of applying paragraph (2) with respect to such property or investment, the applicable percentage shall be increased by the applicable credit rate increase.

"(ii) APPLICABLE CREDIT RATE INCREASE.—For purposes of clause (i), the applicable credit rate increase shall be an amount equal to—

"(I) in the case of any qualified investment with respect to a qualified facility described in paragraph (2)(A)(i) or with respect to energy storage technology described in paragraph (2)(B)(i), 2 percentage points, and

"(II) in the case of any qualified investment with respect to a qualified facility described in paragraph (2)(A)(ii) or with respect to energy storage technology described in paragraph (2)(B)(ii), 10 percentage points.

"(B) DOMESTIC CONTENT.—Rules similar to the rules of section 48(a)(12) shall apply. Applicability.

"(b) QUALIFIED INVESTMENT WITH RESPECT TO A QUALIFIED FACILITY.— Definitions.

"(1) IN GENERAL.—For purposes of subsection (a), the qualified investment with respect to any qualified facility for any taxable year is the sum of—

"(A) the basis of any qualified property placed in service by the taxpayer during such taxable year which is part of a qualified facility, plus

"(B) the amount of any expenditures which are—

"(i) paid or incurred by the taxpayer for qualified interconnection property—

"(I) in connection with a qualified facility which has a maximum net output of not greater than 5 megawatts (as measured in alternating current), and

"(II) placed in service during the taxable year of the taxpayer, and

"(ii) properly chargeable to capital account of the taxpayer.

"(2) QUALIFIED PROPERTY.—For purposes of this section, the term 'qualified property' means property—

"(A) which is—

"(i) tangible personal property, or

"(ii) other tangible property (not including a building or its structural components), but only if such property is used as an integral part of the qualified facility,

"(B) with respect to which depreciation (or amortization in lieu of depreciation) is allowable, and

"(C)(i) the construction, reconstruction, or erection of which is completed by the taxpayer, or

"(ii) which is acquired by the taxpayer if the original use of such property commences with the taxpayer.

"(3) QUALIFIED FACILITY.—

"(A) IN GENERAL.—For purposes of this section, the term 'qualified facility' means a facility—

"(i) which is used for the generation of electricity,

"(ii) which is placed in service after December 31, 2024, and

"(iii) for which the anticipated greenhouse gas emissions rate (as determined under subparagraph (B)(ii)) is not greater than zero.

Applicability.

"(B) ADDITIONAL RULES.—

"(i) EXPANSION OF FACILITY; INCREMENTAL PRODUCTION.—Rules similar to the rules of section 45Y(b)(1)(C) shall apply for purposes of this paragraph.

"(ii) GREENHOUSE GAS EMISSIONS RATE.—Rules similar to the rules of section 45Y(b)(2) shall apply for purposes of this paragraph.

"(C) EXCLUSION.—The term 'qualified facility' shall not include any facility for which—

"(i) a renewable electricity production credit determined under section 45,

"(ii) an advanced nuclear power facility production credit determined under section 45J,

"(iii) a carbon oxide sequestration credit determined under section 45Q,

"(iv) a zero-emission nuclear power production credit determined under section 45U,

"(v) a clean electricity production credit determined under section 45Y,

"(vi) an energy credit determined under section 48, or

"(vii) a qualifying advanced coal project credit under section 48A,

is allowed under section 38 for the taxable year or any prior taxable year.

"(4) QUALIFIED INTERCONNECTION PROPERTY.—For purposes of this paragraph, the term 'qualified interconnection property' has the meaning given such term in section 48(a)(8)(B).

"(5) COORDINATION WITH REHABILITATION CREDIT.—The qualified investment with respect to any qualified facility for any taxable year shall not include that portion of the basis of any property which is attributable to qualified rehabilitation expenditures (as defined in section 47(c)(2)).

"(6) DEFINITIONS.—For purposes of this subsection, the terms 'CO2e per KWh' and 'greenhouse gas emissions rate' have the same meaning given such terms under section 45Y.

"(c) QUALIFIED INVESTMENT WITH RESPECT TO ENERGY STORAGE TECHNOLOGY.—

"(1) QUALIFIED INVESTMENT.—For purposes of subsection (a), the qualified investment with respect to energy storage technology for any taxable year is the basis of any energy storage technology placed in service by the taxpayer during such taxable year.

"(2) ENERGY STORAGE TECHNOLOGY.—For purposes of this section, the term 'energy storage technology' has the meaning given such term in section 48(c)(6) (except that subparagraph (D) of such section shall not apply). Definition.

"(d) SPECIAL RULES.— Applicability.

"(1) CERTAIN PROGRESS EXPENDITURE RULES MADE APPLICABLE.—Rules similar to the rules of subsections (c)(4) and (d) of section 46 (as in effect on the day before the date of the enactment of the Revenue Reconciliation Act of 1990) shall apply for purposes of subsection (a).

"(2) SPECIAL RULE FOR PROPERTY FINANCED BY SUBSIDIZED ENERGY FINANCING OR PRIVATE ACTIVITY BONDS.—Rules similar to the rules of section 45(b)(3) shall apply.

"(3) PREVAILING WAGE REQUIREMENTS.—Rules similar to the rules of section 48(a)(10) shall apply.

"(4) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

"(5) DOMESTIC CONTENT REQUIREMENT FOR ELECTIVE PAYMENT.—In the case of a taxpayer making an election under section 6417 with respect to a credit under this section, rules similar to the rules of section 45Y(g)(12) shall apply.

"(e) CREDIT PHASE-OUT.—

"(1) IN GENERAL.—The amount of the clean electricity investment credit under subsection (a) for any qualified investment with respect to any qualified facility or energy storage technology the construction of which begins during a calendar year described in paragraph (2) shall be equal to the product of—

"(A) the amount of the credit determined under subsection (a) without regard to this subsection, multiplied by

"(B) the phase-out percentage under paragraph (2).

"(2) PHASE-OUT PERCENTAGE.—The phase-out percentage under this paragraph is equal to—

"(A) for any qualified investment with respect to any qualified facility or energy storage technology the construction of which begins during the first calendar year following the applicable year, 100 percent,

"(B) for any qualified investment with respect to any qualified facility or energy storage technology the construction of which begins during the second calendar year following the applicable year, 75 percent,

"(C) for any qualified investment with respect to any qualified facility or energy storage technology the construction of which begins during the third calendar year following the applicable year, 50 percent, and

"(D) for any qualified investment with respect to any qualified facility or energy storage technology the construction of which begins during any calendar year subsequent to the calendar year described in subparagraph (C), 0 percent.

Definition. "(3) APPLICABLE YEAR.—For purposes of this subsection, the term 'applicable year' has the same meaning given such term in section 45Y(d)(3).

Definition. "(f) GREENHOUSE GAS.—In this section, the term 'greenhouse gas' has the same meaning given such term under section 45Y(e)(2).

"(g) RECAPTURE OF CREDIT.—For purposes of section 50, if the Secretary determines that the greenhouse gas emissions rate for a qualified facility is greater than 10 grams of CO_2e per KWh, any property for which a credit was allowed under this section with respect to such facility shall cease to be investment credit property in the taxable year in which the determination is made.

Definitions. "(h) SPECIAL RULES FOR CERTAIN FACILITIES PLACED IN SERVICE IN CONNECTION WITH LOW-INCOME COMMUNITIES.—

"(1) IN GENERAL.—In the case of any applicable facility with respect to which the Secretary makes an allocation of environmental justice capacity limitation under paragraph (4)—

"(A) the applicable percentage otherwise determined under subsection (a)(2) with respect to any eligible property which is part of such facility shall be increased by—

"(i) in the case of a facility described in subclause (I) of paragraph (2)(A)(iii) and not described in subclause (II) of such paragraph, 10 percentage points, and

"(ii) in the case of a facility described in subclause (II) of paragraph (2)(A)(iii), 20 percentage points, and

"(B) the increase in the credit determined under subsection (a) by reason of this subsection for any taxable year with respect to all property which is part of such facility shall not exceed the amount which bears the same ratio to the amount of such increase (determined without regard to this subparagraph) as—

"(i) the environmental justice capacity limitation allocated to such facility, bears to

"(ii) the total megawatt nameplate capacity of such facility, as measured in direct current.

"(2) APPLICABLE FACILITY.—For purposes of this subsection—

"(A) IN GENERAL.—The term 'applicable facility' means any qualified facility—

"(i) which is not described in section 45Y(b)(2)(B),

"(ii) which has a maximum net output of less than 5 megawatts (as measured in alternating current), and

"(iii) which—

"(I) is located in a low-income community (as defined in section 45D(e)) or on Indian land (as defined in section 2601(2) of the Energy Policy Act of 1992 (25 U.S.C. 3501(2))), or

"(II) is part of a qualified low-income residential building project or a qualified low-income economic benefit project.

"(B) QUALIFIED LOW-INCOME RESIDENTIAL BUILDING PROJECT.—A facility shall be treated as part of a qualified low-income residential building project if—

"(i) such facility is installed on a residential rental building which participates in a covered housing program (as defined in section 41411(a) of the Violence Against Women Act of 1994 (34 U.S.C. 12491(a)(3)), a housing assistance program administered by the Department of Agriculture under title V of the Housing Act of 1949, a housing program administered by a tribally designated housing entity (as defined in section 4(22) of the Native American Housing Assistance and Self-Determination Act of 1996 (25 U.S.C. 4103(22))) or such other affordable housing programs as the Secretary may provide, and

"(ii) the financial benefits of the electricity produced by such facility are allocated equitably among the occupants of the dwelling units of such building.

"(C) QUALIFIED LOW-INCOME ECONOMIC BENEFIT PROJECT.—A facility shall be treated as part of a qualified low-income economic benefit project if at least 50 percent of the financial benefits of the electricity produced by such facility are provided to households with income of—

"(i) less than 200 percent of the poverty line (as defined in section 36B(d)(3)(A)) applicable to a family of the size involved, or

"(ii) less than 80 percent of area median gross income (as determined under section 142(d)(2)(B)).

"(D) FINANCIAL BENEFIT.—For purposes of subparagraphs (B) and (C), electricity acquired at a below-market rate shall not fail to be taken into account as a financial benefit.

"(3) ELIGIBLE PROPERTY.—For purposes of this subsection, the term 'eligible property' means a qualified investment with respect to any applicable facility.

"(4) ALLOCATIONS.—

"(A) IN GENERAL.—Not later than January 1, 2025, the Secretary shall establish a program to allocate amounts of environmental justice capacity limitation to applicable facilities. In establishing such program and to carry out the purposes of this subsection, the Secretary shall provide procedures to allow for an efficient allocation process, including, when determined appropriate, consideration of multiple projects in a single application if such projects will be placed in service by a single taxpayer. Deadline. Procedures.

"(B) LIMITATION.—The amount of environmental justice capacity limitation allocated by the Secretary under subparagraph (A) during any calendar year shall not exceed the annual capacity limitation with respect to such year.

Time period.

"(C) ANNUAL CAPACITY LIMITATION.—For purposes of this paragraph, the term 'annual capacity limitation' means 1.8 gigawatts of direct current capacity for each calendar year during the period beginning on January 1, 2025, and ending on December 31 of the applicable year (as defined in section 45Y(d)(3)), and zero thereafter.

"(D) CARRYOVER OF UNUSED LIMITATION.—

"(i) IN GENERAL.—If the annual capacity limitation for any calendar year exceeds the aggregate amount allocated for such year under this paragraph, such limitation for the succeeding calendar year shall be increased by the amount of such excess. No amount may be carried under the preceding sentence to any calendar year after the third calendar year following the applicable year (as defined in section 45Y(d)(3)).

"(ii) CARRYOVER FROM SECTION 48 FOR CALENDAR YEAR 2025.—If the annual capacity limitation for calendar year 2024 under section 48(e)(4)(D) exceeds the aggregate amount allocated for such year under such section, such excess amount may be carried over and applied to the annual capacity limitation under this subsection for calendar year 2025. The annual capacity limitation for calendar year 2025 shall be increased by the amount of such excess.

"(E) PLACED IN SERVICE DEADLINE.—

"(i) IN GENERAL.—Paragraph (1) shall not apply with respect to any property which is placed in service after the date that is 4 years after the date of the allocation with respect to the facility of which such property is a part.

"(ii) APPLICATION OF CARRYOVER.—Any amount of environmental justice capacity limitation which expires under clause (i) during any calendar year shall be taken into account as an excess described in subparagraph (D)(i) (or as an increase in such excess) for such calendar year, subject to the limitation imposed by the last sentence of such subparagraph.

Regulations. Guidelines.

"(5) RECAPTURE.—The Secretary shall, by regulations or other guidance, provide for recapturing the benefit of any increase in the credit allowed under subsection (a) by reason of this subsection with respect to any property which ceases to be property eligible for such increase (but which does not cease to be investment credit property within the meaning of section 50(a)). The period and percentage of such recapture shall be determined under rules similar to the rules of section 50(a). To the extent provided by the Secretary, such recapture may not apply with respect to any property if, within 12 months after the date the taxpayer becomes aware (or reasonably should have become aware) of such property ceasing to be property eligible for such increase, the eligibility of such property for such increase is restored. The preceding sentence shall not apply more than once with respect to any facility.

Determination.

Time period.

Deadline.

"(i) GUIDANCE.—Not later than January 1, 2025, the Secretary shall issue guidance regarding implementation of this section.".

(b) CONFORMING AMENDMENTS.—

(1) Section 46, as amended by section 107(d) of the CHIPS Act of 2022, is amended—

26 USC 46.

(A) in paragraph (5), by striking "and" at the end,

(B) in paragraph (6), by striking the period at the end and inserting ", and", and

(C) by adding at the end the following:

"(7) the clean electricity investment credit.".

(2) Section 49(a)(1)(C), as amended by section 107(d) of the CHIPS Act of 2022, is amended— 26 USC 49.

(A) by striking "and" at the end of clause (v),

(B) by striking the period at the end of clause (vi) and inserting a comma, and

(C) by adding at the end the following new clauses:

"(vii) the basis of any qualified property which is part of a qualified facility under section 48E, and

"(viii) the basis of any energy storage technology under section 48E.".

(3) Section 50(a)(2)(E), as amended by section 107(d) of the CHIPS Act of 2022, is amended by striking "or 48D(b)(5)" and inserting "48D(b)(5), or 48E(e)". 26 USC 50.

(4) Section 50(c)(3) is amended by inserting "or clean electricity investment credit" after "In the case of any energy credit".

(5) The table of sections for subpart E of part IV of subchapter A of chapter 1, as amended by section 107(d) of the CHIPS Act of 2022, is amended by inserting after the item relating to section 48D the following new item: 26 USC 46 prec.

"48E. Clean electricity investment credit.".

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to property placed in service after December 31, 2024. 26 USC 48E note.

SEC. 13703. COST RECOVERY FOR QUALIFIED FACILITIES, QUALIFIED PROPERTY, AND ENERGY STORAGE TECHNOLOGY.

(a) IN GENERAL.—Section 168(e)(3)(B) is amended— 26 USC 168.

(1) in clause (vi)(III), by striking "and" at the end,

(2) in clause (vii), by striking the period at the end and inserting ", and", and

(3) by inserting after clause (vii) the following:

"(viii) any qualified facility (as defined in section 45Y(b)(1)(A)), any qualified property (as defined in subsection (b)(2) of section 48E) which is a qualified investment (as defined in subsection (b)(1) of such section), or any energy storage technology (as defined in subsection (c)(2) of such section).".

(b) EFFECTIVE DATE.—The amendments made by this section shall apply to facilities and property placed in service after December 31, 2024. 26 USC 168 note.

SEC. 13704. CLEAN FUEL PRODUCTION CREDIT.

(a) IN GENERAL.—Subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new section:

"SEC. 45Z. CLEAN FUEL PRODUCTION CREDIT. 26 USC 45Z.

"(a) AMOUNT OF CREDIT.—

"(1) IN GENERAL.—For purposes of section 38, the clean fuel production credit for any taxable year is an amount equal to the product of—

"(A) the applicable amount per gallon (or gallon equivalent) with respect to any transportation fuel which is—

"(i) produced by the taxpayer at a qualified facility, and

"(ii) sold by the taxpayer in a manner described in paragraph (4) during the taxable year, and

"(B) the emissions factor for such fuel (as determined under subsection (b)).

"(2) APPLICABLE AMOUNT.—

"(A) BASE AMOUNT.—In the case of any transportation fuel produced at a qualified facility which does not satisfy the requirements described in subparagraph (B), the applicable amount shall be 20 cents.

"(B) ALTERNATIVE AMOUNT.—In the case of any transportation fuel produced at a qualified facility which satisfies the requirements under paragraphs (6) and (7) of subsection (f), the applicable amount shall be $1.00.

"(3) SPECIAL RATE FOR SUSTAINABLE AVIATION FUEL.—

"(A) IN GENERAL.—In the case of a transportation fuel which is sustainable aviation fuel, paragraph (2) shall be applied—

"(i) in the case of fuel produced at a qualified facility described in paragraph (2)(A), by substituting '35 cents' for '20 cents', and

"(ii) in the case of fuel produced at a qualified facility described in paragraph (2)(B), by substituting '$1.75' for '$1.00'.

Definition.

"(B) SUSTAINABLE AVIATION FUEL.—For purposes of this subparagraph (A), the term 'sustainable aviation fuel' means liquid fuel, the portion of which is not kerosene, which is sold for use in an aircraft and which—

"(i) meets the requirements of—

"(I) ASTM International Standard D7566, or

"(II) the Fischer Tropsch provisions of ASTM International Standard D1655, Annex A1, and

"(ii) is not derived from palm fatty acid distillates or petroleum.

"(4) SALE.—For purposes of paragraph (1), the transportation fuel is sold in a manner described in this paragraph if such fuel is sold by the taxpayer to an unrelated person—

"(A) for use by such person in the production of a fuel mixture,

"(B) for use by such person in a trade or business, or

"(C) who sells such fuel at retail to another person and places such fuel in the fuel tank of such other person.

"(5) ROUNDING.—If any amount determined under paragraph (1) is not a multiple of 1 cent, such amount shall be rounded to the nearest cent.

"(b) EMISSIONS FACTORS.—

Determinations.

"(1) EMISSIONS FACTOR.—

"(A) CALCULATION.—

"(i) IN GENERAL.—The emissions factor of a transportation fuel shall be an amount equal to the quotient of—

"(I) an amount equal to—

"(aa) 50 kilograms of CO_2e per mmBTU, minus

"(bb) the emissions rate for such fuel, divided by

"(II) 50 kilograms of CO_2e per mmBTU.

"(B) ESTABLISHMENT OF EMISSIONS RATE.—

"(i) IN GENERAL.—Subject to clauses (ii) and (iii), the Secretary shall annually publish a table which sets forth the emissions rate for similar types and categories of transportation fuels based on the amount of lifecycle greenhouse gas emissions (as described in section 211(o)(1)(H) of the Clean Air Act (42 U.S.C. 7545(o)(1)(H)), as in effect on the date of the enactment of this section) for such fuels, expressed as kilograms of CO_2e per mmBTU, which a taxpayer shall use for purposes of this section. Publication.

"(ii) NON-AVIATION FUEL.—In the case of any transportation fuel which is not a sustainable aviation fuel, the lifecycle greenhouse gas emissions of such fuel shall be based on the most recent determinations under the Greenhouse gases, Regulated Emissions, and Energy use in Transportation model developed by Argonne National Laboratory, or a successor model (as determined by the Secretary).

"(iii) AVIATION FUEL.—In the case of any transportation fuel which is a sustainable aviation fuel, the lifecycle greenhouse gas emissions of such fuel shall be determined in accordance with—

"(I) the most recent Carbon Offsetting and Reduction Scheme for International Aviation which has been adopted by the International Civil Aviation Organization with the agreement of the United States, or

"(II) any similar methodology which satisfies the criteria under section 211(o)(1)(H) of the Clean Air Act (42 U.S.C. 7545(o)(1)(H)), as in effect on the date of enactment of this section.

"(C) ROUNDING OF EMISSIONS RATE.—

"(i) IN GENERAL.—Subject to clause (ii), the Secretary may round the emissions rates under subparagraph (B) to the nearest multiple of 5 kilograms of CO_2e per mmBTU.

"(ii) EXCEPTION.—In the case of an emissions rate that is between 2.5 kilograms of CO_2e per mmBTU and -2.5 kilograms of CO_2e per mmBTU, the Secretary may round such rate to zero.

"(D) PROVISIONAL EMISSIONS RATE.—In the case of any transportation fuel for which an emissions rate has not been established under subparagraph (B), a taxpayer producing such fuel may file a petition with the Secretary for determination of the emissions rate with respect to such fuel.

"(2) ROUNDING.—If any amount determined under paragraph (1)(A) is not a multiple of 0.1, such amount shall be rounded to the nearest multiple of 0.1.

"(c) INFLATION ADJUSTMENT.—

Effective date.

"(1) IN GENERAL.—In the case of calendar years beginning after 2024, the 20 cent amount in subsection (a)(2)(A), the $1.00 amount in subsection (a)(2)(B), the 35 cent amount in subsection (a)(3)(A)(i), and the $1.75 amount in subsection (a)(3)(A)(ii) shall each be adjusted by multiplying such amount by the inflation adjustment factor for the calendar year in which the sale of the transportation fuel occurs. If any amount as increased under the preceding sentence is not a multiple of 1 cent, such amount shall be rounded to the nearest multiple of 1 cent.

Determination. Publication.

"(2) INFLATION ADJUSTMENT FACTOR.—For purposes of paragraph (1), the inflation adjustment factor shall be the inflation adjustment factor determined and published by the Secretary pursuant to section 45Y(c), determined by substituting 'calendar year 2022' for 'calendar year 1992' in paragraph (3) thereof.

"(d) DEFINITIONS.—In this section:

"(1) mmBTU.—The term 'mmBTU' means 1,000,000 British thermal units.

"(2) CO_2e.—The term 'CO_2e' means, with respect to any greenhouse gas, the equivalent carbon dioxide (as determined based on relative global warming potential).

"(3) GREENHOUSE GAS.—The term 'greenhouse gas' has the same meaning given that term under section 211(o)(1)(G) of the Clean Air Act (42 U.S.C. 7545(o)(1)(G)), as in effect on the date of the enactment of this section.

"(4) QUALIFIED FACILITY.—The term 'qualified facility'—

"(A) means a facility used for the production of transportation fuels, and

"(B) does not include any facility for which one of the following credits is allowed under section 38 for the taxable year:

"(i) The credit for production of clean hydrogen under section 45V.

"(ii) The credit determined under section 46 to the extent that such credit is attributable to the energy credit determined under section 48 with respect to any specified clean hydrogen production facility for which an election is made under subsection (a)(15) of such section.

"(iii) The credit for carbon oxide sequestration under section 45Q.

"(5) TRANSPORTATION FUEL.—

"(A) IN GENERAL.—The term 'transportation fuel' means a fuel which—

"(i) is suitable for use as a fuel in a highway vehicle or aircraft,

"(ii) has an emissions rate which is not greater than 50 kilograms of CO_2e per mmBTU, and

"(iii) is not derived from coprocessing an applicable material (or materials derived from an applicable material) with a feedstock which is not biomass.

"(B) DEFINITIONS.—In this paragraph—

"(i) APPLICABLE MATERIAL.—The term 'applicable material' means—

"(I) monoglycerides, diglycerides, and triglycerides,

"(II) free fatty acids, and

"(III) fatty acid esters.

"(ii) BIOMASS.—The term 'biomass' has the same meaning given such term in section 45K(c)(3).

"(e) GUIDANCE.—Not later than January 1, 2025, the Secretary shall issue guidance regarding implementation of this section, including calculation of emissions factors for transportation fuel, the table described in subsection (b)(1)(B)(i), and the determination of clean fuel production credits under this section. Deadline. Determination.

"(f) SPECIAL RULES.— Applicability.

"(1) ONLY REGISTERED PRODUCTION IN THE UNITED STATES TAKEN INTO ACCOUNT.—

"(A) IN GENERAL.—No clean fuel production credit shall be determined under subsection (a) with respect to any transportation fuel unless—

"(i) the taxpayer—

"(I) is registered as a producer of clean fuel under section 4101 at the time of production, and

"(II) in the case of any transportation fuel which is a sustainable aviation fuel, provides—

"(aa) certification (in such form and manner as the Secretary shall prescribe) from an unrelated party demonstrating compliance with— Certification.

"(AA) any general requirements, supply chain traceability requirements, and information transmission requirements established under the Carbon Offsetting and Reduction Scheme for International Aviation described in subclause (I) of subsection (b)(1)(B)(iii), or

"(BB) in the case of any methodology described in subclause (II) of such subsection, requirements similar to the requirements described in subitem (AA), and

"(bb) such other information with respect to such fuel as the Secretary may require for purposes of carrying out this section, and

"(ii) such fuel is produced in the United States.

"(B) UNITED STATES.—For purposes of this paragraph, the term 'United States' includes any possession of the United States. Definition.

"(2) PRODUCTION ATTRIBUTABLE TO THE TAXPAYER.—In the case of a facility in which more than 1 person has an ownership interest, except to the extent provided in regulations prescribed by the Secretary, production from the facility shall be allocated among such persons in proportion to their respective ownership interests in the gross sales from such facility.

"(3) RELATED PERSONS.—Persons shall be treated as related to each other if such persons would be treated as a single employer under the regulations prescribed under section 52(b). In the case of a corporation which is a member of an affiliated group of corporations filing a consolidated return, such corporation shall be treated as selling fuel to an unrelated person if such fuel is sold to such a person by another member of such group.

"(4) PASS-THRU IN THE CASE OF ESTATES AND TRUSTS.—Under regulations prescribed by the Secretary, rules similar to the rules of subsection (d) of section 52 shall apply.

"(5) ALLOCATION OF CREDIT TO PATRONS OF AGRICULTURAL COOPERATIVE.—Rules similar to the rules of section 45Y(g)(6) shall apply.

"(6) PREVAILING WAGE REQUIREMENTS.—

"(A) IN GENERAL.—Subject to subparagraph (B), rules similar to the rules of section 45(b)(7) shall apply.

"(B) SPECIAL RULE FOR FACILITIES PLACED IN SERVICE BEFORE JANUARY 1, 2025.—For purposes of subparagraph (A), in the case of any qualified facility placed in service before January 1, 2025—

"(i) clause (i) of section 45(b)(7)(A) shall not apply, and

"(ii) clause (ii) of such section shall be applied by substituting 'with respect to any taxable year beginning after December 31, 2024, for which the credit is allowed under this section' for 'with respect to any taxable year, for any portion of such taxable year which is within the period described in subsection (a)(2)(A)(ii)'.

"(7) APPRENTICESHIP REQUIREMENTS.—Rules similar to the rules of section 45(b)(8) shall apply.

"(g) TERMINATION.—This section shall not apply to transportation fuel sold after December 31, 2027.".

(b) CONFORMING AMENDMENTS.—

(1) Section 25C(d)(3), as amended by the preceding provisions of this Act, is amended— 26 USC 25.

(A) in subparagraph (A), by striking "and" at the end,

(B) in subparagraph (B), by striking the period at the end and inserting ", and", and

(C) by adding at the end the following new subparagraph:

"(C) transportation fuel (as defined in section 45Z(d)(5)).".

(2) Section 30C(c)(1)(B), as amended by the preceding provisions of this Act, is amended by adding at the end the following new clause:

"(iv) Any transportation fuel (as defined in section 45Z(d)(5)).".

(3) Section 38(b), as amended by the preceding provisions of this Act, is amended—

(A) in paragraph (38), by striking "plus" at the end,

(B) in paragraph (39), by striking the period at the end and inserting ", plus", and

(C) by adding at the end the following new paragraph:

"(40) the clean fuel production credit determined under section 45Z(a).".

(4) The table of sections for subpart D of part IV of subchapter A of chapter 1, as amended by the preceding provisions of this Act, is amended by adding at the end the following new item: 26 USC 38 prec.

"Sec. 45Z. Clean fuel production credit.".

(5) Section 4101(a)(1), as amended by the preceding provisions of this Act, is amended by inserting "every person producing a fuel eligible for the clean fuel production credit (pursuant to section 45Z)," after "section 6426(k)(3)),". 26 USC 4101.

(c) EFFECTIVE DATE.—The amendments made by this section shall apply to transportation fuel produced after December 31, 2024. 26 USC 45Z note.

PART 8—CREDIT MONETIZATION AND APPROPRIATIONS

SEC. 13801. ELECTIVE PAYMENT FOR ENERGY PROPERTY AND ELECTRICITY PRODUCED FROM CERTAIN RENEWABLE RESOURCES, ETC.

(a) IN GENERAL.—Subchapter B of chapter 65 is amended by inserting after section 6416 the following new section:

"SEC. 6417. ELECTIVE PAYMENT OF APPLICABLE CREDITS. 26 USC 6417.

"(a) IN GENERAL.—In the case of an applicable entity making an election (at such time and in such manner as the Secretary may provide) under this section with respect to any applicable credit determined with respect to such entity, such entity shall be treated as making a payment against the tax imposed by subtitle A (for the taxable year with respect to which such credit was determined) equal to the amount of such credit.

"(b) APPLICABLE CREDIT.—The term 'applicable credit' means each of the following: Definition.

"(1) So much of the credit for alternative fuel vehicle refueling property allowed under section 30C which, pursuant to subsection (d)(1) of such section, is treated as a credit listed in section 38(b).

"(2) So much of the renewable electricity production credit determined under section 45(a) as is attributable to qualified facilities which are originally placed in service after December 31, 2022.

"(3) So much of the credit for carbon oxide sequestration determined under section 45Q(a) as is attributable to carbon capture equipment which is originally placed in service after December 31, 2022.

"(4) The zero-emission nuclear power production credit determined under section 45U(a).

"(5) So much of the credit for production of clean hydrogen determined under section 45V(a) as is attributable to qualified clean hydrogen production facilities which are originally placed in service after December 31, 2012.

"(6) In the case of a tax-exempt entity described in clause (i), (ii), or (iv) of section 168(h)(2)(A), the credit for qualified commercial vehicles determined under section 45W by reason of subsection (d)(3) thereof.

"(7) The credit for advanced manufacturing production under section 45X(a).

"(8) The clean electricity production credit determined under section 45Y(a).

"(9) The clean fuel production credit determined under section 45Z(a).

"(10) The energy credit determined under section 48.

"(11) The qualifying advanced energy project credit determined under section 48C.

"(12) The clean electricity investment credit determined under section 48E.

"(c) APPLICATION TO PARTNERSHIPS AND S CORPORATIONS.—

"(1) IN GENERAL.—In the case of any applicable credit determined with respect to any facility or property held directly by a partnership or S corporation, any election under subsection (a) shall be made by such partnership or S corporation. If such partnership or S corporation makes an election under such subsection (in such manner as the Secretary may provide) with respect to such credit—

"(A) the Secretary shall make a payment to such partnership or S corporation equal to the amount of such credit,

"(B) subsection (e) shall be applied with respect to such credit before determining any partner's distributive share, or shareholder's pro rata share, of such credit,

"(C) any amount with respect to which the election in subsection (a) is made shall be treated as tax exempt income for purposes of sections 705 and 1366, and

"(D) a partner's distributive share of such tax exempt income shall be based on such partner's distributive share of the otherwise applicable credit for each taxable year.

"(2) COORDINATION WITH APPLICATION AT PARTNER OR SHAREHOLDER LEVEL.—In the case of any facility or property held directly by a partnership or S corporation, no election by any partner or shareholder shall be allowed under subsection (a) with respect to any applicable credit determined with respect to such facility or property.

"(3) TREATMENT OF PAYMENTS TO PARTNERSHIPS AND S CORPORATIONS.—For purposes of section 1324 of title 31, United States Code, the payments under paragraph (1)(A) shall be treated in the same manner as a refund due from a credit provision referred to in subsection (b)(2) of such section.

"(d) SPECIAL RULES.—For purposes of this section—

Definition.
Effective dates.

"(1) APPLICABLE ENTITY.—

"(A) IN GENERAL.—The term 'applicable entity' means—

"(i) any organization exempt from the tax imposed by subtitle A,

"(ii) any State or political subdivision thereof,

"(iii) the Tennessee Valley Authority,

"(iv) an Indian tribal government (as defined in section 30D(g)(9)),

"(v) any Alaska Native Corporation (as defined in section 3 of the Alaska Native Claims Settlement Act (43 U.S.C. 1602(m)), or

"(vi) any corporation operating on a cooperative basis which is engaged in furnishing electric energy to persons in rural areas.

"(B) ELECTION WITH RESPECT TO CREDIT FOR PRODUCTION OF CLEAN HYDROGEN.—If a taxpayer other than an entity described in subparagraph (A) makes an election under this subparagraph with respect to any taxable year in which such taxpayer has placed in service a qualified clean hydrogen production facility (as defined in section 45V(c)(3)), such taxpayer shall be treated as an applicable entity for purposes of this section for such taxable year,

but only with respect to the credit described in subsection (b)(5).

"(C) ELECTION WITH RESPECT TO CREDIT FOR CARBON OXIDE SEQUESTRATION.—If a taxpayer other than an entity described in subparagraph (A) makes an election under this subparagraph with respect to any taxable year in which such taxpayer has, after December 31, 2022, placed in service carbon capture equipment at a qualified facility (as defined in section 45Q(d)), such taxpayer shall be treated as an applicable entity for purposes of this section for such taxable year, but only with respect to the credit described in subsection (b)(3).

"(D) ELECTION WITH RESPECT TO ADVANCED MANUFACTURING PRODUCTION CREDIT.—

"(i) IN GENERAL.—If a taxpayer other than an entity described in subparagraph (A) makes an election under this subparagraph with respect to any taxable year in which such taxpayer has, after December 31, 2022, produced eligible components (as defined in section 45X(c)(1)), such taxpayer shall be treated as an applicable entity for purposes of this section for such taxable year, but only with respect to the credit described in subsection (b)(7).

"(ii) LIMITATION.—

"(I) IN GENERAL.—Except as provided in subclause (II), if a taxpayer makes an election under this subparagraph with respect to any taxable year, such taxpayer shall be treated as having made such election for each of the 4 succeeding taxable years ending before January 1, 2033.

"(II) EXCEPTION.—A taxpayer may elect to revoke the application of the election made under this subparagraph to any taxable year described in subclause (I). Any such election, if made, shall apply to the applicable year specified in such election and each subsequent taxable year within the period described in subclause (I). Any election under this subclause may not be subsequently revoked.

"(iii) PROHIBITION ON TRANSFER.—For any taxable year described in clause (ii)(I), no election may be made by the taxpayer under section 6418(a) for such taxable year with respect to eligible components for purposes of the credit described in subsection (b)(7).

"(E) OTHER RULES.—

"(i) IN GENERAL.—An election made under subparagraph (B), (C), or (D) shall be made at such time and in such manner as the Secretary may provide.

"(ii) LIMITATION.—No election may be made under subparagraph (B), (C), or (D) with respect to any taxable year beginning after December 31, 2032. Effective date.

"(2) APPLICATION.—In the case of any applicable entity which makes the election described in subsection (a), any applicable credit shall be determined— Determination.

"(A) without regard to paragraphs (3) and (4)(A)(i) of section 50(b), and

"(B) by treating any property with respect to which such credit is determined as used in a trade or business of the applicable entity.

"(3) ELECTIONS.—

"(A) IN GENERAL.—

"(i) DUE DATE.—Any election under subsection (a) shall be made not later than—

"(I) in the case of any government, or political subdivision, described in paragraph (1) and for which no return is required under section 6011 or 6033(a), such date as is determined appropriate by the Secretary, or

"(II) in any other case, the due date (including extensions of time) for the return of tax for the taxable year for which the election is made, but in no event earlier than 180 days after the date of the enactment of this section.

Applicability.

"(ii) ADDITIONAL RULES.—Any election under subsection (a), once made, shall be irrevocable and shall apply (except as otherwise provided in this paragraph) with respect to any credit for the taxable year for which the election is made.

Applicability.

"(B) RENEWABLE ELECTRICITY PRODUCTION CREDIT.—In the case of the credit described in subsection (b)(2), any election under subsection (a) shall—

"(i) apply separately with respect to each qualified facility,

"(ii) be made for the taxable year in which such qualified facility is originally placed in service, and

"(iii) shall apply to such taxable year and to any subsequent taxable year which is within the period described in subsection (a)(2)(A)(ii) of section 45 with respect to such qualified facility.

"(C) CREDIT FOR CARBON OXIDE SEQUESTRATION.—

Applicability.

"(i) IN GENERAL.—In the case of the credit described in subsection (b)(3), any election under subsection (a) shall—

"(I) apply separately with respect to the carbon capture equipment originally placed in service by the applicable entity during a taxable year, and

Time period.

"(II)(aa) in the case of a taxpayer who makes an election described in paragraph (1)(C), apply to the taxable year in which such equipment is placed in service and the 4 subsequent taxable years with respect to such equipment which end before January 1, 2033, and

"(bb) in any other case, apply to such taxable year and to any subsequent taxable year which is within the period described in paragraph (3)(A) or (4)(A) of section 45Q(a) with respect to such equipment.

"(ii) PROHIBITION ON TRANSFER.—For any taxable year described in clause (i)(II)(aa) with respect to carbon capture equipment, no election may be made by the taxpayer under section 6418(a) for such taxable year with respect to such equipment for purposes of the credit described in subsection (b)(3).

"(iii) REVOCATION OF ELECTION.—In the case of a taxpayer who makes an election described in paragraph (1)(C) with respect to carbon capture equipment, such taxpayer may, at any time during the period described in clause (i)(II)(aa), revoke the application of such election with respect to such equipment for any subsequent taxable years during such period. Any such election, if made, shall apply to the applicable year specified in such election and each subsequent taxable year within the period described in clause (i)(II)(aa). Any election under this subclause may not be subsequently revoked. Applicability.

"(D) CREDIT FOR PRODUCTION OF CLEAN HYDROGEN.— Applicability. Time period.

"(i) IN GENERAL.—In the case of the credit described in subsection (b)(5), any election under subsection (a) shall—

"(I) apply separately with respect to each qualified clean hydrogen production facility,

"(II) be made for the taxable year in which such facility is placed in service (or within the 1-year period subsequent to the date of enactment of this section in the case of facilities placed in service before December 31, 2022), and

"(III)(aa) in the case of a taxpayer who makes an election described in paragraph (1)(B), apply to such taxable year and the 4 subsequent taxable years with respect to such facility which end before January 1, 2033, and

"(bb) in any other case, apply to such taxable year and all subsequent taxable years with respect to such facility.

"(ii) PROHIBITION ON TRANSFER.—For any taxable year described in clause (i)(III)(aa) with respect to a qualified clean hydrogen production facility, no election may be made by the taxpayer under section 6418(a) for such taxable year with respect to such facility for purposes of the credit described in subsection (b)(5).

"(iii) REVOCATION OF ELECTION.—In the case of a taxpayer who makes an election described in paragraph (1)(B) with respect to a qualified clean hydrogen production facility, such taxpayer may, at any time during the period described in clause (i)(III)(aa), revoke the application of such election with respect to such facility for any subsequent taxable years during such period. Any such election, if made, shall apply to the applicable year specified in such election and each subsequent taxable year within the period described in clause (i)(II)(aa). Any election under this subclause may not be subsequently revoked. Applicability.

"(E) CLEAN ELECTRICITY PRODUCTION CREDIT.—In the case of the credit described in subsection (b)(8), any election under subsection (a) shall— Applicability.

"(i) apply separately with respect to each qualified facility,

"(ii) be made for the taxable year in which such facility is placed in service, and

"(iii) shall apply to such taxable year and to any subsequent taxable year which is within the period described in subsection (b)(1)(B) of section 45Y with respect to such facility.

"(4) TIMING.—The payment described in subsection (a) shall be treated as made on—

Claims.

"(A) in the case of any government, or political subdivision, described in paragraph (1) and for which no return is required under section 6011 or 6033(a), the later of the date that a return would be due under section 6033(a) if such government or subdivision were described in that section or the date on which such government or subdivision submits a claim for credit or refund (at such time and in such manner as the Secretary shall provide), and

Determination.

"(B) in any other case, the later of the due date (determined without regard to extensions) of the return of tax for the taxable year or the date on which such return is filed.

"(5) ADDITIONAL INFORMATION.—As a condition of, and prior to, any amount being treated as a payment which is made by an applicable entity under subsection (a), the Secretary may require such information or registration as the Secretary deems necessary for purposes of preventing duplication, fraud, improper payments, or excessive payments under this section.

"(6) EXCESSIVE PAYMENT.—

Determination.

"(A) IN GENERAL.—In the case of any amount treated as a payment which is made by the applicable entity under subsection (a), or the amount of the payment made pursuant to subsection (c), which the Secretary determines constitutes an excessive payment, the tax imposed on such entity by chapter 1 (regardless of whether such entity would otherwise be subject to tax under such chapter) for the taxable year in which such determination is made shall be increased by an amount equal to the sum of—

"(i) the amount of such excessive payment, plus

"(ii) an amount equal to 20 percent of such excessive payment.

"(B) REASONABLE CAUSE.—Subparagraph (A)(ii) shall not apply if the applicable entity demonstrates to the satisfaction of the Secretary that the excessive payment resulted from reasonable cause.

"(C) EXCESSIVE PAYMENT DEFINED.—For purposes of this paragraph, the term 'excessive payment' means, with respect to a facility or property for which an election is made under this section for any taxable year, an amount equal to the excess of—

"(i) the amount treated as a payment which is made by the applicable entity under subsection (a), or the amount of the payment made pursuant to subsection (c), with respect to such facility or property for such taxable year, over

"(ii) the amount of the credit which, without application of this section, would be otherwise allowable (as determined pursuant to paragraph (2) and without regard to section 38(c)) under this title with respect to such facility or property for such taxable year.

"(e) DENIAL OF DOUBLE BENEFIT.—In the case of an applicable entity making an election under this section with respect to an applicable credit, such credit shall be reduced to zero and shall, for any other purposes under this title, be deemed to have been allowed to such entity for such taxable year.

"(f) MIRROR CODE POSSESSIONS.—In the case of any possession of the United States with a mirror code tax system (as defined in section 24(k)), this section shall not be treated as part of the income tax laws of the United States for purposes of determining the income tax law of such possession unless such possession elects to have this section be so treated. Determination.

"(g) BASIS REDUCTION AND RECAPTURE.—Except as otherwise provided in subsection (c)(2)(A), rules similar to the rules of section 50 shall apply for purposes of this section. Applicability.

"(h) REGULATIONS.—The Secretary shall issue such regulations or other guidance as may be necessary to carry out the purposes of this section, including guidance to ensure that the amount of the payment or deemed payment made under this section is commensurate with the amount of the credit that would be otherwise allowable (determined without regard to section 38(c)).". Guidelines.

(b) TRANSFER OF CERTAIN CREDITS.—Subchapter B of chapter 65, as amended by subsection (a), is amended by inserting after section 6417 the following new section:

"SEC. 6418. TRANSFER OF CERTAIN CREDITS. 26 USC 6418.

"(a) IN GENERAL.—In the case of an eligible taxpayer which elects to transfer all (or any portion specified in the election) of an eligible credit determined with respect to such taxpayer for any taxable year to a taxpayer (referred to in this section as the 'transferee taxpayer') which is not related (within the meaning of section 267(b) or 707(b)(1)) to the eligible taxpayer, the transferee taxpayer specified in such election (and not the eligible taxpayer) shall be treated as the taxpayer for purposes of this title with respect to such credit (or such portion thereof).

"(b) TREATMENT OF PAYMENTS MADE IN CONNECTION WITH TRANSFER.—With respect to any amount paid by a transferee taxpayer to an eligible taxpayer as consideration for a transfer described in subsection (a), such consideration—

"(1) shall be required to be paid in cash, Requirement.

"(2) shall not be includible in gross income of the eligible taxpayer, and

"(3) with respect to the transferee taxpayer, shall not be deductible under this title.

"(c) APPLICATION TO PARTNERSHIPS AND S CORPORATIONS.—

"(1) IN GENERAL.—In the case of any eligible credit determined with respect to any facility or property held directly by a partnership or S corporation, if such partnership or S corporation makes an election under subsection (a) (in such manner as the Secretary may provide) with respect to such credit—

"(A) any amount received as consideration for a transfer described in such subsection shall be treated as tax exempt income for purposes of sections 705 and 1366, and

"(B) a partner's distributive share of such tax exempt income shall be based on such partner's distributive share of the otherwise eligible credit for each taxable year.

"(2) COORDINATION WITH APPLICATION AT PARTNER OR SHAREHOLDER LEVEL.—In the case of any facility or property held directly by a partnership or S corporation, no election by any partner or shareholder shall be allowed under subsection (a) with respect to any eligible credit determined with respect to such facility or property.

"(d) TAXABLE YEAR IN WHICH CREDIT TAKEN INTO ACCOUNT.—In the case of any credit (or portion thereof) with respect to which an election is made under subsection (a), such credit shall be taken into account in the first taxable year of the transferee taxpayer ending with, or after, the taxable year of the eligible taxpayer with respect to which the credit was determined.

"(e) LIMITATIONS ON ELECTION.—

Deadline.
Time period.

"(1) TIME FOR ELECTION.—An election under subsection (a) to transfer any portion of an eligible credit shall be made not later than the due date (including extensions of time) for the return of tax for the taxable year for which the credit is determined, but in no event earlier than 180 days after the date of the enactment of this section. Any such election, once made, shall be irrevocable.

"(2) NO ADDITIONAL TRANSFERS.—No election may be made under subsection (a) by a transferee taxpayer with respect to any portion of an eligible credit which has been previously transferred to such taxpayer pursuant to this section.

"(f) DEFINITIONS.—For purposes of this section—

"(1) ELIGIBLE CREDIT.—

"(A) IN GENERAL.—The term 'eligible credit' means each of the following:

"(i) So much of the credit for alternative fuel vehicle refueling property allowed under section 30C which, pursuant to subsection (d)(1) of such section, is treated as a credit listed in section 38(b).

"(ii) The renewable electricity production credit determined under section 45(a).

"(iii) The credit for carbon oxide sequestration determined under section 45Q(a).

"(iv) The zero-emission nuclear power production credit determined under section 45U(a).

"(v) The clean hydrogen production credit determined under section 45V(a).

"(vi) The advanced manufacturing production credit determined under section 45X(a).

"(vii) The clean electricity production credit determined under section 45Y(a).

"(viii) The clean fuel production credit determined under section 45Z(a).

"(ix) The energy credit determined under section 48.

"(x) The qualifying advanced energy project credit determined under section 48C.

"(xi) The clean electricity investment credit determined under section 48E.

"(B) ELECTION FOR CERTAIN CREDITS.—In the case of any eligible credit described in clause (ii), (iii), (v), or (vii) of subparagraph (A), an election under subsection (a) shall be made—

"(i) separately with respect to each facility for which such credit is determined, and

"(ii) for each taxable year during the 10-year period beginning on the date such facility was originally placed in service (or, in the case of the credit described in clause (iii), for each year during the 12-year period beginning on the date the carbon capture equipment was originally placed in service at such facility). Time periods. Effective dates.

"(C) EXCEPTION FOR BUSINESS CREDIT CARRYFORWARDS OR CARRYBACKS.—The term 'eligible credit' shall not include any business credit carryforward or business credit carryback determined under section 39.

"(2) ELIGIBLE TAXPAYER.—The term 'eligible taxpayer' means any taxpayer which is not described in section 6417(d)(1)(A).

"(g) SPECIAL RULES.—For purposes of this section—

"(1) ADDITIONAL INFORMATION.—As a condition of, and prior to, any transfer of any portion of an eligible credit pursuant to subsection (a), the Secretary may require such information (including, in such form or manner as is determined appropriate by the Secretary, such information returns) or registration as the Secretary deems necessary for purposes of preventing duplication, fraud, improper payments, or excessive payments under this section. Determination.

"(2) EXCESSIVE CREDIT TRANSFER.—

"(A) IN GENERAL.—In the case of any portion of an eligible credit which is transferred to a transferee taxpayer pursuant to subsection (a) which the Secretary determines constitutes an excessive credit transfer, the tax imposed on the transferee taxpayer by chapter 1 (regardless of whether such entity would otherwise be subject to tax under such chapter) for the taxable year in which such determination is made shall be increased by an amount equal to the sum of— Determination.

"(i) the amount of such excessive credit transfer, plus

"(ii) an amount equal to 20 percent of such excessive credit transfer.

"(B) REASONABLE CAUSE.—Subparagraph (A)(ii) shall not apply if the transferee taxpayer demonstrates to the satisfaction of the Secretary that the excessive credit transfer resulted from reasonable cause.

"(C) EXCESSIVE CREDIT TRANSFER DEFINED.—For purposes of this paragraph, the term 'excessive credit transfer' means, with respect to a facility or property for which an election is made under subsection (a) for any taxable year, an amount equal to the excess of— Definition.

"(i) the amount of the eligible credit claimed by the transferee taxpayer with respect to such facility or property for such taxable year, over

"(ii) the amount of such credit which, without application of this section, would be otherwise allowable under this title with respect to such facility or property for such taxable year.

"(3) BASIS REDUCTION; NOTIFICATION OF RECAPTURE.—In the case of any election under subsection (a) with respect to

any portion of an eligible credit described in clauses (ix) through (xi) of subsection (f)(1)(A)—

Applicability.

"(A) subsection (c) of section 50 shall apply to the applicable investment credit property (as defined in subsection (a)(5) of such section) as if such eligible credit was allowed to the eligible taxpayer, and

Notices.

"(B) if, during any taxable year, the applicable investment credit property (as defined in subsection (a)(5) of section 50) is disposed of, or otherwise ceases to be investment credit property with respect to the eligible taxpayer, before the close of the recapture period (as described in subsection (a)(1) of such section)—

"(i) such eligible taxpayer shall provide notice of such occurrence to the transferee taxpayer (in such form and manner as the Secretary shall prescribe), and

"(ii) the transferee taxpayer shall provide notice of the recapture amount (as defined in subsection (c)(2) of such section), if any, to the eligible taxpayer (in such form and manner as the Secretary shall prescribe).

"(4) PROHIBITION ON ELECTION OR TRANSFER WITH RESPECT TO PROGRESS EXPENDITURES.—This section shall not apply with respect to any amount of an eligible credit which is allowed pursuant to rules similar to the rules of subsections (c)(4) and (d) of section 46 (as in effect on the day before the date of the enactment of the Revenue Reconciliation Act of 1990).

Guidelines.

"(h) REGULATIONS.—The Secretary shall issue such regulations or other guidance as may be necessary to carry out the purposes of this section, including regulations or other guidance providing rules for determining a partner's distributive share of the tax exempt income described in subsection (c)(1).".

26 USC 50.

(c) REAL ESTATE INVESTMENT TRUSTS.—Section 50(d) is amended by adding at the end the following: "In the case of a real estate investment trust making an election under section 6418, paragraphs (1)(B) and (2)(B) of the section 46(e) referred to in paragraph (1) of this subsection shall not apply to any investment credit property of such real estate investment trust to which such election applies.".

(d) 3-YEAR CARRYBACK FOR APPLICABLE CREDITS.—Section 39(a) is amended by adding at the end the following:

"(4) 3-YEAR CARRYBACK FOR APPLICABLE CREDITS.—Notwithstanding subsection (d), in the case of any applicable credit (as defined in section 6417(b))—

"(A) this section shall be applied separately from the business credit (other than the applicable credit),

"(B) paragraph (1) shall be applied by substituting 'each of the 3 taxable years' for 'the taxable year' in subparagraph (A) thereof, and

"(C) paragraph (2) shall be applied—

"(i) by substituting '23 taxable years' for '21 taxable years' in subparagraph (A) thereof, and

"(ii) by substituting '22 taxable years' for '20 taxable years' in subparagraph (B) thereof.".

(e) CLERICAL AMENDMENT.—The table of sections for subchapter B of chapter 65 is amended by inserting after the item relating to section 6416 the following new items: 26 USC 6411 prec.

"Sec. 6417. Elective payment of applicable credits.
"Sec. 6418. Transfer of certain credits.".

(f) GROSS-UP OF DIRECT SPENDING.—Beginning in fiscal year 2023 and each fiscal year thereafter, the portion of any payment made to a taxpayer pursuant to an election under section 6417 of the Internal Revenue Code of 1986, or any amount treated as a payment which is made by the taxpayer under subsection (a) of such section, that is direct spending shall be increased by 6.0445 percent. Effective date. Time periods. 26 USC 6417 note.

(g) EFFECTIVE DATE.—The amendments made by this section shall apply to taxable years beginning after December 31, 2022. 26 USC 6417 note.

SEC. 13802. APPROPRIATIONS. Effective date.

Immediately upon the enactment of this Act, in addition to amounts otherwise available, there are appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $500,000,000 to remain available until September 30, 2031, for necessary expenses for the Internal Revenue Service to carry out this subtitle (and the amendments made by this subtitle), which shall supplement and not supplant any other appropriations that may be available for this purpose.

PART 9—OTHER PROVISIONS

SEC. 13901. PERMANENT EXTENSION OF TAX RATE TO FUND BLACK LUNG DISABILITY TRUST FUND.

(a) IN GENERAL.—Section 4121 is amended by striking subsection (e). 26 USC 4121.

(b) EFFECTIVE DATE.—The amendment made by this section shall apply to sales in calendar quarters beginning after the date which is 1 day after the date of enactment of this Act. 26 USC 4121 note.

SEC. 13902. INCREASE IN RESEARCH CREDIT AGAINST PAYROLL TAX FOR SMALL BUSINESSES.

(a) IN GENERAL.—Clause (i) of section 41(h)(4)(B) is amended—

(1) by striking "AMOUNT.—The amount" and inserting "AMOUNT.—

"(I) IN GENERAL.—The amount", and

(2) by adding at the end the following new subclause:

"(II) INCREASE.—In the case of taxable years beginning after December 31, 2022, the amount in subclause (I) shall be increased by $250,000.". Effective date.

(b) ALLOWANCE OF CREDIT.—

(1) IN GENERAL.—Paragraph (1) of section 3111(f) is amended—

(A) by striking "for a taxable year, there shall be allowed" and inserting "for a taxable year—

"(A) there shall be allowed",

(B) by striking "equal to the" and inserting "equal to so much of the",

(C) by striking the period at the end and inserting "as does not exceed the limitation of subclause (I) of section 41(h)(4)(B)(i) (applied without regard to subclause (II) thereof), and", and

(D) by adding at the end the following new subparagraph:

"(B) there shall be allowed as a credit against the tax imposed by subsection (b) for the first calendar quarter which begins after the date on which the taxpayer files the return specified in section 41(h)(4)(A)(ii) an amount equal to so much of the payroll tax credit portion determined under section 41(h)(2) as is not allowed as a credit under subparagraph (A).".

26 USC 3111.

(2) LIMITATION.—Paragraph (2) of section 3111(f) is amended—

(A) by striking "paragraph (1)" and inserting "paragraph (1)(A)", and

(B) by inserting ", and the credit allowed by paragraph (1)(B) shall not exceed the tax imposed by subsection (b) for any calendar quarter," after "calendar quarter".

(3) CARRYOVER.—Paragraph (3) of section 3111(f) is amended by striking "the credit" and inserting "any credit".

(4) DEDUCTION ALLOWED.—Paragraph (4) of section 3111(f) is amended—

(A) by striking "credit" and inserting "credits", and

(B) by striking "subsection (a)" and inserting "subsection (a) or (b)".

(c) AGGREGATION RULES.—Clause (ii) of section 41(h)(5)(B) is amended by striking "the $250,000 amount" and inserting "each of the $250,000 amounts".

26 USC 41 note.

(d) EFFECTIVE DATE.—The amendments made by this section shall apply to taxable years beginning after December 31, 2022.

SEC. 13903. REINSTATEMENT OF LIMITATION RULES FOR DEDUCTION FOR STATE AND LOCAL, ETC., TAXES; EXTENSION OF LIMITATION ON EXCESS BUSINESS LOSSES OF NONCORPORATE TAXPAYERS.

(a) REINSTATEMENT OF LIMITATION RULES FOR DEDUCTION FOR STATE AND LOCAL, ETC., TAXES.—

(1) IN GENERAL.—Section 164(b)(6), as amended by section 13904, is further amended—

(A) in the heading, by striking "2026" and inserting "2025", and

(B) by striking "2027" and inserting "2026".

26 USC 164 note.

(2) EFFECTIVE DATE.—The amendments made by this subsection shall apply to taxable years beginning after December 31, 2022.

(b) EXTENSION OF LIMITATION ON EXCESS BUSINESS LOSSES OF NONCORPORATE TAXPAYERS.—

(1) IN GENERAL.—Section 461(l)(1) is amended by striking "January 1, 2027" each place it appears and inserting "January 1, 2029".

26 USC 461 note.

(2) EFFECTIVE DATE.—The amendments made by this subsection shall apply to taxable years beginning after December 31, 2026.

SEC. 13904. REMOVAL OF HARMFUL SMALL BUSINESS TAXES; EXTENSION OF LIMITATION ON DEDUCTION FOR STATE AND LOCAL, ETC., TAXES.

(a) REMOVAL OF HARMFUL SMALL BUSINESS TAXES.—Subparagraph (D) of section 59(k)(1), as added by section 10101, is amended to read as follows:

"(D) SPECIAL RULES FOR DETERMINING APPLICABLE CORPORATION STATUS.—Solely for purposes of determining whether a corporation is an applicable corporation under this paragraph, all adjusted financial statement income of persons treated as a single employer with such corporation under subsection (a) or (b) of section 52 shall be treated as adjusted financial statement income of such corporation, and adjusted financial statement income of such corporation shall be determined without regard to paragraphs (2)(D)(i) and (11) of section 56A(c).".

(b) EXTENSION OF LIMITATION ON DEDUCTION FOR STATE AND LOCAL, ETC., TAXES.—

(1) IN GENERAL.—Section 164(b)(6) is amended—

(A) in the heading, by striking "2025" and inserting "2026", and

(B) by striking "2026" and inserting "2027".

(2) EFFECTIVE DATE.—The amendments made by this subsection shall apply to taxable years beginning after December 31, 2022. 26 USC 164 note.

TITLE II—COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY

Subtitle A—General Provisions

SEC. 20001. DEFINITION OF SECRETARY. 7 USC 6936 note.

In this title, the term "Secretary" means the Secretary of Agriculture.

Subtitle B—Conservation

SEC. 21001. ADDITIONAL AGRICULTURAL CONSERVATION INVESTMENTS.

(a) APPROPRIATIONS.—In addition to amounts otherwise available (and subject to subsection (b)), there are appropriated to the Secretary, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2031 (subject to the condition that no such funds may be disbursed after September 30, 2031)— Time periods.

(1) to carry out, using the facilities and authorities of the Commodity Credit Corporation, the environmental quality incentives program under subchapter A of chapter 4 of subtitle D of title XII of the Food Security Act of 1985 (16 U.S.C. 3839aa through 3839aa–8)—

(A)(i) $250,000,000 for fiscal year 2023;

(ii) $1,750,000,000 for fiscal year 2024;

(iii) $3,000,000,000 for fiscal year 2025; and

(iv) $3,450,000,000 for fiscal year 2026; and

(B) subject to the conditions on the use of the funds that—

(i) section 1240B(f)(1) of the Food Security Act of 1985 (16 U.S.C. 3839aa–2(f)(1)) shall not apply;

Applicability.

(ii) section 1240H(c)(2) of the Food Security Act of 1985 (16 U.S.C. 3839aa–8(c)(2)) shall be applied—

(I) by substituting "$50,000,000" for "$25,000,000"; and

(II) with the Secretary prioritizing proposals that utilize diet and feed management to reduce enteric methane emissions from ruminants; and

Determination.

(iii) the funds shall be available for 1 or more agricultural conservation practices or enhancements that the Secretary determines directly improve soil carbon, reduce nitrogen losses, or reduce, capture, avoid, or sequester carbon dioxide, methane, or nitrous oxide emissions, associated with agricultural production;

(2) to carry out, using the facilities and authorities of the Commodity Credit Corporation, the conservation stewardship program under subchapter B of that chapter (16 U.S.C. 3839aa–21 through 3839aa–25)—

(A)(i) $250,000,000 for fiscal year 2023;

(ii) $500,000,000 for fiscal year 2024;

(iii) $1,000,000,000 for fiscal year 2025; and

(iv) $1,500,000,000 for fiscal year 2026; and

(B) subject to the condition on the use of the funds that the funds shall only be available for 1 or more agricultural conservation practices, enhancements, or bundles that the Secretary determines directly improve soil carbon, reduce nitrogen losses, or reduce, capture, avoid, or sequester carbon dioxide, methane, or nitrous oxide emissions, associated with agricultural production;

(3) to carry out, using the facilities and authorities of the Commodity Credit Corporation, the agricultural conservation easement program under subtitle H of title XII of that Act (16 U.S.C. 3865 through 3865d) for easements or interests in land that will most reduce, capture, avoid, or sequester carbon dioxide, methane, or nitrous oxide emissions associated with land eligible for the program—

(A) $100,000,000 for fiscal year 2023;

(B) $200,000,000 for fiscal year 2024;

(C) $500,000,000 for fiscal year 2025; and

(D) $600,000,000 for fiscal year 2026; and

(4) to carry out, using the facilities and authorities of the Commodity Credit Corporation, the regional conservation partnership program under subtitle I of title XII of that Act (16 U.S.C. 3871 through 3871f)—

(A)(i) $250,000,000 for fiscal year 2023;

(ii) $800,000,000 for fiscal year 2024;

(iii) $1,500,000,000 for fiscal year 2025; and

(iv) $2,400,000,000 for fiscal year 2026; and

(B) subject to the conditions on the use of the funds that—

(i) section 1271C(d)(2)(B) of the Food Security Act of 1985 (16 U.S.C. 3871c(d)(2)(B)) shall not apply; and

(ii) the Secretary shall prioritize partnership agreements under section 1271C(d) of the Food Security Act of 1985 (16 U.S.C. 3871c(d)) that support the implementation of conservation projects that assist agricultural producers and nonindustrial private

forestland owners in directly improving soil carbon, reducing nitrogen losses, or reducing, capturing, avoiding, or sequestering carbon dioxide, methane, or nitrous oxide emissions, associated with agricultural production.

(b) CONDITIONS.—The funds made available under subsection (a) are subject to the conditions that the Secretary shall not—

(1) enter into any agreement—

(A) that is for a term extending beyond September 30, 2031; or

(B) under which any payment could be outlaid or funds disbursed after September 30, 2031; or Time period.

(2) use any other funds available to the Secretary to satisfy obligations initially made under this section.

(c) CONFORMING AMENDMENTS.—

(1) Section 1240B of the Food Security Act of 1985 (16 U.S.C. 3839aa–2) is amended—

(A) in subsection (a), by striking "2023" and inserting "2031"; and

(B) in subsection (f)(2)(B)—

(i) in the subparagraph heading, by striking "2023" and inserting "2031"; and

(ii) by striking "2023" and inserting "2031".

(2) Section 1240H of the Food Security Act of 1985 (16 U.S.C. 3839aa–8) is amended by striking "2023" each place it appears and inserting "2031".

(3) Section 1240J(a) of the Food Security Act of 1985 (16 U.S.C. 3839aa–22(a)) is amended, in the matter preceding paragraph (1), by striking "2023" and inserting "2031".

(4) Section 1240L(h)(2)(A) of the Food Security Act of 1985 (16 U.S.C. 3839aa–24(h)(2)(A)) is amended by striking "2023" and inserting "2031".

(5) Section 1241 of the Food Security Act of 1985 (16 U.S.C. 3841) is amended—

(A) in subsection (a)—

(i) in the matter preceding paragraph (1), by striking "2023" and inserting "2031";

(ii) in paragraph (2)(F), by striking "2023" and inserting "2031"; and

(iii) in paragraph (3), by striking "fiscal year 2023" each place it appears and inserting "each of fiscal years 2023 through 2031";

(B) in subsection (b), by striking "2023" and inserting "2031"; and

(C) in subsection (h)—

(i) in paragraph (1)(B), in the subparagraph heading, by striking "2023" and inserting "2031"; and

(ii) by striking "2023" each place it appears and inserting "2031".

(6) Section 1244(n)(3)(A) of the Food Security Act of 1985 (16 U.S.C. 3844(n)(3)(A)) is amended by striking "2023" and inserting "2031".

(7) Section 1271D(a) of the Food Security Act of 1985 (16 U.S.C. 3871d(a)) is amended by striking "2023" and inserting "2031".

7 USC 6936 note.

SEC. 21002. CONSERVATION TECHNICAL ASSISTANCE.

(a) APPROPRIATIONS.—In addition to amounts otherwise available (and subject to subsection (b)), there are appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2031 (subject to the condition that no such funds may be disbursed after September 30, 2031)—

(1) $1,000,000,000 to provide conservation technical assistance through the Natural Resources Conservation Service; and

(2) $300,000,000 to carry out a program to quantify carbon sequestration and carbon dioxide, methane, and nitrous oxide emissions, through which the Natural Resources Conservation Service shall collect field-based data to assess the carbon sequestration and reduction in carbon dioxide, methane, and nitrous oxide emissions outcomes associated with activities carried out pursuant to this section and use the data to monitor and track those carbon sequestration and emissions trends through the Greenhouse Gas Inventory and Assessment Program of the Department of Agriculture.

(b) CONDITIONS.—The funds made available under this section are subject to the conditions that the Secretary shall not—

Time periods.

(1) enter into any agreement—

(A) that is for a term extending beyond September 30, 2031; or

(B) under which any payment could be outlaid or funds disbursed after September 30, 2031;

(2) use any other funds available to the Secretary to satisfy obligations initially made under this section; or

(3) interpret this section to authorize funds of the Commodity Credit Corporation for activities under this section if such funds are not expressly authorized or currently expended for such purposes.

(c) ADMINISTRATIVE COSTS.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available until September 30, 2028, for administrative costs of the agencies and offices of the Department of Agriculture for costs related to implementing this section.

Subtitle C—Rural Development and Agricultural Credit

SEC. 22001. ADDITIONAL FUNDING FOR ELECTRIC LOANS FOR RENEWABLE ENERGY.

Section 9003 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8103) is amended by adding at the end the following:

"(h) ADDITIONAL FUNDING FOR ELECTRIC LOANS FOR RENEWABLE ENERGY.—

"(1) APPROPRIATIONS.—Notwithstanding subsections (a) through (e), and (g), in addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $1,000,000,000, to remain available until September 30, 2031,

for the cost of loans under section 317 of the Rural Electrification Act of 1936 (7 U.S.C. 940g), including for projects that store electricity that support the types of eligible projects under that section, which shall be forgiven in an amount that is not greater than 50 percent of the loan based on how the borrower and the project meets the terms and conditions for loan forgiveness consistent with the purposes of that section established by the Secretary, except as provided in paragraph (3).

"(2) LIMITATION.—The Secretary shall not enter into any loan agreement pursuant this subsection that could result in disbursements after September 30, 2031. Time period.

"(3) EXCEPTION.—The Secretary shall establish criteria for waiving the 50 percent limitation described in paragraph (1).". Criteria. Waiver.

SEC. 22002. RURAL ENERGY FOR AMERICA PROGRAM.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary, out of any money in the Treasury not otherwise appropriated, for eligible projects under section 9007 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8107), and notwithstanding section 9007(c)(3)(A) of that Act, the amount of a grant shall not exceed 50 percent of the cost of the activity carried out using the grant funds—

(1) $820,250,000 for fiscal year 2022, to remain available until September 30, 2031; and

(2) $180,276,500 for each of fiscal years 2023 through 2027, to remain available until September 30, 2031.

(b) UNDERUTILIZED RENEWABLE ENERGY TECHNOLOGIES.—In addition to amounts otherwise available, there is appropriated to the Secretary, out of any money in the Treasury not otherwise appropriated, to provide grants and loans guaranteed by the Secretary (including the costs of such loans) under the program described in subsection (a) relating to underutilized renewable energy technologies, and to provide technical assistance for applying to the program described in subsection (a), including for underutilized renewable energy technologies, notwithstanding section 9007(c)(3)(A) of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8107(c)(3)(A)), the amount of a grant shall not exceed 50 percent of the cost of the activity carried out using the grant funds, and to the extent the following amounts remain available at the end of each fiscal year, the Secretary shall use such amounts in accordance with subsection (a)—

(1) $144,750,000 for fiscal year 2022, to remain available until September 30, 2031; and

(2) $31,813,500 for each of fiscal years 2023 through 2027, to remain available until September 30, 2031.

(c) LIMITATION.—The Secretary shall not enter into, pursuant to this section— Time period.

(1) any loan agreement that may result in a disbursement after September 30, 2031; or

(2) any grant agreement that may result in any outlay after September 30, 2031.

SEC. 22003. BIOFUEL INFRASTRUCTURE AND AGRICULTURE PRODUCT MARKET EXPANSION.

Section 9003 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8103) (as amended by section 22001) is amended by adding at the end the following:

"(i) BIOFUEL INFRASTRUCTURE AND AGRICULTURE PRODUCT MARKET EXPANSION.—

"(1) APPROPRIATION.—Notwithstanding subsections (a) through (e) and subsection (g), in addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $500,000,000, to remain available until September 30, 2031, to carry out this subsection.

Grants.

"(2) USE OF FUNDS.—The Secretary shall use the amounts made available by paragraph (1) to provide grants, for which the Federal share shall be not more than 75 percent of the total cost of carrying out a project for which the grant is provided, on a competitive basis, to increase the sale and use of agricultural commodity-based fuels through infrastructure improvements for blending, storing, supplying, or distributing biofuels, except for transportation infrastructure not on location where such biofuels are blended, stored, supplied, or distributed—

Determination.

"(A) by installing, retrofitting, or otherwise upgrading fuel dispensers or pumps and related equipment, storage tank system components, and other infrastructure required at a location related to dispensing certain biofuel blends to ensure the increased sales of fuels with high levels of commodity-based ethanol and biodiesel that are at or greater than the levels required in the Notice of Funding Availability for the Higher Blends Infrastructure Incentive Program for Fiscal Year 2020, published in the Federal Register (85 Fed. Reg. 26656), as determined by the Secretary; and

"(B) by building and retrofitting home heating oil distribution centers or equivalent entities and distribution systems for ethanol and biodiesel blends.".

SEC. 22004. USDA ASSISTANCE FOR RURAL ELECTRIC COOPERATIVES.

Section 9003 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8103) (as amended by section 22003) is amended by adding at the end the following:

"(j) USDA ASSISTANCE FOR RURAL ELECTRIC COOPERATIVES.—

"(1) APPROPRIATION.—Notwithstanding subsections (a) through (e) and (g), in addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $9,700,000,000, to remain available until September 30, 2031, for the long-term resiliency, reliability, and affordability of rural electric systems by providing to an eligible entity (defined as an electric cooperative described in section 501(c)(12) or 1381(a)(2) of the Internal Revenue Code of 1986 and is or has been a Rural Utilities Service electric loan borrower pursuant to the Rural Electrification Act of 1936 or serving a predominantly rural area or a wholly or jointly owned subsidiary of such electric cooperative) loans, modifications of loans,

the cost of loans and modifications, and other financial assistance to achieve the greatest reduction in carbon dioxide, methane, and nitrous oxide emissions associated with rural electric systems through the purchase of renewable energy, renewable energy systems, zero-emission systems, and carbon capture and storage systems, to deploy such systems, or to make energy efficiency improvements to electric generation and transmission systems of the eligible entity after the date of enactment of this subsection.

"(2) LIMITATION.—No eligible entity may receive an amount equal to more than 10 percent of the total amount made available by this subsection.

"(3) REQUIREMENT.—The amount of a grant under this subsection shall be not more than 25 percent of the total project costs of the eligible entity carrying out a project using a grant under this subsection.

"(4) PROHIBITION.—Nothing in this subsection shall be interpreted to authorize funds of the Commodity Credit Corporation for activities under this subsection if such funds are not expressly authorized or currently expended for such purposes.

"(5) DISBURSEMENTS.—The Secretary shall not enter into, pursuant to this subsection— Time period.

"(A) any loan agreement that may result in a disbursement after September 30, 2031; or

"(B) any grant agreement that may result in any outlay after September 30, 2031.".

SEC. 22005. ADDITIONAL USDA RURAL DEVELOPMENT ADMINISTRATIVE FUNDS.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available until September 30, 2031, for administrative costs and salaries and expenses for the Rural Development mission area and administrative costs of the agencies and offices of the Department for costs related to implementing this subtitle.

SEC. 22006. FARM LOAN IMMEDIATE RELIEF FOR BORROWERS WITH AT-RISK AGRICULTURAL OPERATIONS.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of amounts in the Treasury not otherwise appropriated, $3,100,000,000, to remain available until September 30, 2031, to provide payments to, for the cost of loans or loan modifications for, or to carry out section 331(b)(4) of the Consolidated Farm and Rural Development Act (7 U.S.C. 1981(b)(4)) with respect to distressed borrowers of direct or guaranteed loans administered by the Farm Service Agency under subtitle A, B, or C of that Act (7 U.S.C. 1922 through 1970). In carrying out this section, the Secretary shall provide relief to those borrowers whose agricultural operations are at financial risk as expeditiously as possible, as determined by the Secretary. Determination.

SEC. 22007. USDA ASSISTANCE AND SUPPORT FOR UNDERSERVED FARMERS, RANCHERS, AND FORESTERS.

Section 1006 of the American Rescue Plan Act of 2021 (7 U.S.C. 2279 note; Public Law 117–2) is amended to read as follows:

"SEC. 1006. USDA ASSISTANCE AND SUPPORT FOR UNDERSERVED FARMERS, RANCHERS, FORESTERS.

"(a) TECHNICAL AND OTHER ASSISTANCE.—In addition to amounts otherwise available, there is appropriated to the Secretary of Agriculture for fiscal year 2022, to remain available until September 30, 2031, out of any money in the Treasury not otherwise appropriated, $125,000,000 to provide outreach, mediation, financial training, capacity building training, cooperative development and agricultural credit training and support, and other technical assistance on issues concerning food, agriculture, agricultural credit, agricultural extension, rural development, or nutrition to underserved farmers, ranchers, or forest landowners, including veterans, limited resource producers, beginning farmers and ranchers, and farmers, ranchers, and forest landowners living in high poverty areas.

"(b) LAND LOSS ASSISTANCE.—In addition to amounts otherwise available, there is appropriated to the Secretary of Agriculture for fiscal year 2022, to remain available until September 30, 2031, out of any money in the Treasury not otherwise appropriated, $250,000,000 to provide grants and loans to eligible entities, as determined by the Secretary, to improve land access (including heirs' property and fractionated land issues) for underserved farmers, ranchers, and forest landowners, including veterans, limited resource producers, beginning farmers and ranchers, and farmers, ranchers, and forest landowners living in high poverty areas.

"(c) EQUITY COMMISSIONS.—In addition to amounts otherwise available, there is appropriated to the Secretary of Agriculture for fiscal year 2022, to remain available until September 30, 2031, out of any money in the Treasury not otherwise appropriated, $10,000,000 to fund the activities of one or more equity commissions that will address racial equity issues within the Department of Agriculture and the programs of the Department of Agriculture.

"(d) RESEARCH, EDUCATION, AND EXTENSION.—In addition to amounts otherwise available, there is appropriated to the Secretary of Agriculture for fiscal year 2022, to remain available until September 30, 2031, out of any money in the Treasury not otherwise appropriated, $250,000,000 to support and supplement agricultural research, education, and extension, as well as scholarships and programs that provide internships and pathways to agricultural sector or Federal employment, for 1890 Institutions (as defined in section 2 of the Agricultural, Research, Extension, and Education Reform Act of 1998 (7 U.S.C. 7601)), 1994 Institutions (as defined in section 532 of the Equity in Educational Land-Grant Status Act of 1994 (7 U.S.C. 301 note; Public Law 103–382)), Alaska Native serving institutions and Native Hawaiian serving institutions eligible to receive grants under subsections (a) and (b), respectively, of section 1419B of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3156), Hispanic-serving institutions eligible to receive grants under section 1455 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3241), and the insular area institutions of higher education located in the territories of the United States, as referred to in section 1489 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3361).

Time period.

"(e) DISCRIMINATION FINANCIAL ASSISTANCE.—In addition to amounts otherwise available, there is appropriated to the Secretary

of Agriculture for fiscal year 2022, to remain available until September 30, 2031, out of any money in the Treasury not otherwise appropriated, $2,200,000,000 for a program to provide financial assistance, including the cost of any financial assistance, to farmers, ranchers, or forest landowners determined to have experienced discrimination prior to January 1, 2021, in Department of Agriculture farm lending programs, under which the amount of financial assistance provided to a recipient may be not more than $500,000, as determined to be appropriate based on any consequences experienced from the discrimination, which program shall be administered through 1 or more qualified nongovernmental entities selected by the Secretary subject to standards set and enforced by the Secretary.

"(f) ADMINISTRATIVE COSTS.—In addition to amounts otherwise available, there is appropriated to the Secretary of Agriculture for fiscal year 2022, to remain available until September 30, 2031, out of any money in the Treasury not otherwise appropriated, $24,000,000 for administrative costs, including training employees, of the agencies and offices of the Department of Agriculture to carry out this section.

"(g) LIMITATION.—The funds made available under this section are subject to the condition that the Secretary shall not—

"(1) enter into any agreement under which any payment could be outlaid or funds disbursed after September 30, 2031; or Time period.

"(2) use any other funds available to the Secretary to satisfy obligations initially made under this section.".

SEC. 22008. REPEAL OF FARM LOAN ASSISTANCE.

Section 1005 of the American Rescue Plan Act of 2021 (7 U.S.C. 1921 note; Public Law 117–2) is repealed.

Subtitle D—Forestry

SEC. 23001. NATIONAL FOREST SYSTEM RESTORATION AND FUELS REDUCTION PROJECTS.

(a) APPROPRIATIONS.—In addition to amounts otherwise available, there are appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2031—

(1) $1,800,000,000 for hazardous fuels reduction projects on National Forest System land within the wildland-urban interface;

(2) $200,000,000 for vegetation management projects on National Forest System land carried out in accordance with a plan developed under section 303(d)(1) or 304(a)(3) of the Healthy Forests Restoration Act of 2003 (16 U.S.C. 6542(d)(1) or 6543(a)(3));

(3) $100,000,000 to provide for environmental reviews by the Chief of the Forest Service in satisfying the obligations of the Chief of the Forest Service under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 through 4370m–12); and

(4) $50,000,000 for the protection of old-growth forests on National Forest System land and to complete an inventory of old-growth forests and mature forests within the National Forest System.

(b) RESTRICTIONS.—None of the funds made available by paragraph (1) or (2) of subsection (a) may be used for any activity—

(1) conducted in a wilderness area or wilderness study area;

(2) that includes the construction of a permanent road or motorized trail;

Deadline.

(3) that includes the construction of a temporary road, except in the case of a temporary road that is decommissioned by the Secretary not later than 3 years after the earlier of—

(A) the date on which the temporary road is no longer needed; and

(B) the date on which the project for which the temporary road was constructed is completed;

(4) inconsistent with the applicable land management plan;

(5) inconsistent with the prohibitions of the rule of the Forest Service entitled "Special Areas; Roadless Area Conservation" (66 Fed. Reg. 3244 (January 12, 2001)), as modified by subparts C and D of part 294 of title 36, Code of Federal Regulations; or

(6) carried out on any land that is not National Forest System land, including other forested land on Federal, State, Tribal, or private land.

(c) LIMITATIONS.—Nothing in this section shall be interpreted to authorize funds of the Commodity Credit Corporation for activities under this section if such funds are not expressly authorized or currently expended for such purposes.

(d) COST-SHARING WAIVER.—

(1) IN GENERAL.—The non-Federal cost-share requirement of a project described in paragraph (2) may be waived at the discretion of the Secretary.

(2) PROJECT DESCRIBED.—A project referred to in paragraph (1) is a project that—

(A) is carried out using funds made available under this section;

Requirement.
Contracts.

(B) requires a partnership agreement, including a cooperative agreement or mutual interest agreement; and

(C) is subject to a non-Federal cost-share requirement.

(e) DEFINITIONS.—In this section:

(1) DECOMMISSION.—The term "decommission" means, with respect to a road—

(A) reestablishing native vegetation on the road;

(B) restoring any natural drainage, watershed function, or other ecological processes that were disrupted or adversely impacted by the road by removing or hydrologically disconnecting the road prism and reestablishing stable slope contours; and

(C) effectively blocking the road to vehicular traffic, where feasible.

(2) ECOLOGICAL INTEGRITY.—The term "ecological integrity" has the meaning given the term in section 219.19 of title 36, Code of Federal Regulations (as in effect on the date of enactment of this Act).

(3) HAZARDOUS FUELS REDUCTION PROJECT.—The term "hazardous fuels reduction project" means an activity, including the use of prescribed fire, to protect structures and communities from wildfire that is carried out on National Forest System land.

(4) RESTORATION.—The term "restoration" has the meaning given the term in section 219.19 of title 36, Code of Federal Regulations (as in effect on the date of enactment of this Act).

(5) VEGETATION MANAGEMENT PROJECT.—The term "vegetation management project" means an activity carried out on National Forest System land to enhance the ecological integrity and achieve the restoration of a forest ecosystem through the removal of vegetation, the use of prescribed fire, the restoration of aquatic habitat, or the decommissioning of an unauthorized, temporary, or system road.

(6) WILDLAND-URBAN INTERFACE.—The term "wildland-urban interface" has the meaning given the term in section 101 of the Healthy Forests Restoration Act of 2003 (16 U.S.C. 6511).

SEC. 23002. COMPETITIVE GRANTS FOR NON-FEDERAL FOREST LANDOWNERS.

(a) APPROPRIATIONS.—In addition to amounts otherwise available, there are appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2031—

(1) $150,000,000 for the competitive grant program under section 13A of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2109a) for providing through that program a cost share to carry out climate mitigation or forest resilience practices in the case of underserved forest landowners, subject to the condition that subsection (h) of that section shall not apply;

(2) $150,000,000 for the competitive grant program under section 13A of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2109a) for providing through that program grants to support the participation of underserved forest landowners in emerging private markets for climate mitigation or forest resilience, subject to the condition that subsection (h) of that section shall not apply;

(3) $100,000,000 for the competitive grant program under section 13A of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2109a) for providing through that program grants to support the participation of forest landowners who own less than 2,500 acres of forest land in emerging private markets for climate mitigation or forest resilience, subject to the condition that subsection (h) of that section shall not apply;

(4) $50,000,000 for the competitive grant program under section 13A of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2109a) to provide grants to states and other eligible entities to provide payments to owners of private forest land for implementation of forestry practices on private forest land, that are determined by the Secretary, based on the best available science, to provide measurable increases in carbon sequestration and storage beyond customary practices on comparable land, subject to the conditions that—

(A) those payments shall not preclude landowners from participation in other public and private sector financial incentive programs; and

(B) subsection (h) of that section shall not apply; and

(5) $100,000,000 to provide grants under the wood innovation grant program under section 8643 of the Agriculture Improvement Act of 2018 (7 U.S.C. 7655d), including for the construction of new facilities that advance the purposes of the program and for the hauling of material removed to reduce hazardous fuels to locations where that material can be utilized, subject to the conditions that—

(A) the amount of such a grant shall be not more than $5,000,000; and

(B) notwithstanding subsection (d) of that section, a recipient of such a grant shall provide funds equal to not less than 50 percent of the amount received under the grant, to be derived from non-Federal sources.

Waiver.
Contracts.

(b) COST-SHARING REQUIREMENT.—Any partnership agreements, including cooperative agreements and mutual interest agreements, using funds made available under this section shall be subject to a non-Federal cost-share requirement of not less than 20 percent of the project cost, which may be waived at the discretion of the Secretary.

(c) LIMITATIONS.—Nothing in this section shall be interpreted to authorize funds of the Commodity Credit Corporation for activities under this section if such funds are not expressly authorized or currently expended for such purposes.

SEC. 23003. STATE AND PRIVATE FORESTRY CONSERVATION PROGRAMS.

(a) APPROPRIATIONS.—In addition to amounts otherwise available, there are appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2031—

(1) $700,000,000 to provide competitive grants to States through the Forest Legacy Program established under section 7 of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2103c) for projects for the acquisition of land and interests in land; and

(2) $1,500,000,000 to provide multiyear, programmatic, competitive grants to a State agency, a local governmental entity, an agency or governmental entity of the District of Columbia, an agency or governmental entity of an insular area (as defined in section 1404 of the National Agricultural Research, Extension, and Teaching Policy Act of 1977 (7 U.S.C. 3103)), an Indian Tribe, or a nonprofit organization through the Urban and Community Forestry Assistance program established under section 9(c) of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2105(c)) for tree planting and related activities.

(b) WAIVER.—Any non-Federal cost-share requirement otherwise applicable to projects carried out under this section may be waived at the discretion of the Secretary.

SEC. 23004. LIMITATION.

The funds made available under this subtitle are subject to the condition that the Secretary shall not—

Time periods.

(1) enter into any agreement—

(A) that is for a term extending beyond September 30, 2031; or

(B) under which any payment could be outlaid or funds disbursed after September 30, 2031; or

(2) use any other funds available to the Secretary to satisfy obligations initially made under this subtitle.

SEC. 23005. ADMINISTRATIVE COSTS.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000 to remain available until September 30, 2031, for administrative costs of the agencies and offices of the Department of Agriculture for costs related to implementing this subtitle.

TITLE III—COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS

SEC. 30001. ENHANCED USE OF DEFENSE PRODUCTION ACT OF 1950.

In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $500,000,000, to remain available until September 30, 2024, to carry out the Defense Production Act of 1950 (50 U.S.C. 4501 et seq.).

SEC. 30002. IMPROVING ENERGY EFFICIENCY OR WATER EFFICIENCY OR CLIMATE RESILIENCE OF AFFORDABLE HOUSING.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary of Housing and Urban Development (in this section referred to as the "Secretary") for fiscal year 2022, out of any money in the Treasury not otherwise appropriated—

(1) $837,500,000, to remain available until September 30, 2028, for the cost of providing direct loans, the costs of modifying such loans, and for grants, as provided for and subject to terms and conditions in subsection (b), including to subsidize gross obligations for the principal amount of such loans, not to exceed $4,000,000,000, to fund projects that improve energy or water efficiency, enhance indoor air quality or sustainability, implement the use of zero-emission electricity generation, low-emission building materials or processes, energy storage, or building electrification strategies, or address climate resilience, of an eligible property;

(2) $60,000,000, to remain available until September 30, 2030, for the costs to the Secretary for information technology, research and evaluation, and administering and overseeing the implementation of this section;

(3) $60,000,000, to remain available until September 30, 2029, for expenses of contracts or cooperative agreements administered by the Secretary; and

(4) $42,500,000, to remain available until September 30, 2028, for energy and water benchmarking of properties eligible to receive grants or loans under this section, regardless of whether they actually received such grants or loans, along with associated data analysis and evaluation at the property and portfolio level, and the development of information technology systems necessary for the collection, evaluation, and analysis of such data.

(b) LOAN AND GRANT TERMS AND CONDITIONS.—Amounts made available under this section shall be for direct loans, grants, and

direct loans that can be converted to grants to eligible recipients that agree to an extended period of affordability for the property.

(c) DEFINITIONS.—As used in this section—

(1) the term "eligible recipient" means any owner or sponsor of an eligible property; and

(2) the term "eligible property" means a property assisted pursuant to—

(A) section 202 of the Housing Act of 1959 (12 U.S.C. 1701q);

(B) section 202 of the Housing Act of 1959 (former 12 U.S.C. 1701q), as such section existed before the enactment of the Cranston-Gonzalez National Affordable Housing Act;

(C) section 811 of the Cranston-Gonzalez National Affordable Housing Act (42 U.S.C. 8013);

(D) section 8(b) of the United States Housing Act of 1937 (42 U.S.C. 1437f(b));

(E) section 236 of the National Housing Act (12 U.S.C. 1715z–1); or

(F) a Housing Assistance Payments contract for Project-Based Rental Assistance in fiscal year 2021.

(d) WAIVER.—The Secretary may waive or specify alternative requirements for any provision of subsection (c) or (bb) of section 8 of the United States Housing Act of 1937 (42 U.S.C. 1437f(c), 1437f(bb)) upon a finding that the waiver or alternative requirement is necessary to facilitate the use of amounts made available under this section.

Notice.
Requirements.
Determination.
Effective date.

(e) IMPLEMENTATION.—The Secretary shall have the authority to establish by notice any requirements that the Secretary determines are necessary for timely and effective implementation of the program and expenditure of funds appropriated, which requirements shall take effect upon issuance.

TITLE IV—COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

SEC. 40001. INVESTING IN COASTAL COMMUNITIES AND CLIMATE RESILIENCE.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $2,600,000,000, to remain available until September 30, 2026, to provide funding through direct expenditure, contracts, grants, cooperative agreements, or technical assistance to coastal states (as defined in paragraph (4) of section 304 of the Coastal Zone Management Act of 1972 (16 U.S.C. 1453(4))), the District of Columbia, Tribal Governments, nonprofit organizations, local governments, and institutions of higher education (as defined in subsection (a) of section 101 of the Higher Education Act of 1965 (20 U.S.C. 1001(a))), for the conservation, restoration, and protection of coastal and marine habitats, resources, Pacific salmon and other marine fisheries, to enable coastal communities to prepare for extreme storms and other changing climate conditions, and for projects that support natural resources that sustain coastal and marine resource dependent

communities, marine fishery and marine mammal stock assessments, and for related administrative expenses.

(b) TRIBAL GOVERNMENT DEFINED.—In this section, the term "Tribal Government" means the recognized governing body of any Indian or Alaska Native tribe, band, nation, pueblo, village, community, component band, or component reservation, individually identified (including parenthetically) in the list published most recently as of the date of enactment of this subsection pursuant to section 104 of the Federally Recognized Indian Tribe List Act of 1994 (25 U.S.C. 5131).

SEC. 40002. FACILITIES OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AND NATIONAL MARINE SANCTUARIES.

(a) NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION FACILITIES.—In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $150,000,000, to remain available until September 30, 2026, for the construction of new facilities, facilities in need of replacement, piers, marine operations facilities, and fisheries laboratories.

(b) NATIONAL MARINE SANCTUARIES FACILITIES.—In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $50,000,000, to remain available until September 30, 2026, for the construction of facilities to support the National Marine Sanctuary System established under subsection (c) of section 301 of the National Marine Sanctuaries Act (16 U.S.C. 1431(c)).

SEC. 40003. NOAA EFFICIENT AND EFFECTIVE REVIEWS.

In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $20,000,000, to remain available until September 30, 2026, to conduct more efficient, accurate, and timely reviews for planning, permitting and approval processes through the hiring and training of personnel, and the purchase of technical and scientific services and new equipment, and to improve agency transparency, accountability, and public engagement.

SEC. 40004. OCEANIC AND ATMOSPHERIC RESEARCH AND FORECASTING FOR WEATHER AND CLIMATE.

(a) FORECASTING AND RESEARCH.—In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $150,000,000, to remain available until September 30, 2026, to accelerate advances and improvements in research, observation systems, modeling, forecasting, assessments, and dissemination of information to the public as it pertains to ocean and atmospheric processes related to weather, coasts, oceans, and climate, and to carry out section 102(a) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8512(a)), and for related administrative expenses.

(b) RESEARCH GRANTS AND SCIENCE INFORMATION, PRODUCTS, AND SERVICES.—In addition to amounts otherwise available, there

are appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2026, $50,000,000 for competitive grants to fund climate research as it relates to weather, ocean, coastal, and atmospheric processes and conditions, and impacts to marine species and coastal habitat, and for related administrative expenses.

SEC. 40005. COMPUTING CAPACITY AND RESEARCH FOR WEATHER, OCEANS, AND CLIMATE.

In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $190,000,000, to remain available until September 30, 2026, for the procurement of additional high-performance computing, data processing capacity, data management, and storage assets, to carry out section 204(a)(2) of the High-Performance Computing Act of 1991 (15 U.S.C. 5524(a)(2)), and for transaction agreements authorized under section 301(d)(1)(A) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8531(d)(1)(A)), and for related administrative expenses.

SEC. 40006. ACQUISITION OF HURRICANE FORECASTING AIRCRAFT.

In addition to amounts otherwise available, there is appropriated to the National Oceanic and Atmospheric Administration for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available until September 30, 2026, for the acquisition of hurricane hunter aircraft under section 413(a) of the Weather Research and Forecasting Innovation Act of 2017 (15 U.S.C. 8549(a)).

49 USC 44504 note.

SEC. 40007. ALTERNATIVE FUEL AND LOW-EMISSION AVIATION TECHNOLOGY PROGRAM.

(a) APPROPRIATION AND ESTABLISHMENT.—For purposes of establishing a competitive grant program for eligible entities to carry out projects located in the United States that produce, transport, blend, or store sustainable aviation fuel, or develop, demonstrate, or apply low-emission aviation technologies, in addition to amounts otherwise available, there are appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2026—

(1) $244,530,000 for projects relating to the production, transportation, blending, or storage of sustainable aviation fuel;

(2) $46,530,000 for projects relating to low-emission aviation technologies; and

(3) $5,940,000 to fund the award of grants under this section, and oversight of the program, by the Secretary.

(b) CONSIDERATIONS.—In carrying out subsection (a), the Secretary shall consider, with respect to a proposed project—

(1) the capacity for the eligible entity to increase the domestic production and deployment of sustainable aviation fuel or the use of low-emission aviation technologies among the United States commercial aviation and aerospace industry;

(2) the projected greenhouse gas emissions from such project, including emissions resulting from the development of the project, and the potential the project has to reduce

or displace, on a lifecycle basis, United States greenhouse gas emissions associated with air travel;

(3) the capacity to create new jobs and develop supply chain partnerships in the United States;

(4) for projects related to the production of sustainable aviation fuel, the projected lifecycle greenhouse gas emissions benefits from the proposed project, which shall include feedstock and fuel production and potential direct and indirect greenhouse gas emissions (including resulting from changes in land use); and

(5) the benefits of ensuring a diversity of feedstocks for sustainable aviation fuel, including the use of waste carbon oxides and direct air capture.

(c) COST SHARE.—The Federal share of the cost of a project carried out using grant funds under subsection (a) shall be 75 percent of the total proposed cost of the project, except that such Federal share shall increase to 90 percent of the total proposed cost of the project if the eligible entity is a small hub airport or nonhub airport, as such terms are defined in section 47102 of title 49, United States Code.

(d) FUEL EMISSIONS REDUCTION TEST.—For purposes of clause (ii) of subsection (e)(7)(E), the Secretary shall, not later than 2 years after the date of enactment of this section, adopt at least 1 methodology for testing lifecycle greenhouse gas emissions that meets the requirements of such clause. Deadline.

(e) DEFINITIONS.—In this section:

(1) ELIGIBLE ENTITY.—The term "eligible entity" means—

(A) a State or local government, including the District of Columbia, other than an airport sponsor;

(B) an air carrier;

(C) an airport sponsor;

(D) an accredited institution of higher education;

(E) a research institution;

(F) a person or entity engaged in the production, transportation, blending, or storage of sustainable aviation fuel in the United States or feedstocks in the United States that could be used to produce sustainable aviation fuel;

(G) a person or entity engaged in the development, demonstration, or application of low-emission aviation technologies; or

(H) nonprofit entities or nonprofit consortia with experience in sustainable aviation fuels, low-emission aviation technologies, or other clean transportation research programs.

(2) FEEDSTOCK.—The term "feedstock" means sources of hydrogen and carbon not originating from unrefined or refined petrochemicals.

(3) INDUCED LAND-USE CHANGE VALUES.—The term "induced land-use change values" means the greenhouse gas emissions resulting from the conversion of land to the production of feedstocks and from the conversion of other land due to the displacement of crops or animals for which the original land was previously used.

(4) LIFECYCLE GREENHOUSE GAS EMISSIONS.—The term "lifecycle greenhouse gas emissions" means the combined greenhouse gas emissions from feedstock production, collection of

feedstock, transportation of feedstock to fuel production facilities, conversion of feedstock to fuel, transportation and distribution of fuel, and fuel combustion in an aircraft engine, as well as from induced land-use change values.

(5) LOW-EMISSION AVIATION TECHNOLOGIES.—The term "low-emission aviation technologies" means technologies, produced in the United States, that significantly—

(A) improve aircraft fuel efficiency;

(B) increase utilization of sustainable aviation fuel; or

(C) reduce greenhouse gas emissions produced during operation of civil aircraft.

(6) SECRETARY.—The term "Secretary" means the Secretary of Transportation.

(7) SUSTAINABLE AVIATION FUEL.—The term "sustainable aviation fuel" means liquid fuel, produced in the United States, that—

(A) consists of synthesized hydrocarbons;

(B) meets the requirements of—

(i) ASTM International Standard D7566; or

(ii) the co-processing provisions of ASTM International Standard D1655, Annex A1 (or such successor standard);

(C) is derived from biomass (in a similar manner as such term is defined in section 45K(c)(3) of the Internal Revenue Code of 1986), waste streams, renewable energy sources, or gaseous carbon oxides;

(D) is not derived from palm fatty acid distillates; and

Determinations.

(E) achieves at least a 50 percent lifecycle greenhouse gas emissions reduction in comparison with petroleum-based jet fuel, as determined by a test that shows—

(i) the fuel production pathway achieves at least a 50 percent reduction of the aggregate attributional core lifecycle emissions and the induced land-use change values under a lifecycle methodology for sustainable aviation fuels similar to that adopted by the International Civil Aviation Organization with the agreement of the United States; or

(ii) the fuel production pathway achieves at least a 50 percent reduction of the aggregate attributional core lifecycle greenhouse gas emissions values and the induced land-use change values under another methodology that the Secretary determines is—

(I) reflective of the latest scientific understanding of lifecycle greenhouse gas emissions; and

(II) as stringent as the requirement under clause (i).

TITLE V—COMMITTEE ON ENERGY AND NATURAL RESOURCES

Subtitle A—Energy

PART 1—GENERAL PROVISIONS

SEC. 50111. DEFINITIONS. 42 USC 17113b note.

In this subtitle:

(1) GREENHOUSE GAS.—The term "greenhouse gas" has the meaning given the term in section 1610(a) of the Energy Policy Act of 1992 (42 U.S.C. 13389(a)).

(2) SECRETARY.—The term "Secretary" means the Secretary of Energy.

(3) STATE.—The term "State" means a State, the District of Columbia, and a United States Insular Area (as that term is defined in section 50211).

(4) STATE ENERGY OFFICE.—The term "State energy office" has the meaning given the term in section 124(a) of the Energy Policy Act of 2005 (42 U.S.C. 15821(a)).

(5) STATE ENERGY PROGRAM.—The term "State Energy Program" means the State Energy Program established pursuant to part D of title III of the Energy Policy and Conservation Act (42 U.S.C. 6321 through 6326).

PART 2—RESIDENTIAL EFFICIENCY AND ELECTRIFICATION REBATES

SEC. 50121. HOME ENERGY PERFORMANCE-BASED, WHOLE-HOUSE REBATES. 42 USC 18795.

(a) APPROPRIATION.—

(1) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $4,300,000,000, to remain available through September 30, 2031, to carry out a program to award grants to State energy offices to develop and implement a HOMES rebate program.

(2) ALLOCATION OF FUNDS.—

(A) IN GENERAL.—The Secretary shall reserve funds made available under paragraph (1) for each State energy office—

(i) in accordance with the allocation formula for the State Energy Program in effect on January 1, 2022; and Effective date.

(ii) to be distributed to a State energy office if the application of the State energy office under subsection (b) is approved.

(B) ADDITIONAL FUNDS.—Not earlier than 2 years after the date of enactment of this Act, any money reserved under subparagraph (A) but not distributed under clause (ii) of that subparagraph shall be redistributed to the State energy offices operating a HOMES rebate program using a grant received under this section in proportion to the Deadline.

amount distributed to those State energy offices under subparagraph (A)(ii).

(3) ADMINISTRATIVE EXPENSES.—Of the funds made available under paragraph (1), the Secretary shall use not more than 3 percent for—

(A) administrative purposes; and

(B) providing technical assistance relating to activities carried out under this section.

Grants.
Plan.

(b) APPLICATION.—A State energy office seeking a grant under this section shall submit to the Secretary an application that includes a plan to implement a HOMES rebate program, including a plan—

Procedures.
Determination.

(1) to use procedures, as approved by the Secretary, for determining the reductions in home energy use resulting from the implementation of a home energy efficiency retrofit that are calibrated to historical energy usage for a home consistent with BPI 2400, for purposes of modeled performance home rebates;

(2) to use open-source advanced measurement and verification software, as approved by the Secretary, for determining and documenting the monthly and hourly (if available) weather-normalized energy use of a home before and after the implementation of a home energy efficiency retrofit, for purposes of measured performance home rebates;

(3) to value savings based on time, location, or greenhouse gas emissions;

Certification.

(4) for quality monitoring to ensure that each home energy efficiency retrofit for which a rebate is provided is documented in a certificate that—

(A) is provided by the contractor and certified by a third party to the homeowner; and

(B) details the work performed, the equipment and materials installed, and the projected energy savings or energy generation to support accurate valuation of the retrofit;

(5) to provide a contractor performing a home energy efficiency retrofit or an aggregator who has the right to claim a rebate $200 for each home located in a disadvantaged community that receives a home energy efficiency retrofit for which a rebate is provided under the program; and

(6) to ensure that a homeowner or aggregator does not receive a rebate for the same upgrade through both a HOMES rebate program and any other Federal grant or rebate program, pursuant to subsection (c)(7).

(c) HOMES REBATE PROGRAM.—

Effective date.
Deadline.

(1) IN GENERAL.—A HOMES rebate program carried out by a State energy office receiving a grant pursuant to this section shall provide rebates to homeowners and aggregators for whole-house energy saving retrofits begun on or after the date of enactment of this Act and completed by not later than September 30, 2031.

(2) AMOUNT OF REBATE.—Subject to paragraph (3), under a HOMES rebate program, the amount of a rebate shall not exceed—

(A) for individuals and aggregators carrying out energy efficiency upgrades of single-family homes—

(i) in the case of a retrofit that achieves modeled energy system savings of not less than 20 percent but less than 35 percent, the lesser of—

(I) $2,000; and

(II) 50 percent of the project cost;

(ii) in the case of a retrofit that achieves modeled energy system savings of not less than 35 percent, the lesser of—

(I) $4,000; and

(II) 50 percent of the project cost; and

(iii) for measured energy savings, in the case of a home or portfolio of homes that achieves energy savings of not less than 15 percent—

(I) a payment rate per kilowatt hour saved, or kilowatt hour-equivalent saved, equal to $2,000 for a 20 percent reduction of energy use for the average home in the State; or

(II) 50 percent of the project cost;

(B) for multifamily building owners and aggregators carrying out energy efficiency upgrades of multifamily buildings—

(i) in the case of a retrofit that achieves modeled energy system savings of not less than 20 percent but less than 35 percent, $2,000 per dwelling unit, with a maximum of $200,000 per multifamily building;

(ii) in the case of a retrofit that achieves modeled energy system savings of not less than 35 percent, $4,000 per dwelling unit, with a maximum of $400,000 per multifamily building; or

(iii) for measured energy savings, in the case of a multifamily building or portfolio of multifamily buildings that achieves energy savings of not less than 15 percent—

(I) a payment rate per kilowatt hour saved, or kilowatt hour-equivalent saved, equal to $2,000 for a 20 percent reduction of energy use per dwelling unit for the average multifamily building in the State; or

(II) 50 percent of the project cost; and

(C) for individuals and aggregators carrying out energy efficiency upgrades of a single-family home occupied by a low- or moderate-income household or a multifamily building not less than 50 percent of the dwelling units of which are occupied by low- or moderate-income households—

(i) in the case of a retrofit that achieves modeled energy system savings of not less than 20 percent but less than 35 percent, the lesser of—

(I) $4,000 per single-family home or dwelling unit; and

(II) 80 percent of the project cost;

(ii) in the case of a retrofit that achieves modeled energy system savings of not less than 35 percent, the lesser of—

(I) $8,000 per single-family home or dwelling unit; and

(II) 80 percent of the project cost; and

(iii) for measured energy savings, in the case of a single-family home, multifamily building, or portfolio of single-family homes or multifamily buildings that achieves energy savings of not less than 15 percent—

(I) a payment rate per kilowatt hour saved, or kilowatt hour-equivalent saved, equal to $4,000 for a 20 percent reduction of energy use per single-family home or dwelling unit, as applicable, for the average single-family home or multifamily building in the State; or

(II) 80 percent of the project cost.

(3) REBATES TO LOW- OR MODERATE-INCOME HOUSEHOLDS.—On approval from the Secretary, notwithstanding paragraph (2), a State energy office carrying out a HOMES rebate program using a grant awarded pursuant to this section may increase rebate amounts for low- or moderate-income households.

(4) USE OF FUNDS.—A State energy office that receives a grant pursuant to this section may use not more than 20 percent of the grant amount for planning, administration, or technical assistance related to a HOMES rebate program.

Publication.

(5) DATA ACCESS GUIDELINES.—The Secretary shall develop and publish guidelines for States relating to residential electric and natural gas energy data sharing.

(6) EXEMPTION.—Activities carried out by a State energy office using a grant awarded pursuant to this section shall not be subject to the expenditure prohibitions and limitations described in section 420.18 of title 10, Code of Federal Regulations.

(7) PROHIBITION ON COMBINING REBATES.—A rebate provided by a State energy office under a HOMES rebate program may not be combined with any other Federal grant or rebate, including a rebate provided under a high-efficiency electric home rebate program (as defined in section 50122(d)), for the same single upgrade.

(d) DEFINITIONS.—In this section:

(1) DISADVANTAGED COMMUNITY.—The term "disadvantaged community" means a community that the Secretary determines, based on appropriate data, indices, and screening tools, is economically, socially, or environmentally disadvantaged.

(2) HOMES REBATE PROGRAM.—The term "HOMES rebate program" means a Home Owner Managing Energy Savings rebate program established by a State energy office as part of an approved State energy conservation plan under the State Energy Program.

(3) LOW- OR MODERATE-INCOME HOUSEHOLD.—The term "low- or moderate-income household" means an individual or family the total annual income of which is less than 80 percent of the median income of the area in which the individual or family resides, as reported by the Department of Housing and Urban Development, including an individual or family that has demonstrated eligibility for another Federal program with income restrictions equal to or below 80 percent of area median income.

42 USC 18795a.

SEC. 50122. HIGH-EFFICIENCY ELECTRIC HOME REBATE PROGRAM.

(a) APPROPRIATIONS.—

(1) FUNDS TO STATE ENERGY OFFICES AND INDIAN TRIBES.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to carry out a program—

(A) to award grants to State energy offices to develop and implement a high-efficiency electric home rebate program in accordance with subsection (c), $4,275,000,000, to remain available through September 30, 2031; and

(B) to award grants to Indian Tribes to develop and implement a high-efficiency electric home rebate program in accordance with subsection (c), $225,000,000, to remain available through September 30, 2031.

(2) ALLOCATION OF FUNDS.—

(A) STATE ENERGY OFFICES.—The Secretary shall reserve funds made available under paragraph (1)(A) for each State energy office—

(i) in accordance with the allocation formula for the State Energy Program in effect on January 1, 2022; and Effective date.

(ii) to be distributed to a State energy office if the application of the State energy office under subsection (b) is approved.

(B) INDIAN TRIBES.—The Secretary shall reserve funds made available under paragraph (1)(B)—

(i) in a manner determined appropriate by the Secretary; and

(ii) to be distributed to an Indian Tribe if the application of the Indian Tribe under subsection (b) is approved.

(C) ADDITIONAL FUNDS.—Not earlier than 2 years after the date of enactment of this Act, any money reserved under— Deadline.

(i) subparagraph (A) but not distributed under clause (ii) of that subparagraph shall be redistributed to the State energy offices operating a high-efficiency electric home rebate program in proportion to the amount distributed to those State energy offices under that clause; and

(ii) subparagraph (B) but not distributed under clause (ii) of that subparagraph shall be redistributed to the Indian Tribes operating a high-efficiency electric home rebate program in proportion to the amount distributed to those Indian Tribes under that clause.

(3) ADMINISTRATIVE EXPENSES.—Of the funds made available under paragraph (1), the Secretary shall use not more than 3 percent for—

(A) administrative purposes; and

(B) providing technical assistance relating to activities carried out under this section.

(b) APPLICATION.—A State energy office or Indian Tribe seeking a grant under the program shall submit to the Secretary an application that includes a plan to implement a high-efficiency electric home rebate program, including— Plans.

(1) a plan to verify the income eligibility of eligible entities seeking a rebate for a qualified electrification project; Verification.

(2) a plan to allow rebates for qualified electrification projects at the point of sale in a manner that ensures that the income eligibility of an eligible entity seeking a rebate may be verified at the point of sale;

(3) a plan to ensure that an eligible entity does not receive a rebate for the same qualified electrification project through both a high-efficiency electric home rebate program and any other Federal grant or rebate program, pursuant to subsection (c)(8); and

(4) any additional information that the Secretary may require.

(c) HIGH-EFFICIENCY ELECTRIC HOME REBATE PROGRAM.—

Grants.

(1) IN GENERAL.—Under the program, the Secretary shall award grants to State energy offices and Indian Tribes to establish a high-efficiency electric home rebate program under which rebates shall be provided to eligible entities for qualified electrification projects.

(2) GUIDELINES.—The Secretary shall prescribe guidelines for high-efficiency electric home rebate programs, including guidelines for providing point of sale rebates in a manner consistent with the income eligibility requirements under this section.

(3) AMOUNT OF REBATE.—

(A) APPLIANCE UPGRADES.—The amount of a rebate provided under a high-efficiency electric home rebate program for the purchase of an appliance under a qualified electrification project shall be—

(i) not more than $1,750 for a heat pump water heater;

(ii) not more than $8,000 for a heat pump for space heating or cooling; and

(iii) not more than $840 for—

(I) an electric stove, cooktop, range, or oven; or

(II) an electric heat pump clothes dryer.

(B) NONAPPLIANCE UPGRADES.—The amount of a rebate provided under a high-efficiency electric home rebate program for the purchase of a nonappliance upgrade under a qualified electrification project shall be—

(i) not more than $4,000 for an electric load service center upgrade;

(ii) not more than $1,600 for insulation, air sealing, and ventilation; and

(iii) not more than $2,500 for electric wiring.

(C) MAXIMUM REBATE.—An eligible entity receiving multiple rebates under this section may receive not more than a total of $14,000 in rebates.

(4) LIMITATIONS.—A rebate provided using funding under this section shall not exceed—

(A) in the case of an eligible entity described in subsection (d)(1)(A)—

(i) 50 percent of the cost of the qualified electrification project for a household the annual income of which is not less than 80 percent and not greater than 150 percent of the area median income; and

(ii) 100 percent of the cost of the qualified electrification project for a household the annual income

of which is less than 80 percent of the area median income;

(B) in the case of an eligible entity described in subsection (d)(1)(B)—

(i) 50 percent of the cost of the qualified electrification project for a multifamily building not less than 50 percent of the residents of which are households the annual income of which is not less than 80 percent and not greater than 150 percent of the area median income; and

(ii) 100 percent of the cost of the qualified electrification project for a multifamily building not less than 50 percent of the residents of which are households the annual income of which is less than 80 percent of the area median income; or

(C) in the case of an eligible entity described in subsection (d)(1)(C)—

(i) 50 percent of the cost of the qualified electrification project for a household—

(I) on behalf of which the eligible entity is working; and

(II) the annual income of which is not less than 80 percent and not greater than 150 percent of the area median income; and

(ii) 100 percent of the cost of the qualified electrification project for a household—

(I) on behalf of which the eligible entity is working; and

(II) the annual income of which is less than 80 percent of the area median income.

(5) AMOUNT FOR INSTALLATION OF UPGRADES.—

(A) IN GENERAL.—In the case of an eligible entity described in subsection (d)(1)(C) that receives a rebate under the program and performs the installation of the applicable qualified electrification project, a State energy office or Indian Tribe shall provide to that eligible entity, in addition to the rebate, an amount that—

(i) does not exceed $500; and

(ii) is commensurate with the scale of the upgrades installed as part of the qualified electrification project, as determined by the Secretary. Determination.

(B) TREATMENT.—An amount received under subparagraph (A) by an eligible entity described in that subparagraph shall not be subject to the requirement under paragraph (6).

(6) REQUIREMENT.—An eligible entity described in subparagraph (C) of subsection (d)(1) shall discount the amount of a rebate received for a qualified electrification project from any amount charged by that eligible entity to the eligible entity described in subparagraph (A) or (B) of that subsection on behalf of which the qualified electrification project is carried out.

(7) EXEMPTION.—Activities carried out by a State energy office using a grant provided under the program shall not be subject to the expenditure prohibitions and limitations described in section 420.18 of title 10, Code of Federal Regulations.

(8) PROHIBITION ON COMBINING REBATES.—A rebate provided by a State energy office or Indian Tribe under a high-efficiency electric home rebate program may not be combined with any other Federal grant or rebate, including a rebate provided under a HOMES rebate program (as defined in section 50121(d)), for the same qualified electrification project.

(9) ADMINISTRATIVE COSTS.—A State energy office or Indian Tribe that receives a grant under the program shall use not more than 20 percent of the grant amount for planning, administration, or technical assistance relating to a high-efficiency electric home rebate program.

(d) DEFINITIONS.—In this section:

(1) ELIGIBLE ENTITY.—The term "eligible entity" means—

(A) a low- or moderate-income household;

(B) an individual or entity that owns a multifamily building not less than 50 percent of the residents of which are low- or moderate-income households; and

Determination.

(C) a governmental, commercial, or nonprofit entity, as determined by the Secretary, carrying out a qualified electrification project on behalf of an entity described in subparagraph (A) or (B).

(2) HIGH-EFFICIENCY ELECTRIC HOME REBATE PROGRAM.—The term "high-efficiency electric home rebate program" means a rebate program carried out by a State energy office or Indian Tribe pursuant to subsection (c) using a grant received under the program.

(3) INDIAN TRIBE.—The term "Indian Tribe" has the meaning given the term in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5304).

(4) LOW- OR MODERATE-INCOME HOUSEHOLD.—The term "low- or moderate-income household" means an individual or family the total annual income of which is less than 150 percent of the median income of the area in which the individual or family resides, as reported by the Department of Housing and Urban Development, including an individual or family that has demonstrated eligibility for another Federal program with income restrictions equal to or below 150 percent of area median income.

(5) PROGRAM.—The term "program" means the program carried out by the Secretary under subsection (a)(1).

(6) QUALIFIED ELECTRIFICATION PROJECT.—

(A) IN GENERAL.—The term "qualified electrification project" means a project that—

(i) includes the purchase and installation of—

(I) an electric heat pump water heater;

(II) an electric heat pump for space heating and cooling;

(III) an electric stove, cooktop, range, or oven;

(IV) an electric heat pump clothes dryer;

(V) an electric load service center;

(VI) insulation;

(VII) air sealing and materials to improve ventilation; or

(VIII) electric wiring;

(ii) with respect to any appliance described in clause (i), the purchase of which is carried out—

(I) as part of new construction;

(II) to replace a nonelectric appliance; or

(III) as a first-time purchase with respect to that appliance; and

(iii) is carried out at, or relating to, a single-family home or multifamily building, as applicable and defined by the Secretary.

(B) EXCLUSIONS.—The term "qualified electrification project" does not include any project with respect to which the appliance, system, equipment, infrastructure, component, or other item described in subclauses (I) through (VIII) of subparagraph (A)(i) is not certified under the Energy Star program established by section 324A of the Energy Policy and Conservation Act (42 U.S.C. 6294a), if applicable.

SEC. 50123. STATE-BASED HOME ENERGY EFFICIENCY CONTRACTOR TRAINING GRANTS.

42 USC 18795b.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $200,000,000, to remain available through September 30, 2031, to carry out a program to provide financial assistance to States to develop and implement a State program described in section 362(d)(13) of the Energy Policy and Conservation Act (42 U.S.C. 6322(d)(13)), which shall provide training and education to contractors involved in the installation of home energy efficiency and electrification improvements, including improvements eligible for rebates under a HOMES rebate program (as defined in section 50121(d)) or a high-efficiency electric home rebate program (as defined in section 50122(d)), as part of an approved State energy conservation plan under the State Energy Program.

(b) USE OF FUNDS.—A State may use amounts received under subsection (a)—

(1) to reduce the cost of training contractor employees;

(2) to provide testing and certification of contractors trained and educated under a State program developed and implemented pursuant to subsection (a); and

(3) to partner with nonprofit organizations to develop and implement a State program pursuant to subsection (a).

(c) ADMINISTRATIVE EXPENSES.—Of the amounts received by a State under subsection (a), a State shall use not more than 10 percent for administrative expenses associated with developing and implementing a State program pursuant to that subsection.

PART 3—BUILDING EFFICIENCY AND RESILIENCE

SEC. 50131. ASSISTANCE FOR LATEST AND ZERO BUILDING ENERGY CODE ADOPTION.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated—

(1) $330,000,000, to remain available through September 30, 2029, to carry out activities under part D of title III of the Energy Policy and Conservation Act (42 U.S.C. 6321 through 6326) in accordance with subsection (b); and

(2) $670,000,000, to remain available through September 30, 2029, to carry out activities under part D of title III of the Energy Policy and Conservation Act (42 U.S.C. 6321 through 6326) in accordance with subsection (c).

Grants.

(b) LATEST BUILDING ENERGY CODE.—The Secretary shall use funds made available under subsection (a)(1) for grants to assist States, and units of local government that have authority to adopt building codes—

(1) to adopt—

(A) a building energy code (or codes) for residential buildings that meets or exceeds the 2021 International Energy Conservation Code, or achieves equivalent or greater energy savings;

(B) a building energy code (or codes) for commercial buildings that meets or exceeds the ANSI/ASHRAE/IES Standard 90.1–2019, or achieves equivalent or greater energy savings; or

(C) any combination of building energy codes described in subparagraph (A) or (B); and

Plan.

(2) to implement a plan for the jurisdiction to achieve full compliance with any building energy code adopted under paragraph (1) in new and renovated residential or commercial buildings, as applicable, which plan shall include active training and enforcement programs and measurement of the rate of compliance each year.

Grants.

(c) ZERO ENERGY CODE.—The Secretary shall use funds made available under subsection (a)(2) for grants to assist States, and units of local government that have authority to adopt building codes—

(1) to adopt a building energy code (or codes) for residential and commercial buildings that meets or exceeds the zero energy provisions in the 2021 International Energy Conservation Code or an equivalent stretch code; and

Plan.

(2) to implement a plan for the jurisdiction to achieve full compliance with any building energy code adopted under paragraph (1) in new and renovated residential and commercial buildings, which plan shall include active training and enforcement programs and measurement of the rate of compliance each year.

(d) STATE MATCH.—The State cost share requirement under the item relating to "Department of Energy—Energy Conservation" in title II of the Department of the Interior and Related Agencies Appropriations Act, 1985 (42 U.S.C. 6323a; 98 Stat. 1861), shall not apply to assistance provided under this section.

(e) ADMINISTRATIVE COSTS.—Of the amounts made available under this section, the Secretary shall reserve not more than 5 percent for administrative costs necessary to carry out this section.

PART 4—DOE LOAN AND GRANT PROGRAMS

SEC. 50141. FUNDING FOR DEPARTMENT OF ENERGY LOAN PROGRAMS OFFICE.

(a) COMMITMENT AUTHORITY.—In addition to commitment authority otherwise available and previously provided, the Secretary may make commitments to guarantee loans for eligible projects under section 1703 of the Energy Policy Act of 2005 (42 U.S.C.

16513), up to a total principal amount of $40,000,000,000, to remain available through September 30, 2026.

(b) APPROPRIATION.—In addition to amounts otherwise available and previously provided, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $3,600,000,000, to remain available through September 30, 2026, for the costs of guarantees made under section 1703 of the Energy Policy Act of 2005 (42 U.S.C. 16513), using the loan guarantee authority provided under subsection (a) of this section.

(c) ADMINISTRATIVE EXPENSES.—Of the amount made available under subsection (b), the Secretary shall reserve not more than 3 percent for administrative expenses to carry out title XVII of the Energy Policy Act of 2005 and for carrying out section 1702(h)(3) of such Act (42 U.S.C. 16512(h)(3)).

(d) LIMITATIONS.—

President. Compliance.

(1) CERTIFICATION.—None of the amounts made available under this section for loan guarantees shall be available for any project unless the President has certified in advance in writing that the loan guarantee and the project comply with the provisions under this section.

(2) DENIAL OF DOUBLE BENEFIT.—Except as provided in paragraph (3), none of the amounts made available under this section for loan guarantees shall be available for commitments to guarantee loans for any projects under which funds, personnel, or property (tangible or intangible) of any Federal agency, instrumentality, personnel, or affiliated entity are expected to be used (directly or indirectly) through acquisitions, contracts, demonstrations, exchanges, grants, incentives, leases, procurements, sales, other transaction authority, or other arrangements to support the project or to obtain goods or services from the project.

(3) EXCEPTION.—Paragraph (2) shall not preclude the use of the loan guarantee authority provided under this section for commitments to guarantee loans for—

(A) projects benefitting from otherwise allowable Federal tax benefits;

(B) projects benefitting from being located on Federal land pursuant to a lease or right-of-way agreement for which all consideration for all uses is—

(i) paid exclusively in cash;

(ii) deposited in the Treasury as offsetting receipts; and

(iii) equal to the fair market value;

(C) projects benefitting from the Federal insurance program under section 170 of the Atomic Energy Act of 1954 (42 U.S.C. 2210); or

(D) electric generation projects using transmission facilities owned or operated by a Federal Power Marketing Administration or the Tennessee Valley Authority that have been authorized, approved, and financed independent of the project receiving the guarantee.

(e) GUARANTEE.—Section 1701(4)(A) of the Energy Policy Act of 2005 (42 U.S.C. 16511(4)(A)) is amended by inserting ", except that a loan guarantee may guarantee any debt obligation of a non-Federal borrower to any Eligible Lender (as defined in section

609.2 of title 10, Code of Federal Regulations)" before the period at the end.

(f) SOURCE OF PAYMENTS.—Section 1702(b) of the Energy Policy Act of 2005 (42 U.S.C. 16512(b)(2)) is amended by adding at the end the following:

"(3) SOURCE OF PAYMENTS.—The source of a payment received from a borrower under subparagraph (A) or (B) of paragraph (2) may not be a loan or other debt obligation that is made or guaranteed by the Federal Government.".

SEC. 50142. ADVANCED TECHNOLOGY VEHICLE MANUFACTURING.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $3,000,000,000, to remain available through September 30, 2028, for the costs of providing direct loans under section 136(d) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17013(d)): *Provided*, That funds appropriated by this section may be used for the costs of providing direct loans for reequipping, expanding, or establishing a manufacturing facility in the United States to produce, or for engineering integration performed in the United States of, advanced technology vehicles described in subparagraph (C), (D), (E), or (F) of section 136(a)(1) of such Act (42 U.S.C. 17013(a)(1)) only if such advanced technology vehicles emit, under any possible operational mode or condition, low or zero exhaust emissions of greenhouse gases.

(b) ADMINISTRATIVE COSTS.—The Secretary shall reserve not more than $25,000,000 of amounts made available under subsection (a) for administrative costs of providing loans as described in subsection (a).

(c) ELIMINATION OF LOAN PROGRAM CAP.—Section 136(d)(1) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17013(d)(1)) is amended by striking "a total of not more than $25,000,000,000 in".

SEC. 50143. DOMESTIC MANUFACTURING CONVERSION GRANTS.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $2,000,000,000, to remain available through September 30, 2031, to provide grants for domestic production of efficient hybrid, plug-in electric hybrid, plug-in electric drive, and hydrogen fuel cell electric vehicles, in accordance with section 712 of the Energy Policy Act of 2005 (42 U.S.C. 16062).

Requirement.

(b) COST SHARE.—The Secretary shall require a recipient of a grant provided under subsection (a) to provide not less than 50 percent of the cost of the project carried out using the grant.

(c) ADMINISTRATIVE COSTS.—The Secretary shall reserve not more than 3 percent of amounts made available under subsection (a) for administrative costs of making grants described in such subsection (a) pursuant to section 712 of the Energy Policy Act of 2005 (42 U.S.C. 16062).

SEC. 50144. ENERGY INFRASTRUCTURE REINVESTMENT FINANCING.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $5,000,000,000, to remain available through September 30, 2026,

to carry out activities under section 1706 of the Energy Policy Act of 2005.

(b) COMMITMENT AUTHORITY.—The Secretary may make, through September 30, 2026, commitments to guarantee loans for projects under section 1706 of the Energy Policy Act of 2005 the total principal amount of which is not greater than $250,000,000,000, subject to the limitations that apply to loan guarantees under section 50141(d). Time period. Applicability.

(c) ENERGY INFRASTRUCTURE REINVESTMENT FINANCING.—Title XVII of the Energy Policy Act of 2005 is amended by inserting after section 1705 (42 U.S.C. 16516) the following:

"SEC. 1706. ENERGY INFRASTRUCTURE REINVESTMENT FINANCING. 42 USC 16517.

"(a) IN GENERAL.—Notwithstanding section 1703, the Secretary may make guarantees, including refinancing, under this section only for projects that—

"(1) retool, repower, repurpose, or replace energy infrastructure that has ceased operations; or

"(2) enable operating energy infrastructure to avoid, reduce, utilize, or sequester air pollutants or anthropogenic emissions of greenhouse gases.

"(b) INCLUSION.—A project under subsection (a) may include the remediation of environmental damage associated with energy infrastructure.

"(c) REQUIREMENT.—A project under subsection (a)(1) that involves electricity generation through the use of fossil fuels shall be required to have controls or technologies to avoid, reduce, utilize, or sequester air pollutants and anthropogenic emissions of greenhouse gases.

"(d) APPLICATION.—To apply for a guarantee under this section, an applicant shall submit to the Secretary an application at such time, in such manner, and containing such information as the Secretary may require, including—

"(1) a detailed plan describing the proposed project; Plan.

"(2) an analysis of how the proposed project will engage with and affect associated communities; and Analysis.

"(3) in the case of an applicant that is an electric utility, an assurance that the electric utility shall pass on any financial benefit from the guarantee made under this section to the customers of, or associated communities served by, the electric utility.

"(e) TERM.—Notwithstanding section 1702(f), the term of an obligation shall require full repayment over a period not to exceed 30 years. Requirement. Time period.

"(f) DEFINITION OF ENERGY INFRASTRUCTURE.—In this section, the term 'energy infrastructure' means a facility, and associated equipment, used for—

"(1) the generation or transmission of electric energy; or

"(2) the production, processing, and delivery of fossil fuels, fuels derived from petroleum, or petrochemical feedstocks.".

(d) CONFORMING AMENDMENT.—Section 1702(o)(3) of the Energy Policy Act of 2005 (42 U.S.C. 16512(o)(3)) is amended by inserting "and projects described in section 1706(a)" before the period at the end.

SEC. 50145. TRIBAL ENERGY LOAN GUARANTEE PROGRAM.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022,

out of any money in the Treasury not otherwise appropriated, $75,000,000, to remain available through September 30, 2028, to carry out section 2602(c) of the Energy Policy Act of 1992 (25 U.S.C. 3502(c)), subject to the limitations that apply to loan guarantees under section 50141(d).

(b) DEPARTMENT OF ENERGY TRIBAL ENERGY LOAN GUARANTEE PROGRAM.—Section 2602(c) of the Energy Policy Act of 1992 (25 U.S.C. 3502(c)) is amended—

(1) in paragraph (1), by striking ") for an amount equal to not more than 90 percent of" and inserting ", except that a loan guarantee may guarantee any debt obligation of a non-Federal borrower to any Eligible Lender (as defined in section 609.2 of title 10, Code of Federal Regulations)) for"; and

(2) in paragraph (4), by striking "$2,000,000,000" and inserting "$20,000,000,000".

PART 5—ELECTRIC TRANSMISSION

42 USC 18715.

SEC. 50151. TRANSMISSION FACILITY FINANCING.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $2,000,000,000, to remain available through September 30, 2030, to carry out this section: *Provided*, That the Secretary shall not enter into any loan agreement pursuant to this section that could result in disbursements after September 30, 2031.

Determination.

(b) USE OF FUNDS.—The Secretary shall use the amounts made available by subsection (a) to carry out a program to pay the costs of direct loans to non-Federal borrowers, subject to the limitations that apply to loan guarantees under section 50141(d) and under such terms and conditions as the Secretary determines to be appropriate, for the construction or modification of electric transmission facilities designated by the Secretary to be necessary in the national interest under section 216(a) of the Federal Power Act (16 U.S.C. 824p(a)).

(c) LOANS.—A direct loan provided under this section—

(1) shall have a term that does not exceed the lesser of—

(A) 90 percent of the projected useful life, in years, of the eligible transmission facility; and

(B) 30 years;

(2) shall not exceed 80 percent of the project costs; and

(3) shall, on first issuance, be subject to the condition that the direct loan is not subordinate to other financing.

Determination.

(d) INTEREST RATES.—A direct loan provided under this section shall bear interest at a rate determined by the Secretary, taking into consideration market yields on outstanding marketable obligations of the United States of comparable maturities as of the date on which the direct loan is made.

(e) DEFINITION OF DIRECT LOAN.—In this section, the term "direct loan" has the meaning given the term in section 502 of the Federal Credit Reform Act of 1990 (2 U.S.C. 661a).

42 USC 18715a.

SEC. 50152. GRANTS TO FACILITATE THE SITING OF INTERSTATE ELECTRICITY TRANSMISSION LINES.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated,

$760,000,000, to remain available through September 30, 2029, for making grants in accordance with this section and for administrative expenses associated with carrying out this section.

(b) USE OF FUNDS.—

(1) IN GENERAL.—The Secretary may make a grant under this section to a siting authority for, with respect to a covered transmission project, any of the following activities:

(A) Studies and analyses of the impacts of the covered transmission project.

(B) Examination of up to 3 alternate siting corridors within which the covered transmission project feasibly could be sited.

(C) Participation by the siting authority in regulatory proceedings or negotiations in another jurisdiction, or under the auspices of a Transmission Organization (as defined in section 3 of the Federal Power Act (16 U.S.C. 796)) that is also considering the siting or permitting of the covered transmission project.

(D) Participation by the siting authority in regulatory proceedings at the Federal Energy Regulatory Commission or a State regulatory commission for determining applicable rates and cost allocation for the covered transmission project.

(E) Other measures and actions that may improve the chances of, and shorten the time required for, approval by the siting authority of the application relating to the siting or permitting of the covered transmission project, as the Secretary determines appropriate.

(2) ECONOMIC DEVELOPMENT.—The Secretary may make a grant under this section to a siting authority, or other State, local, or Tribal governmental entity, for economic development activities for communities that may be affected by the construction and operation of a covered transmission project, provided that the Secretary shall not enter into any grant agreement pursuant to this section that could result in any outlays after September 30, 2031.

(c) CONDITIONS.—

(1) FINAL DECISION ON APPLICATION.—In order to receive a grant for an activity described in subsection (b)(1), the Secretary shall require a siting authority to agree, in writing, to reach a final decision on the application relating to the siting or permitting of the applicable covered transmission project not later than 2 years after the date on which such grant is provided, unless the Secretary authorizes an extension for good cause. Requirement. Deadline.

(2) FEDERAL SHARE.—The Federal share of the cost of an activity described in subparagraph (C) or (D) of subsection (b)(1) shall not exceed 50 percent.

(3) ECONOMIC DEVELOPMENT.—The Secretary may only disburse grant funds for economic development activities under subsection (b)(2)— Disbursement.

(A) to a siting authority upon approval by the siting authority of the applicable covered transmission project; and

(B) to any other State, local, or Tribal governmental entity upon commencement of construction of the applicable

covered transmission project in the area under the jurisdiction of the entity.

Deadline.

(d) RETURNING FUNDS.—If a siting authority that receives a grant for an activity described in subsection (b)(1) fails to use all grant funds within 2 years of receipt, the siting authority shall return to the Secretary any such unused funds.

(e) DEFINITIONS.—In this section:

(1) COVERED TRANSMISSION PROJECT.—The term "covered transmission project" means a high-voltage interstate or offshore electricity transmission line—

(A) that is proposed to be constructed and to operate—

(i) at a minimum of 275 kilovolts of either alternating-current or direct-current electric energy by an entity; or

(ii) offshore and at a minimum of 200 kilovolts of either alternating-current or direct-current electric energy by an entity; and

(B) for which such entity has applied, or informed a siting authority of such entity's intent to apply, for regulatory approval.

(2) SITING AUTHORITY.—The term "siting authority" means a State, local, or Tribal governmental entity with authority to make a final determination regarding the siting, permitting, or regulatory status of a covered transmission project that is proposed to be located in an area under the jurisdiction of the entity.

42 USC 18715b.

SEC. 50153. INTERREGIONAL AND OFFSHORE WIND ELECTRICITY TRANSMISSION PLANNING, MODELING, AND ANALYSIS.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available through September 30, 2031, to carry out this section.

(b) USE OF FUNDS.—The Secretary shall use amounts made available under subsection (a)—

(1) to pay expenses associated with convening relevant stakeholders to address the development of interregional electricity transmission and transmission of electricity that is generated by offshore wind; and

Determination.

(2) to conduct planning, modeling, and analysis regarding interregional electricity transmission and transmission of electricity that is generated by offshore wind, taking into account the local, regional, and national economic, reliability, resilience, security, public policy, and environmental benefits of interregional electricity transmission and transmission of electricity that is generated by offshore wind, including planning, modeling, and analysis, as the Secretary determines appropriate, pertaining to—

(A) clean energy integration into the electric grid, including the identification of renewable energy zones;

(B) the effects of changes in weather due to climate change on the reliability and resilience of the electric grid;

(C) cost allocation methodologies that facilitate the expansion of the bulk power system;

(D) the benefits of coordination between generator interconnection processes and transmission planning processes;

(E) the effect of increased electrification on the electric grid;

(F) power flow modeling;

(G) the benefits of increased interconnections or interties between or among the Western Interconnection, the Eastern Interconnection, the Electric Reliability Council of Texas, and other interconnections, as applicable;

(H) the cooptimization of transmission and generation, including variable energy resources, energy storage, and demand-side management;

(I) the opportunities for use of nontransmission alternatives, energy storage, and grid-enhancing technologies;

(J) economic development opportunities for communities arising from development of interregional electricity transmission and transmission of electricity that is generated by offshore wind;

(K) evaluation of existing rights-of-way and the need for additional transmission corridors; and

(L) a planned national transmission grid, which would include a networked transmission system to optimize the existing grid for interconnection of offshore wind farms.

PART 6—INDUSTRIAL

SEC. 50161. ADVANCED INDUSTRIAL FACILITIES DEPLOYMENT PROGRAM. 42 USC 17113a.

(a) OFFICE OF CLEAN ENERGY DEMONSTRATIONS.—In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Office of Clean Energy Demonstrations, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $5,812,000,000, to remain available through September 30, 2026, to carry out this section.

(b) FINANCIAL ASSISTANCE.—The Secretary shall use funds appropriated by subsection (a) to provide financial assistance, on a competitive basis, to eligible entities to carry out projects for—

(1) the purchase and installation, or implementation, of advanced industrial technology at an eligible facility;

(2) retrofits, upgrades to, or operational improvements at an eligible facility to install or implement advanced industrial technology; or

(3) engineering studies and other work needed to prepare an eligible facility for activities described in paragraph (1) or (2).

(c) APPLICATION.—To be eligible to receive financial assistance under subsection (b), an eligible entity shall submit to the Secretary an application at such time, in such manner, and containing such information as the Secretary may require, including the expected greenhouse gas emissions reductions to be achieved by carrying out the project.

(d) PRIORITY.—In providing financial assistance under subsection (b), the Secretary shall give priority consideration to projects on the basis of, as determined by the Secretary— Determination.

(1) the expected greenhouse gas emissions reductions to be achieved by carrying out the project;

(2) the extent to which the project would provide the greatest benefit for the greatest number of people within the area in which the eligible facility is located; and

(3) whether the eligible entity participates or would participate in a partnership with purchasers of the output of the eligible facility.

Requirement.

(e) COST SHARE.—The Secretary shall require an eligible entity to provide not less than 50 percent of the cost of a project carried out pursuant to this section.

(f) ADMINISTRATIVE COSTS.—The Secretary shall reserve not more than $300,000,000 of amounts made available under subsection (a) for administrative costs of carrying out this section.

(g) DEFINITIONS.—In this section:

Determination.

(1) ADVANCED INDUSTRIAL TECHNOLOGY.—The term "advanced industrial technology" means a technology directly involved in an industrial process, as described in any of paragraphs (1) through (6) of section 454(c) of the Energy Independence and Security Act of 2007 (42 U.S.C. 17113(c)), and designed to accelerate greenhouse gas emissions reduction progress to net-zero at an eligible facility, as determined by the Secretary.

(2) ELIGIBLE ENTITY.—The term "eligible entity" means the owner or operator of an eligible facility.

(3) ELIGIBLE FACILITY.—The term "eligible facility" means a domestic, non-Federal, nonpower industrial or manufacturing facility engaged in energy-intensive industrial processes, including production processes for iron, steel, steel mill products, aluminum, cement, concrete, glass, pulp, paper, industrial ceramics, chemicals, and other energy intensive industrial processes, as determined by the Secretary.

(4) FINANCIAL ASSISTANCE.—The term "financial assistance" means a grant, rebate, direct loan, or cooperative agreement.

PART 7—OTHER ENERGY MATTERS

SEC. 50171. DEPARTMENT OF ENERGY OVERSIGHT.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $20,000,000, to remain available through September 30, 2031, for oversight by the Department of Energy Office of Inspector General of the Department of Energy activities for which funding is appropriated in this subtitle.

SEC. 50172. NATIONAL LABORATORY INFRASTRUCTURE.

(a) OFFICE OF SCIENCE.—In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Director of the Office of Science, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available through September 30, 2027—

(1) $133,240,000 to carry out activities for science laboratory infrastructure projects;

(2) $303,656,000 to carry out activities for high energy physics construction and major items of equipment projects;

(3) $280,000,000 to carry out activities for fusion energy science construction and major items of equipment projects;

(4) $217,000,000 to carry out activities for nuclear physics construction and major items of equipment projects;

(5) $163,791,000 to carry out activities for advanced scientific computing research facilities;

(6) $294,500,000 to carry out activities for basic energy sciences projects; and

(7) $157,813,000 to carry out activities for isotope research and development facilities.

(b) OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $150,000,000, to remain available through September 30, 2027, to carry out activities for infrastructure and general plant projects carried out by the Office of Fossil Energy and Carbon Management.

(c) OFFICE OF NUCLEAR ENERGY.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $150,000,000, to remain available through September 30, 2027, to carry out activities for infrastructure and general plant projects carried out by the Office of Nuclear Energy.

(d) OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY.—In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $150,000,000, to remain available through September 30, 2027, to carry out activities for infrastructure and general plant projects carried out by the Office of Energy Efficiency and Renewable Energy.

SEC. 50173. AVAILABILITY OF HIGH-ASSAY LOW-ENRICHED URANIUM.

(a) APPROPRIATIONS.—In addition to amounts otherwise available, there is appropriated to the Secretary of for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available through September 30, 2026—

(1) $100,000,000 to carry out the program elements described in subparagraphs (A) through (C) of section 2001(a)(2) of the Energy Act of 2020 (42 U.S.C. 16281(a)(2));

(2) $500,000,000 to carry out the program elements described in subparagraphs (D) through (H) of that section; and

(3) $100,000,000 to carry out activities to support the availability of high-assay low-enriched uranium for civilian domestic research, development, demonstration, and commercial use under section 2001 of the Energy Act of 2020 (42 U.S.C. 16281).

(b) COMPETITIVE PROCEDURES.—To the maximum extent practicable, the Department of Energy shall, in a manner consistent with section 989 of the Energy Policy Act of 2005 (42 U.S.C. 16353), use a competitive, merit-based review process in carrying out research, development, demonstration, and deployment activities under section 2001 of the Energy Act of 2020 (42 U.S.C. 16281).

(c) ADMINISTRATIVE EXPENSES.—The Secretary may use not more than 3 percent of the amounts appropriated by subsection (a) for administrative purposes.

Subtitle B—Natural Resources

PART 1—GENERAL PROVISIONS

43 USC 3006 note.

SEC. 50211. DEFINITIONS.

In this subtitle:

(1) SECRETARY.—The term "Secretary" means the Secretary of the Interior.

(2) UNITED STATES INSULAR AREAS.—The term "United States Insular Areas" means American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, the Commonwealth of Puerto Rico, and the United States Virgin Islands.

PART 2—PUBLIC LANDS

SEC. 50221. NATIONAL PARKS AND PUBLIC LANDS CONSERVATION AND RESILIENCE.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $250,000,000, to remain available through September 30, 2031, to carry out projects for the conservation, protection, and resiliency of lands and resources administered by the National Park Service and Bureau of Land Management. None of the funds provided under this section shall be subject to cost-share or matching requirements.

SEC. 50222. NATIONAL PARKS AND PUBLIC LANDS CONSERVATION AND ECOSYSTEM RESTORATION.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $250,000,000, to remain available through September 30, 2031, to carry out conservation, ecosystem and habitat restoration projects on lands administered by the National Park Service and Bureau of Land Management. None of the funds provided under this section shall be subject to cost-share or matching requirements.

SEC. 50223. NATIONAL PARK SERVICE EMPLOYEES.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $500,000,000, to remain available through September 30, 2030, to hire employees to serve in units of the National Park System or national historic or national scenic trails administered by the National Park Service.

SEC. 50224. NATIONAL PARK SYSTEM DEFERRED MAINTENANCE.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $200,000,000, to remain available through September 30, 2026, to carry out priority deferred maintenance projects, through direct expenditures or transfers, within the boundaries of the National Park System.

PART 3—DROUGHT RESPONSE AND PREPAREDNESS

SEC. 50231. BUREAU OF RECLAMATION DOMESTIC WATER SUPPLY PROJECTS.

In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Commissioner of Reclamation, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $550,000,000, to remain available through September 30, 2031, for grants, contracts, or financial assistance agreements for disadvantaged communities (identified according to criteria adopted by the Commissioner of Reclamation) in a manner as determined by the Commissioner of Reclamation for up to 100 percent of the cost of the planning, design, or construction of water projects the primary purpose of which is to provide domestic water supplies to communities or households that do not have reliable access to domestic water supplies in a State or territory described in the first section of the Act of June 17, 1902 (43 U.S.C. 391; 32 Stat. 388, chapter 1093).

SEC. 50232. CANAL IMPROVEMENT PROJECTS.

In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Commissioner of Reclamation, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $25,000,000, to remain available through September 30, 2031, for the design, study, and implementation of projects (including pilot and demonstration projects) to cover water conveyance facilities with solar panels to generate renewable energy in a manner as determined by the Secretary or for other solar projects associated with Bureau of Reclamation projects that increase water efficiency and assist in implementation of clean energy goals.

SEC. 50233. DROUGHT MITIGATION IN THE RECLAMATION STATES.

(a) DEFINITION OF RECLAMATION STATE.—In this section, the term "Reclamation State" means a State or territory described in the first section of the Act of June 17, 1902 (32 Stat. 388, chapter 1093; 43 U.S.C. 391).

(b) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Secretary (acting through the Commissioner of Reclamation), for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $4,000,000,000, to remain available through September 30, 2026, for grants, contracts, or financial assistance agreements, in accordance with the reclamation laws, to or with public entities and Indian Tribes, that provide for the conduct of the following activities to mitigate the impacts of drought in the Reclamation States, with priority given to the Colorado River Basin and other basins experiencing comparable levels of long-term drought, to be implemented in compliance with applicable environmental law:

(1) Compensation for a temporary or multiyear voluntary reduction in diversion of water or consumptive water use.

(2) Voluntary system conservation projects that achieve verifiable reductions in use of or demand for water supplies or provide environmental benefits in the Lower Basin or Upper Basin of the Colorado River.

(3) Ecosystem and habitat restoration projects to address issues directly caused by drought in a river basin or inland water body.

(c) REPORT.—Not later than 1 year after the date of enactment of this Act, and each year thereafter, the Secretary shall submit to Congress a report that describes any expenditures under this section.

PART 4—INSULAR AFFAIRS

SEC. 50241. OFFICE OF INSULAR AFFAIRS CLIMATE CHANGE TECHNICAL ASSISTANCE.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Office of Insular Affairs, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $15,000,000, to remain available through September 30, 2026, to provide technical assistance for climate change planning, mitigation, adaptation, and resilience to United States Insular Areas.

(b) ADMINISTRATIVE EXPENSES.—In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Office of Insular Affairs, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $900,000, to remain available through September 30, 2026, for necessary administrative expenses associated with carrying out this section.

PART 5—OFFSHORE WIND

SEC. 50251. LEASING ON THE OUTER CONTINENTAL SHELF.

(a) LEASING AUTHORIZED.—The Secretary may grant leases, easements, and rights-of-way pursuant to section 8(p)(1)(C) of the Outer Continental Shelf Lands Act (43 U.S.C. 1337(p)(1)(C)) in an area withdrawn by—

(1) the Presidential memorandum entitled "Memorandum on the Withdrawal of Certain Areas of the United States Outer Continental Shelf from Leasing Disposition" and dated September 8, 2020; or

(2) the Presidential memorandum entitled "Presidential Determination on the Withdrawal of Certain Areas of the United States Outer Continental Shelf from Leasing Disposition" and dated September 25, 2020.

(b) OFFSHORE WIND FOR THE TERRITORIES.—

(1) APPLICATION OF OUTER CONTINENTAL SHELF LANDS ACT WITH RESPECT TO TERRITORIES OF THE UNITED STATES.—

(A) IN GENERAL.—Section 2 of the Outer Continental Shelf Lands Act (43 U.S.C. 1331) is amended—

(i) in subsection (a)—

(I) by striking "means all" and inserting the following: "means—

"(1) all"; and

(II) in paragraph (1) (as so designated), by striking "control;" and inserting the following: "control or within the exclusive economic zone of the United States and adjacent to any territory of the United States; and"; and

(III) by adding at the end following:

"(2) does not include any area conveyed by Congress to a territorial government for administration;";

(ii) in subsection (p), by striking "and" after the semicolon at the end;

(iii) in subsection (q), by striking the period at the end and inserting "; and"; and

(iv) by adding at the end the following:

"(r) The term 'State' means—

"(1) each of the several States;

"(2) the Commonwealth of Puerto Rico;

"(3) Guam;

"(4) American Samoa;

"(5) the United States Virgin Islands; and

"(6) the Commonwealth of the Northern Mariana Islands.".

(B) EXCLUSIONS.—Section 18 of the Outer Continental Shelf Lands Act (43 U.S.C. 1344) is amended by adding at the end the following:

"(i) APPLICATION.—This section shall not apply to the scheduling of any lease sale in an area of the outer Continental Shelf that is adjacent to the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, or the Commonwealth of the Northern Mariana Islands.".

(2) WIND LEASE SALES FOR AREAS OF THE OUTER CONTINENTAL SHELF.—The Outer Continental Shelf Lands Act (43 U.S.C. 1331 et seq.) is amended by adding at the end the following:

"SEC. 33. WIND LEASE SALES FOR AREAS OF THE OUTER CONTINENTAL SHELF OFFSHORE OF TERRITORIES OF THE UNITED STATES. 43 USC 1356c.

"(a) WIND LEASE SALES OFF COASTS OF TERRITORIES OF THE UNITED STATES.—

"(1) CALL FOR INFORMATION AND NOMINATIONS.—

"(A) IN GENERAL.—The Secretary shall issue calls for information and nominations for proposed wind lease sales for areas of the outer Continental Shelf described in paragraph (2) that are determined to be feasible.

"(B) INITIAL CALL.—Not later than September 30, 2025, the Secretary shall issue an initial call for information and nominations under this paragraph. Deadline.

"(2) CONDITIONAL WIND LEASE SALES.—The Secretary may conduct wind lease sales in each area within the exclusive economic zone of the United States adjacent to the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, or the Commonwealth of the Northern Mariana Islands that meets each of the following criteria:

"(A) The Secretary has concluded that a wind lease sale in the area is feasible.

"(B) The Secretary has determined that there is sufficient interest in leasing the area. Determination.

"(C) The Secretary has consulted with the Governor of the territory regarding the suitability of the area for wind energy development.".

PART 6—FOSSIL FUEL RESOURCES

Time period. Effective date.

SEC. 50261. OFFSHORE OIL AND GAS ROYALTY RATE.

Section 8(a)(1) of the Outer Continental Shelf Lands Act (43 U.S.C. 1337(a)(1)) is amended—

(1) in each of subparagraphs (A) and (C), by striking "not less than 12½ per centum" each place it appears and inserting "not less than 16⅔ percent, but not more than 18¾ percent, during the 10-year period beginning on the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14', and not less than 16⅔ percent thereafter,";

(2) in subparagraph (F), by striking "no less than 12½ per centum" and inserting "not less than 16⅔ percent, but not more than 18¾ percent, during the 10-year period beginning on the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14', and not less than 16⅔ percent thereafter,"; and

(3) in subparagraph (H), by striking "no less than 12 and ½ per centum" and inserting "not less than 16⅔ percent, but not more than 18¾ percent, during the 10-year period beginning on the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14', and not less than 16⅔ percent thereafter,".

Time periods. Effective dates.

SEC. 50262. MINERAL LEASING ACT MODERNIZATION.

(a) ONSHORE OIL AND GAS ROYALTY RATES.—

(1) LEASE OF OIL AND GAS LAND.—Section 17 of the Mineral Leasing Act (30 U.S.C. 226) is amended—

(A) in subsection (b)(1)(A), in the fifth sentence—

(i) by striking "12.5" and inserting "16⅔"; and

(ii) by inserting "or, in the case of a lease issued during the 10-year period beginning on the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14', 16⅔ percent in amount or value of the production removed or sold from the lease" before the period at the end; and

(B) by striking "12½ per centum" each place it appears and inserting "16⅔ percent".

(2) CONDITIONS FOR REINSTATEMENT.—Section 31(e)(3) of the Mineral Leasing Act (30 U.S.C. 188(e)(3)) is amended by striking "16⅔" each place it appears and inserting "20".

(b) OIL AND GAS MINIMUM BID.—Section 17(b) of the Mineral Leasing Act (30 U.S.C. 226(b)) is amended—

(1) in paragraph (1)(B), in the first sentence, by striking "$2 per acre for a period of 2 years from the date of enactment of the Federal Onshore Oil and Gas Leasing Reform Act of 1987." and inserting "$10 per acre during the 10-year period beginning on the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14'."; and

(2) in paragraph (2)(C), by striking "$2 per acre" and inserting "$10 per acre".

(c) FOSSIL FUEL RENTAL RATES.—

(1) ANNUAL RENTALS.—Section 17(d) of the Mineral Leasing Act (30 U.S.C. 226(d)) is amended, in the first sentence, by

striking "$1.50 per acre" and all that follows through the period at the end and inserting "$3 per acre per year during the 2-year period beginning on the date the lease begins for new leases, and after the end of that 2-year period, $5 per acre per year for the following 6-year period, and not less than $15 per acre per year thereafter, or, in the case of a lease issued during the 10-year period beginning on the date of enactment of the Act titled 'An Act to provide for reconciliation pursuant to title II of S. Con. Res. 14', $3 per acre per year during the 2-year period beginning on the date the lease begins, and after the end of that 2-year period, $5 per acre per year for the following 6-year period, and $15 per acre per year thereafter.".

(2) RENTALS IN REINSTATED LEASES.—Section 31(e)(2) of the Mineral Leasing Act (30 U.S.C. 188(e)(2)) is amended by striking "$10" and inserting "$20".

(d) EXPRESSION OF INTEREST FEE.—Section 17 of the Mineral Leasing Act (30 U.S.C. 226) is amended by adding at the end the following:

"(q) FEE FOR EXPRESSION OF INTEREST.—

"(1) IN GENERAL.—The Secretary shall assess a nonrefundable fee against any person that, in accordance with procedures established by the Secretary to carry out this subsection, submits an expression of interest in leasing land available for disposition under this section for exploration for, and development of, oil or gas. Assessment.

"(2) AMOUNT OF FEE.—

"(A) IN GENERAL.—Subject to subparagraph (B), the fee assessed under paragraph (1) shall be $5 per acre of the area covered by the applicable expression of interest.

"(B) ADJUSTMENT OF FEE.—The Secretary shall, by regulation, not less frequently than every 4 years, adjust the amount of the fee under subparagraph (A) to reflect the change in inflation.". Regulation.

(e) ELIMINATION OF NONCOMPETITIVE LEASING.—

(1) IN GENERAL.—Section 17 of the Mineral Leasing Act (30 U.S.C. 226) is amended—

(A) in subsection (b)—

(i) in paragraph (1)(A)—

(I) in the first sentence, by striking "paragraphs (2) and (3) of this subsection" and inserting "paragraph (2)"; and

(II) by striking the last sentence; and

(ii) by striking paragraph (3);

(B) by striking subsection (c) and inserting the following:

"(c) ADDITIONAL ROUNDS OF COMPETITIVE BIDDING.—Land made available for leasing under subsection (b)(1) for which no bid is accepted or received, or the land for which a lease terminates, expires, is cancelled, or is relinquished, may be made available by the Secretary of the Interior for a new round of competitive bidding under that subsection."; and

(C) by striking subsection (e) and inserting the following:

"(e) TERM OF LEASE.—

"(1) IN GENERAL.—Any lease issued under this section, including a lease for tar sand areas, shall be for a primary term of 10 years.

"(2) CONTINUATION OF LEASE.—A lease described in paragraph (1) shall continue after the primary term of the lease for any period during which oil or gas is produced in paying quantities.

"(3) ADDITIONAL EXTENSIONS.—Any lease issued under this section for land on which, or for which under an approved cooperative or unit plan of development or operation, actual drilling operations were commenced and diligently prosecuted prior to the end of the primary term of the lease shall be extended for 2 years and for any period thereafter during which oil or gas is produced in paying quantities.".

(2) CONFORMING AMENDMENTS.—Section 31 of the Mineral Leasing Act (30 U.S.C. 188) is amended—

(A) in subsection (d)(1), in the first sentence, by striking "or section 17(c) of this Act";

(B) in subsection (e)—

(i) in paragraph (2)—

(I) by striking "either"; and

(II) by striking "or the inclusion" and all that follows through ", all"; and

(ii) in paragraph (3)—

(I) in subparagraph (A), by adding "and" after the semicolon;

(II) by striking subparagraph (B); and

(III) by striking "(3)(A) payment" and inserting the following:

"(3) payment";

(C) in subsection (g)—

(i) in paragraph (1), by striking "as a competitive" and all that follows through "of this Act" and inserting "in the same manner as the original lease issued pursuant to section 17";

(ii) by striking paragraph (2);

(iii) by redesignating paragraphs (3) and (4) as paragraphs (2) and (3), respectively; and

(iv) in paragraph (2) (as so redesignated), by striking "applicable to leases issued under subsection 17(c) of this Act (30 U.S.C. 226(c)) except," and inserting "except";

(D) in subsection (h), by striking "subsections (d) and (f) of this section" and inserting "subsection (d)";

(E) in subsection (i), by striking "(i)(1) In acting" and all that follows through "of this section" in paragraph (2) and inserting the following:

"(i) ROYALTY REDUCTION IN REINSTATED LEASES.—In acting on a petition for reinstatement pursuant to subsection (d)";

(F) by striking subsection (f); and

(G) by redesignating subsections (g) through (j) as subsections (f) through (i), respectively.

30 USC 1727.

SEC. 50263. ROYALTIES ON ALL EXTRACTED METHANE.

(a) IN GENERAL.—For all leases issued after the date of enactment of this Act, except as provided in subsection (b), royalties

paid for gas produced from Federal land and on the outer Continental Shelf shall be assessed on all gas produced, including all gas that is consumed or lost by venting, flaring, or negligent releases through any equipment during upstream operations.

(b) EXCEPTION.—Subsection (a) shall not apply with respect to—

(1) gas vented or flared for not longer than 48 hours in an emergency situation that poses a danger to human health, safety, or the environment; Time period.

(2) gas used or consumed within the area of the lease, unit, or communitized area for the benefit of the lease, unit, or communitized area; or

(3) gas that is unavoidably lost.

SEC. 50264. LEASE SALES UNDER THE 2017–2022 OUTER CONTINENTAL SHELF LEASING PROGRAM. Deadlines.

(a) DEFINITIONS.—In this section:

(1) LEASE SALE 257.—The term "Lease Sale 257" means the lease sale numbered 257 that was approved in the Record of Decision described in the notice of availability of a record of decision issued on August 31, 2021, entitled "Gulf of Mexico, Outer Continental Shelf (OCS), Oil and Gas Lease Sale 257" (86 Fed. Reg. 50160 (September 7, 2021)), and is the subject of the final notice of sale entitled "Gulf of Mexico Outer Continental Shelf Oil and Gas Lease Sale 257" (86 Fed. Reg. 54728 (October 4, 2021)).

(2) LEASE SALE 258.—The term "Lease Sale 258" means the lease sale numbered 258 described in the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Proposed Final Program published on November 18, 2016, and approved by the Secretary in the Record of Decision issued on January 17, 2017, described in the notice of availability entitled "Record of Decision for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program Final Programmatic Environmental Impact Statement; MMAA104000" (82 Fed. Reg. 6643 (January 19, 2017)).

(3) LEASE SALE 259.—The term "Lease Sale 259" means the lease sale numbered 259 described in the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Proposed Final Program published on November 18, 2016, and approved by the Secretary in the Record of Decision issued on January 17, 2017, described in the notice of availability entitled "Record of Decision for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program Final Programmatic Environmental Impact Statement; MMAA104000" (82 Fed. Reg. 6643 (January 19, 2017)).

(4) LEASE SALE 261.—The term "Lease Sale 261" means the lease sale numbered 261 described in the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Proposed Final Program published on November 18, 2016, and approved by the Secretary in the Record of Decision issued on January 17, 2017, described in the notice of availability entitled "Record of Decision for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program Final Programmatic Environmental Impact Statement; MMAA104000" (82 Fed. Reg. 6643 (January 19, 2017)).

(b) LEASE SALE 257 REINSTATEMENT.—

(1) ACCEPTANCE OF BIDS.—Not later 30 days after the date of enactment of this Act, the Secretary shall, without modification or delay—

(A) accept the highest valid bid for each tract or bidding unit of Lease Sale 257 for which a valid bid was received on November 17, 2021; and

(B) provide the appropriate lease form to the winning bidder to execute and return.

(2) LEASE ISSUANCE.—On receipt of an executed lease form under paragraph (1)(B) and payment of the rental for the first year, the balance of the bonus bid (unless deferred), and any required bond or security from the high bidder, the Secretary shall promptly issue to the high bidder a fully executed lease, in accordance with—

(A) the regulations in effect on the date of Lease Sale 257; and

(B) the terms and conditions of the final notice of sale entitled "Gulf of Mexico Outer Continental Shelf Oil and Gas Lease Sale 257" (86 Fed. Reg. 54728 (October 4, 2021)).

(c) REQUIREMENT FOR LEASE SALE 258.—Notwithstanding the expiration of the 2017–2022 leasing program, not later than December 31, 2022, the Secretary shall conduct Lease Sale 258 in accordance with the Record of Decision approved by the Secretary on January 17, 2017, described in the notice of availability entitled "Record of Decision for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program Final Programmatic Environmental Impact Statement; MMAA104000" issued on January 17, 2017 (82 Fed. Reg. 6643 (January 19, 2017)).

(d) REQUIREMENT FOR LEASE SALE 259.—Notwithstanding the expiration of the 2017–2022 leasing program, not later than March 31, 2023, the Secretary shall conduct Lease Sale 259 in accordance with the Record of Decision approved by the Secretary on January 17, 2017, described in the notice of availability entitled "Record of Decision for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program Final Programmatic Environmental Impact Statement; MMAA104000" issued on January 17, 2017 (82 Fed. Reg. 6643 (January 19, 2017)).

(e) REQUIREMENT FOR LEASE SALE 261.—Notwithstanding the expiration of the 2017–2022 leasing program, not later than September 30, 2023, the Secretary shall conduct Lease Sale 261 in accordance with the Record of Decision approved by the Secretary on January 17, 2017, described in the notice of availability entitled "Record of Decision for the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Program Final Programmatic Environmental Impact Statement; MMAA104000" issued on January 17, 2017 (82 Fed. Reg. 6643 (January 19, 2017)).

43 USC 3006.

SEC. 50265. ENSURING ENERGY SECURITY.

(a) DEFINITIONS.—In this section:

(1) FEDERAL LAND.—The term "Federal land" means public lands (as defined in section 103 of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1702)).

(2) OFFSHORE LEASE SALE.—The term "offshore lease sale" means an oil and gas lease sale—

(A) that is held by the Secretary in accordance with the Outer Continental Shelf Lands Act (43 U.S.C. 1331 et seq.); and

(B) that, if any acceptable bids have been received for any tract offered in the lease sale, results in the issuance of a lease.

(3) ONSHORE LEASE SALE.—The term "onshore lease sale" means a quarterly oil and gas lease sale—

(A) that is held by the Secretary in accordance with section 17 of the Mineral Leasing Act (30 U.S.C. 226); and

(B) that, if any acceptable bids have been received for any parcel offered in the lease sale, results in the issuance of a lease.

(b) LIMITATION ON ISSUANCE OF CERTAIN LEASES OR RIGHTS-OF-WAY.—During the 10-year period beginning on the date of enactment of this Act— Time periods. Effective dates.

(1) the Secretary may not issue a right-of-way for wind or solar energy development on Federal land unless—

(A) an onshore lease sale has been held during the 120-day period ending on the date of the issuance of the right-of-way for wind or solar energy development; and

(B) the sum total of acres offered for lease in onshore lease sales during the 1-year period ending on the date of the issuance of the right-of-way for wind or solar energy development is not less than the lesser of—

(i) 2,000,000 acres; and

(ii) 50 percent of the acreage for which expressions of interest have been submitted for lease sales during that period; and

(2) the Secretary may not issue a lease for offshore wind development under section 8(p)(1)(C) of the Outer Continental Shelf Lands Act (43 U.S.C. 1337(p)(1)(C)) unless—

(A) an offshore lease sale has been held during the 1-year period ending on the date of the issuance of the lease for offshore wind development; and

(B) the sum total of acres offered for lease in offshore lease sales during the 1-year period ending on the date of the issuance of the lease for offshore wind development is not less than 60,000,000 acres.

(c) SAVINGS.—Except as expressly provided in paragraphs (1) and (2) of subsection (b), nothing in this section supersedes, amends, or modifies existing law.

PART 7—UNITED STATES GEOLOGICAL SURVEY

SEC. 50271. UNITED STATES GEOLOGICAL SURVEY 3D ELEVATION PROGRAM.

In addition to amounts otherwise available, there is appropriated to the Secretary, acting through the Director of the United States Geological Survey, for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $23,500,000, to remain available through September 30, 2031, to produce, collect, disseminate, and use 3D elevation data.

PART 8—OTHER NATURAL RESOURCES MATTERS

SEC. 50281. DEPARTMENT OF THE INTERIOR OVERSIGHT.

In addition to amounts otherwise available, there is appropriated to the Secretary for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $10,000,000, to remain available through September 30, 2031, for oversight by the Department of the Interior Office of Inspector General of the Department of the Interior activities for which funding is appropriated in this subtitle.

Subtitle C—Environmental Reviews

SEC. 50301. DEPARTMENT OF ENERGY.

In addition to amounts otherwise available, there is appropriated to the Secretary of Energy for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $115,000,000, to remain available through September 30, 2031, to provide for the hiring and training of personnel, the development of programmatic environmental documents, the procurement of technical or scientific services for environmental reviews, the development of environmental data or information systems, stakeholder and community engagement, and the purchase of new equipment for environmental analysis to facilitate timely and efficient environmental reviews and authorizations.

SEC. 50302. FEDERAL ENERGY REGULATORY COMMISSION.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Federal Energy Regulatory Commission for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available through September 30, 2031, to provide for the hiring and training of personnel, the development of programmatic environmental documents, the procurement of technical or scientific services for environmental reviews, the development of environmental data or information systems, stakeholder and community engagement, and the purchase of new equipment for environmental analysis to facilitate timely and efficient environmental reviews and authorizations.

(b) FEES AND CHARGES.—Section 3401(a) of the Omnibus Budget Reconciliation Act of 1986 (42 U.S.C. 7178(a)) shall not apply to the costs incurred by the Federal Energy Regulatory Commission in carrying out this section.

SEC. 50303. DEPARTMENT OF THE INTERIOR.

In addition to amounts otherwise available, there is appropriated to the Secretary of the Interior for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $150,000,000, to remain available through September 30, 2026, to provide for the hiring and training of personnel, the development of programmatic environmental documents, the procurement of technical or scientific services for environmental reviews, the development of environmental data or information systems, stakeholder and community engagement, and the purchase of new equipment for environmental analysis to facilitate timely and efficient environmental reviews and authorizations by the National Park

Service, the Bureau of Land Management, the Bureau of Ocean Energy Management, the Bureau of Reclamation, the Bureau of Safety and Environmental Enforcement, and the Office of Surface Mining Reclamation and Enforcement.

TITLE VI—COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

Subtitle A—Air Pollution

SEC. 60101. CLEAN HEAVY-DUTY VEHICLES.

The Clean Air Act is amended by inserting after section 131 of such Act (42 U.S.C. 7431) the following:

"SEC. 132. CLEAN HEAVY-DUTY VEHICLES. 42 USC 7432.

"(a) APPROPRIATIONS.—

"(1) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $600,000,000, to remain available until September 30, 2031, to carry out this section.

"(2) NONATTAINMENT AREAS.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $400,000,000, to remain available until September 30, 2031, to make awards under this section to eligible recipients and to eligible contractors that propose to replace eligible vehicles to serve 1 or more communities located in an air quality area designated pursuant to section 107 as nonattainment for any air pollutant.

"(3) RESERVATION.—Of the funds appropriated by paragraph (1), the Administrator shall reserve 3 percent for administrative costs necessary to carry out this section.

"(b) PROGRAM.—Beginning not later than 180 days after the date of enactment of this section, the Administrator shall implement a program to make awards of grants and rebates to eligible recipients, and to make awards of contracts to eligible contractors for providing rebates, for up to 100 percent of costs for— Deadline. Grants. Rebates.

"(1) the incremental costs of replacing an eligible vehicle that is not a zero-emission vehicle with a zero-emission vehicle, as determined by the Administrator based on the market value of the vehicles; Determination.

"(2) purchasing, installing, operating, and maintaining infrastructure needed to charge, fuel, or maintain zero-emission vehicles;

"(3) workforce development and training to support the maintenance, charging, fueling, and operation of zero-emission vehicles; and

"(4) planning and technical activities to support the adoption and deployment of zero-emission vehicles.

"(c) APPLICATIONS.—To seek an award under this section, an eligible recipient or eligible contractor shall submit to the Administrator an application at such time, in such manner, and containing such information as the Administrator shall prescribe.

"(d) DEFINITIONS.—For purposes of this section:

"(1) ELIGIBLE CONTRACTOR.—The term 'eligible contractor' means a contractor that has the capacity—

"(A) to sell, lease, license, or contract for service zero-emission vehicles, or charging or other equipment needed to charge, fuel, or maintain zero-emission vehicles, to individuals or entities that own, lease, license, or contract for service an eligible vehicle; or

"(B) to arrange financing for such a sale, lease, license, or contract for service.

"(2) ELIGIBLE RECIPIENT.—The term 'eligible recipient' means—

"(A) a State;

"(B) a municipality;

"(C) an Indian tribe; or

"(D) a nonprofit school transportation association.

"(3) ELIGIBLE VEHICLE.—The term 'eligible vehicle' means a Class 6 or Class 7 heavy-duty vehicle as defined in section 1037.801 of title 40, Code of Federal Regulations (as in effect on the date of enactment of this section).

"(4) GREENHOUSE GAS.—The term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

"(5) ZERO-EMISSION VEHICLE.—The term 'zero-emission vehicle' means a vehicle that has a drivetrain that produces, under any possible operational mode or condition, zero exhaust emissions of—

"(A) any air pollutant that is listed pursuant to section 108(a) (or any precursor to such an air pollutant); and

"(B) any greenhouse gas.".

SEC. 60102. GRANTS TO REDUCE AIR POLLUTION AT PORTS.

The Clean Air Act is amended by inserting after section 132 of such Act, as added by section 60101 of this Act, the following:

42 USC 7433.

"SEC. 133. GRANTS TO REDUCE AIR POLLUTION AT PORTS.

"(a) APPROPRIATIONS.—

"(1) GENERAL ASSISTANCE.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $2,250,000,000, to remain available until September 30, 2027, to award rebates and grants to eligible recipients on a competitive basis—

"(A) to purchase or install zero-emission port equipment or technology for use at, or to directly serve, one or more ports;

"(B) to conduct any relevant planning or permitting in connection with the purchase or installation of such zero-emission port equipment or technology; and

"(C) to develop qualified climate action plans.

"(2) NONATTAINMENT AREAS.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $750,000,000, to remain available until September 30, 2027, to award rebates and grants to eligible recipients to carry out activities described in paragraph (1) with respect to ports located in air quality areas designated pursuant to section 107 as nonattainment for an air pollutant.

"(b) LIMITATION.—Funds awarded under this section shall not be used by any recipient or subrecipient to purchase or install zero-emission port equipment or technology that will not be located at, or directly serve, the one or more ports involved.

"(c) ADMINISTRATION OF FUNDS.—Of the funds made available by this section, the Administrator shall reserve 2 percent for administrative costs necessary to carry out this section.

"(d) DEFINITIONS.—In this section:

"(1) ELIGIBLE RECIPIENT.—The term 'eligible recipient' means—

"(A) a port authority;

"(B) a State, regional, local, or Tribal agency that has jurisdiction over a port authority or a port;

"(C) an air pollution control agency; or

"(D) a private entity that—

"(i) applies for a grant under this section in partnership with an entity described in any of subparagraphs (A) through (C); and

"(ii) owns, operates, or uses the facilities, cargo-handling equipment, transportation equipment, or related technology of a port.

"(2) GREENHOUSE GAS.—The term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

"(3) QUALIFIED CLIMATE ACTION PLAN.—The term 'qualified climate action plan' means a detailed and strategic plan that—

"(A) establishes goals, implementation strategies, and accounting and inventory practices to reduce emissions at one or more ports of—

"(i) greenhouse gases;

"(ii) an air pollutant that is listed pursuant to section 108(a) (or any precursor to such an air pollutant); and

"(iii) hazardous air pollutants;

"(B) includes a strategy to collaborate with, communicate with, and address potential effects on low-income and disadvantaged near-port communities and other stakeholders that may be affected by implementation of the plan; and

"(C) describes how an eligible recipient has implemented or will implement measures to increase the resilience of the one or more ports involved.

"(4) ZERO-EMISSION PORT EQUIPMENT OR TECHNOLOGY.—The term 'zero-emission port equipment or technology' means human-operated equipment or human-maintained technology that—

"(A) produces zero emissions of any air pollutant that is listed pursuant to section 108(a) (or any precursor to such an air pollutant) and any greenhouse gas other than water vapor; or

"(B) captures 100 percent of the emissions described in subparagraph (A) that are produced by an ocean-going vessel at berth.".

SEC. 60103. GREENHOUSE GAS REDUCTION FUND.

The Clean Air Act is amended by inserting after section 133 of such Act, as added by section 60102 of this Act, the following:

42 USC 7434.

"SEC. 134. GREENHOUSE GAS REDUCTION FUND.

Deadlines.

"(a) APPROPRIATIONS.—

"(1) ZERO-EMISSION TECHNOLOGIES.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $7,000,000,000, to remain available until September 30, 2024, to make grants, on a competitive basis and beginning not later than 180 calendar days after the date of enactment of this section, to States, municipalities, Tribal governments, and eligible recipients for the purposes of providing grants, loans, or other forms of financial assistance, as well as technical assistance, to enable low-income and disadvantaged communities to deploy or benefit from zero-emission technologies, including distributed technologies on residential rooftops, and to carry out other greenhouse gas emission reduction activities, as determined appropriate by the Administrator in accordance with this section.

"(2) GENERAL ASSISTANCE.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $11,970,000,000, to remain available until September 30, 2024, to make grants, on a competitive basis and beginning not later than 180 calendar days after the date of enactment of this section, to eligible recipients for the purposes of providing financial assistance and technical assistance in accordance with subsection (b).

"(3) LOW-INCOME AND DISADVANTAGED COMMUNITIES.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $8,000,000,000, to remain available until September 30, 2024, to make grants, on a competitive basis and beginning not later than 180 calendar days after the date of enactment of this section, to eligible recipients for the purposes of providing financial assistance and technical assistance in low-income and disadvantaged communities in accordance with subsection (b).

"(4) ADMINISTRATIVE COSTS.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $30,000,000, to remain available until September 30, 2031, for the administrative costs necessary to carry out activities under this section.

"(b) USE OF FUNDS.—An eligible recipient that receives a grant pursuant to subsection (a) shall use the grant in accordance with the following:

"(1) DIRECT INVESTMENT.—The eligible recipient shall—

"(A) provide financial assistance to qualified projects at the national, regional, State, and local levels;

"(B) prioritize investment in qualified projects that would otherwise lack access to financing; and

"(C) retain, manage, recycle, and monetize all repayments and other revenue received from fees, interest, repaid loans, and all other types of financial assistance provided using grant funds under this section to ensure continued operability.

"(2) INDIRECT INVESTMENT.—The eligible recipient shall provide funding and technical assistance to establish new or

support existing public, quasi-public, not-for-profit, or nonprofit entities that provide financial assistance to qualified projects at the State, local, territorial, or Tribal level or in the District of Columbia, including community- and low-income-focused lenders and capital providers.

"(c) DEFINITIONS.—In this section:

"(1) ELIGIBLE RECIPIENT.—The term 'eligible recipient' means a nonprofit organization that—

"(A) is designed to provide capital, leverage private capital, and provide other forms of financial assistance for the rapid deployment of low- and zero-emission products, technologies, and services;

"(B) does not take deposits other than deposits from repayments and other revenue received from financial assistance provided using grant funds under this section;

"(C) is funded by public or charitable contributions; and

"(D) invests in or finances projects alone or in conjunction with other investors.

"(2) GREENHOUSE GAS.—The term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

"(3) QUALIFIED PROJECT.—The term 'qualified project' includes any project, activity, or technology that—

"(A) reduces or avoids greenhouse gas emissions and other forms of air pollution in partnership with, and by leveraging investment from, the private sector; or

"(B) assists communities in the efforts of those communities to reduce or avoid greenhouse gas emissions and other forms of air pollution.

"(4) ZERO-EMISSION TECHNOLOGY.—The term 'zero-emission technology' means any technology that produces zero emissions of—

"(A) any air pollutant that is listed pursuant to section 108(a) (or any precursor to such an air pollutant); and

"(B) any greenhouse gas.".

SEC. 60104. DIESEL EMISSIONS REDUCTIONS.

(a) GOODS MOVEMENT.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $60,000,000, to remain available until September 30, 2031, for grants, rebates, and loans under section 792 of the Energy Policy Act of 2005 (42 U.S.C. 16132) to identify and reduce diesel emissions resulting from goods movement facilities, and vehicles servicing goods movement facilities, in low-income and disadvantaged communities to address the health impacts of such emissions on such communities.

(b) ADMINISTRATIVE COSTS.—The Administrator of the Environmental Protection Agency shall reserve 2 percent of the amounts made available under this section for the administrative costs necessary to carry out activities pursuant to this section.

SEC. 60105. FUNDING TO ADDRESS AIR POLLUTION.

(a) FENCELINE AIR MONITORING AND SCREENING AIR MONITORING.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury

not otherwise appropriated, $117,500,000, to remain available until September 30, 2031, for grants and other activities authorized under subsections (a) through (c) of section 103 and section 105 of the Clean Air Act (42 U.S.C. 7403(a)–(c), 7405) to deploy, integrate, support, and maintain fenceline air monitoring, screening air monitoring, national air toxics trend stations, and other air toxics and community monitoring.

(b) MULTIPOLLUTANT MONITORING STATIONS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $50,000,000, to remain available until September 30, 2031, for grants and other activities authorized under subsections (a) through (c) of section 103 and section 105 of the Clean Air Act (42 U.S.C. 7403(a)–(c), 7405)—

(1) to expand the national ambient air quality monitoring network with new multipollutant monitoring stations; and

(2) to replace, repair, operate, and maintain existing monitors.

(c) AIR QUALITY SENSORS IN LOW-INCOME AND DISADVANTAGED COMMUNITIES.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $3,000,000, to remain available until September 30, 2031, for grants and other activities authorized under subsections (a) through (c) of section 103 and section 105 of the Clean Air Act (42 U.S.C. 7403(a)–(c), 7405) to deploy, integrate, and operate air quality sensors in low-income and disadvantaged communities.

(d) EMISSIONS FROM WOOD HEATERS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $15,000,000, to remain available until September 30, 2031, for grants and other activities authorized under subsections (a) through (c) of section 103 and section 105 of the Clean Air Act (42 U.S.C. 7403(a)–(c), 7405) for testing and other agency activities to address emissions from wood heaters.

(e) METHANE MONITORING.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $20,000,000, to remain available until September 30, 2031, for grants and other activities authorized under subsections (a) through (c) of section 103 and section 105 of the Clean Air Act (42 U.S.C. 7403(a)–(c), 7405) for monitoring emissions of methane.

(f) CLEAN AIR ACT GRANTS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $25,000,000, to remain available until September 30, 2031, for grants and other activities authorized under subsections (a) through (c) of section 103 and section 105 of the Clean Air Act (42 U.S.C. 7403(a)–(c), 7405).

(g) GREENHOUSE GAS AND ZERO-EMISSION STANDARDS FOR MOBILE SOURCES.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the

Treasury not otherwise appropriated, $5,000,000, to remain available until September 30, 2031, to provide grants to States to adopt and implement greenhouse gas and zero-emission standards for mobile sources pursuant to section 177 of the Clean Air Act (42 U.S.C. 7507).

(h) DEFINITION OF GREENHOUSE GAS.—In this section, the term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

SEC. 60106. FUNDING TO ADDRESS AIR POLLUTION AT SCHOOLS.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $37,500,000, to remain available until September 30, 2031, for grants and other activities to monitor and reduce greenhouse gas emissions and other air pollutants at schools in low-income and disadvantaged communities under subsections (a) through (c) of section 103 of the Clean Air Act (42 U.S.C. 7403(a)–(c)) and section 105 of that Act (42 U.S.C. 7405).

(b) TECHNICAL ASSISTANCE.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $12,500,000, to remain available until September 30, 2031, for providing technical assistance to schools in low-income and disadvantaged communities under subsections (a) through (c) of section 103 of the Clean Air Act (42 U.S.C. 7403(a)–(c)) and section 105 of that Act (42 U.S.C. 7405)—

(1) to address environmental issues;

(2) to develop school environmental quality plans that include standards for school building, design, construction, and renovation; and

(3) to identify and mitigate ongoing air pollution hazards.

(c) DEFINITION OF GREENHOUSE GAS.—In this section, the term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

SEC. 60107. LOW EMISSIONS ELECTRICITY PROGRAM.

The Clean Air Act is amended by inserting after section 134 of such Act, as added by section 60103 of this Act, the following:

"SEC. 135. LOW EMISSIONS ELECTRICITY PROGRAM. 42 USC 7435.

"(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, to remain available until September 30, 2031—

"(1) $17,000,000 for consumer-related education and partnerships with respect to reductions in greenhouse gas emissions that result from domestic electricity generation and use;

"(2) $17,000,000 for education, technical assistance, and partnerships within low-income and disadvantaged communities with respect to reductions in greenhouse gas emissions that result from domestic electricity generation and use;

"(3) $17,000,000 for industry-related outreach, technical assistance, and partnerships with respect to reductions in

greenhouse gas emissions that result from domestic electricity generation and use;

"(4) $17,000,000 for outreach and technical assistance to, and partnerships with, State, Tribal, and local governments with respect to reductions in greenhouse gas emissions that result from domestic electricity generation and use;

Assessment. Deadline.

"(5) $1,000,000 to assess, not later than 1 year after the date of enactment of this section, the reductions in greenhouse gas emissions that result from changes in domestic electricity generation and use that are anticipated to occur on an annual basis through fiscal year 2031; and

"(6) $18,000,000 to ensure that reductions in greenhouse gas emissions are achieved through use of the existing authorities of this Act, incorporating the assessment under paragraph (5).

"(b) ADMINISTRATION OF FUNDS.—Of the amounts made available under subsection (a), the Administrator shall reserve 2 percent for the administrative costs necessary to carry out activities pursuant to that subsection.

"(c) DEFINITION OF GREENHOUSE GAS.—In this section, the term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.".

SEC. 60108. FUNDING FOR SECTION 211(O) OF THE CLEAN AIR ACT.

(a) TEST AND PROTOCOL DEVELOPMENT.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $5,000,000, to remain available until September 30, 2031, to carry out section 211(o) of the Clean Air Act (42 U.S.C. 7545(o)) with respect to—

(1) the development and establishment of tests and protocols regarding the environmental and public health effects of a fuel or fuel additive;

(2) internal and extramural data collection and analyses to regularly update applicable regulations, guidance, and procedures for determining lifecycle greenhouse gas emissions of a fuel; and

(3) the review, analysis, and evaluation of the impacts of all transportation fuels, including fuel lifecycle implications, on the general public and on low-income and disadvantaged communities.

(b) INVESTMENTS IN ADVANCED BIOFUELS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $10,000,000, to remain available until September 30, 2031, for new grants to industry and other related activities under section 211(o) of the Clean Air Act (42 U.S.C. 7545(o)) to support investments in advanced biofuels.

(c) DEFINITION OF GREENHOUSE GAS.—In this section, the term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

SEC. 60109. FUNDING FOR IMPLEMENTATION OF THE AMERICAN INNOVATION AND MANUFACTURING ACT.

(a) APPROPRIATIONS.—

(1) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $20,000,000, to remain available until September 30, 2026, to carry out subsections (a) through (i) and subsection (k) of section 103 of division S of Public Law 116–260 (42 U.S.C. 7675).

(2) IMPLEMENTATION AND COMPLIANCE TOOLS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $3,500,000, to remain available until September 30, 2026, to deploy new implementation and compliance tools to carry out subsections (a) through (i) and subsection (k) of section 103 of division S of Public Law 116–260 (42 U.S.C. 7675).

(3) COMPETITIVE GRANTS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $15,000,000, to remain available until September 30, 2026, for competitive grants for reclaim and innovative destruction technologies under subsections (a) through (i) and subsection (k) of section 103 of division S of Public Law 116–260 (42 U.S.C. 7675).

(b) ADMINISTRATION OF FUNDS.—Of the funds made available pursuant to subsection (a)(3), the Administrator of the Environmental Protection Agency shall reserve 5 percent for administrative costs necessary to carry out activities pursuant to such subsection.

SEC. 60110. FUNDING FOR ENFORCEMENT TECHNOLOGY AND PUBLIC INFORMATION.

(a) COMPLIANCE MONITORING.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $18,000,000, to remain available until September 30, 2031, to update the Integrated Compliance Information System of the Environmental Protection Agency and any associated systems, necessary information technology infrastructure, or public access software tools to ensure access to compliance data and related information.

(b) COMMUNICATIONS WITH ICIS.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $3,000,000, to remain available until September 30, 2031, for grants to States, Indian tribes, and air pollution control agencies (as such terms are defined in section 302 of the Clean Air Act (42 U.S.C. 7602)) to update their systems to ensure communication with the Integrated Compliance Information System of the Environmental Protection Agency and any associated systems.

(c) INSPECTION SOFTWARE.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money

in the Treasury not otherwise appropriated, $4,000,000, to remain available until September 30, 2031—

(1) to acquire or update inspection software for use by the Environmental Protection Agency, States, Indian tribes, and air pollution control agencies (as such terms are defined in section 302 of the Clean Air Act (42 U.S.C. 7602)); or

(2) to acquire necessary devices on which to run such inspection software.

SEC. 60111. GREENHOUSE GAS CORPORATE REPORTING.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $5,000,000, to remain available until September 30, 2031, for the Environmental Protection Agency to support—

(1) enhanced standardization and transparency of corporate climate action commitments and plans to reduce greenhouse gas emissions;

(2) enhanced transparency regarding progress toward meeting such commitments and implementing such plans; and

(3) progress toward meeting such commitments and implementing such plans.

(b) DEFINITION OF GREENHOUSE GAS.—In this section, the term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

42 USC 4321 note.

SEC. 60112. ENVIRONMENTAL PRODUCT DECLARATION ASSISTANCE.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $250,000,000, to remain available until September 30, 2031, to develop and carry out a program to support the development, enhanced standardization and transparency, and reporting criteria for environmental product declarations that include measurements of the embodied greenhouse gas emissions of the material or product associated with all relevant stages of production, use, and disposal, and conform with international standards, for construction materials and products by—

(1) providing grants to businesses that manufacture construction materials and products for developing and verifying environmental product declarations, and to States, Indian Tribes, and nonprofit organizations that will support such businesses;

(2) providing technical assistance to businesses that manufacture construction materials and products in developing and verifying environmental product declarations, and to States, Indian Tribes, and nonprofit organizations that will support such businesses; and

(3) carrying out other activities that assist in measuring, reporting, and steadily reducing the quantity of embodied carbon of construction materials and products.

(b) ADMINISTRATIVE COSTS.—Of the amounts made available under this section, the Administrator of the Environmental Protection Agency shall reserve 5 percent for administrative costs necessary to carry out this section.

(c) DEFINITIONS.—In this section:

(1) GREENHOUSE GAS.—The term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

(2) STATE.—The term "State" has the meaning given to that term in section 302(d) of the Clean Air Act (42 U.S.C. 7602(d)).

SEC. 60113. METHANE EMISSIONS REDUCTION PROGRAM.

The Clean Air Act is amended by inserting after section 135 of such Act, as added by section 60107 of this Act, the following:

"SEC. 136. METHANE EMISSIONS AND WASTE REDUCTION INCENTIVE PROGRAM FOR PETROLEUM AND NATURAL GAS SYSTEMS. 42 USC 7436.

"(a) INCENTIVES FOR METHANE MITIGATION AND MONITORING.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $850,000,000, to remain available until September 30, 2028—

"(1) for grants, rebates, contracts, loans, and other activities of the Environmental Protection Agency for the purposes of providing financial and technical assistance to owners and operators of applicable facilities to prepare and submit greenhouse gas reports under subpart W of part 98 of title 40, Code of Federal Regulations;

"(2) for grants, rebates, contracts, loans, and other activities of the Environmental Protection Agency authorized under subsections (a) through (c) of section 103 for methane emissions monitoring;

"(3) for grants, rebates, contracts, loans, and other activities of the Environmental Protection Agency for the purposes of providing financial and technical assistance to reduce methane and other greenhouse gas emissions from petroleum and natural gas systems, mitigate legacy air pollution from petroleum and natural gas systems, and provide funding for—

"(A) improving climate resiliency of communities and petroleum and natural gas systems;

"(B) improving and deploying industrial equipment and processes that reduce methane and other greenhouse gas emissions and waste;

"(C) supporting innovation in reducing methane and other greenhouse gas emissions and waste from petroleum and natural gas systems;

"(D) permanently shutting in and plugging wells on non-Federal land;

"(E) mitigating health effects of methane and other greenhouse gas emissions, and legacy air pollution from petroleum and natural gas systems in low-income and disadvantaged communities; and

"(F) supporting environmental restoration; and

"(4) to cover all direct and indirect costs required to administer this section, prepare inventories, gather empirical data, and track emissions.

"(b) INCENTIVES FOR METHANE MITIGATION FROM CONVENTIONAL WELLS.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $700,000,000, to remain available until September 30, 2028, for

activities described in paragraphs (1) through (4) of subsection (a) at marginal conventional wells.

"(c) WASTE EMISSIONS CHARGE.—The Administrator shall impose and collect a charge on methane emissions that exceed an applicable waste emissions threshold under subsection (f) from an owner or operator of an applicable facility that reports more than 25,000 metric tons of carbon dioxide equivalent of greenhouse gases emitted per year pursuant to subpart W of part 98 of title 40, Code of Federal Regulations, regardless of the reporting threshold under that subpart.

Definition.

"(d) APPLICABLE FACILITY.—For purposes of this section, the term 'applicable facility' means a facility within the following industry segments, as defined in subpart W of part 98 of title 40, Code of Federal Regulations:

"(1) Offshore petroleum and natural gas production.

"(2) Onshore petroleum and natural gas production.

"(3) Onshore natural gas processing.

"(4) Onshore natural gas transmission compression.

"(5) Underground natural gas storage.

"(6) Liquefied natural gas storage.

"(7) Liquefied natural gas import and export equipment.

"(8) Onshore petroleum and natural gas gathering and boosting.

"(9) Onshore natural gas transmission pipeline.

Time periods.

"(e) CHARGE AMOUNT.—The amount of a charge under subsection (c) for an applicable facility shall be equal to the product obtained by multiplying—

"(1) the number of metric tons of methane emissions reported pursuant to subpart W of part 98 of title 40, Code of Federal Regulations, for the applicable facility that exceed the applicable annual waste emissions threshold listed in subsection (f) during the previous reporting period; and

"(2)(A) $900 for emissions reported for calendar year 2024;

"(B) $1,200 for emissions reported for calendar year 2025; or

"(C) $1,500 for emissions reported for calendar year 2026 and each year thereafter.

Fees.

"(f) WASTE EMISSIONS THRESHOLD.—

"(1) PETROLEUM AND NATURAL GAS PRODUCTION.—With respect to imposing and collecting the charge under subsection (c) for an applicable facility in an industry segment listed in paragraph (1) or (2) of subsection (d), the Administrator shall impose and collect the charge on the reported metric tons of methane emissions from such facility that exceed—

"(A) 0.20 percent of the natural gas sent to sale from such facility; or

"(B) 10 metric tons of methane per million barrels of oil sent to sale from such facility, if such facility sent no natural gas to sale.

"(2) NONPRODUCTION PETROLEUM AND NATURAL GAS SYSTEMS.—With respect to imposing and collecting the charge under subsection (c) for an applicable facility in an industry segment listed in paragraph (3), (6), (7), or (8) of subsection (d), the Administrator shall impose and collect the charge on the reported metric tons of methane emissions that exceed 0.05 percent of the natural gas sent to sale from or through such facility.

"(3) NATURAL GAS TRANSMISSION.—With respect to imposing and collecting the charge under subsection (c) for an applicable facility in an industry segment listed in paragraph (4), (5), or (9) of subsection (d), the Administrator shall impose and collect the charge on the reported metric tons of methane emissions that exceed 0.11 percent of the natural gas sent to sale from or through such facility.

"(4) COMMON OWNERSHIP OR CONTROL.—In calculating the total emissions charge obligation for facilities under common ownership or control, the Administrator shall allow for the netting of emissions by reducing the total obligation to account for facility emissions levels that are below the applicable thresholds within and across all applicable segments identified in subsection (d).

"(5) EXEMPTION.—Charges shall not be imposed pursuant to paragraph (1) on emissions that exceed the waste emissions threshold specified in such paragraph if such emissions are caused by unreasonable delay, as determined by the Administrator, in environmental permitting of gathering or transmission infrastructure necessary for offtake of increased volume as a result of methane emissions mitigation implementation. Determination.

"(6) EXEMPTION FOR REGULATORY COMPLIANCE.— Determination.

"(A) IN GENERAL.—Charges shall not be imposed pursuant to subsection (c) on an applicable facility that is subject to and in compliance with methane emissions requirements pursuant to subsections (b) and (d) of section 111 upon a determination by the Administrator that—

"(i) methane emissions standards and plans pursuant to subsections (b) and (d) of section 111 have been approved and are in effect in all States with respect to the applicable facilities; and

"(ii) compliance with the requirements described in clause (i) will result in equivalent or greater emissions reductions as would be achieved by the proposed rule of the Administrator entitled 'Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review' (86 Fed. Reg. 63110 (November 15, 2021)), if such rule had been finalized and implemented.

"(B) RESUMPTION OF CHARGE.—If the conditions in clause (i) or (ii) of subparagraph (A) cease to apply after the Administrator has made the determination in that subparagraph, the applicable facility will again be subject to the charge under subsection (c) beginning in the first calendar year in which the conditions in either clause (i) or (ii) of that subparagraph are no longer met. Time period.

"(7) PLUGGED WELLS.—Charges shall not be imposed with respect to the emissions rate from any well that has been permanently shut-in and plugged in the previous year in accordance with all applicable closure requirements, as determined by the Administrator. Determination.

"(g) PERIOD.—The charge under subsection (c) shall be imposed and collected beginning with respect to emissions reported for calendar year 2024 and for each year thereafter.

"(h) REPORTING.—Not later than 2 years after the date of enactment of this section, the Administrator shall revise the requirements of subpart W of part 98 of title 40, Code of Federal Regulations, to ensure the reporting under such subpart, and calculation of charges under subsections (e) and (f) of this section, are based on empirical data, including data collected pursuant to subsection (a)(4), accurately reflect the total methane emissions and waste emissions from the applicable facilities, and allow owners and operators of applicable facilities to submit empirical emissions data, in a manner to be prescribed by the Administrator, to demonstrate the extent to which a charge under subsection (c) is owed.

"(i) DEFINITION OF GREENHOUSE GAS.—In this section, the term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.".

SEC. 60114. CLIMATE POLLUTION REDUCTION GRANTS.

The Clean Air Act is amended by inserting after section 136 of such Act, as added by section 60113 of this Act, the following:

42 USC 7437.

"SEC. 137. GREENHOUSE GAS AIR POLLUTION PLANS AND IMPLEMENTATION GRANTS.

"(a) APPROPRIATIONS.—

"(1) GREENHOUSE GAS AIR POLLUTION PLANNING GRANTS.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any amounts in the Treasury not otherwise appropriated, $250,000,000, to remain available until September 30, 2031, to carry out subsection (b).

"(2) GREENHOUSE GAS AIR POLLUTION IMPLEMENTATION GRANTS.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any amounts in the Treasury not otherwise appropriated, $4,750,000,000, to remain available until September 30, 2026, to carry out subsection (c).

"(3) ADMINISTRATIVE COSTS.—Of the funds made available under paragraph (2), the Administrator shall reserve 3 percent for administrative costs necessary to carry out this section, to provide technical assistance to eligible entities, to develop a plan that could be used as a model by grantees in developing a plan under subsection (b), and to model the effects of plans described in this section.

"(b) GREENHOUSE GAS AIR POLLUTION PLANNING GRANTS.—The Administrator shall make a grant to at least one eligible entity in each State for the costs of developing a plan for the reduction of greenhouse gas air pollution to be submitted with an application for a grant under subsection (c). Each such plan shall include programs, policies, measures, and projects that will achieve or facilitate the reduction of greenhouse gas air pollution. Not later than 270 days after the date of enactment of this section, the Administrator shall publish a funding opportunity announcement for grants under this subsection.

Deadline. Publication.

"(c) GREENHOUSE GAS AIR POLLUTION REDUCTION IMPLEMENTATION GRANTS.—

"(1) IN GENERAL.—The Administrator shall competitively award grants to eligible entities to implement plans developed under subsection (b).

"(2) APPLICATION.—To apply for a grant under this subsection, an eligible entity shall submit to the Administrator an application at such time, in such manner, and containing such information as the Administrator shall require, which such application shall include information regarding the degree to which greenhouse gas air pollution is projected to be reduced in total and with respect to low-income and disadvantaged communities.

"(3) TERMS AND CONDITIONS.—The Administrator shall make funds available to a grantee under this subsection in such amounts, upon such a schedule, and subject to such conditions based on its performance in implementing its plan submitted under this section and in achieving projected greenhouse gas air pollution reduction, as determined by the Administrator. Determination.

"(d) DEFINITIONS.—In this section:

"(1) ELIGIBLE ENTITY.—The term 'eligible entity' means—

"(A) a State;

"(B) an air pollution control agency;

"(C) a municipality;

"(D) an Indian tribe; and

"(E) a group of one or more entities listed in subparagraphs (A) through (D).

"(2) GREENHOUSE GAS.—The term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.".

SEC. 60115. ENVIRONMENTAL PROTECTION AGENCY EFFICIENT, ACCURATE, AND TIMELY REVIEWS.

In addition to amounts otherwise available, there is appropriated to the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $40,000,000, to remain available until September 30, 2026, to provide for the development of efficient, accurate, and timely reviews for permitting and approval processes through the hiring and training of personnel, the development of programmatic documents, the procurement of technical or scientific services for reviews, the development of environmental data or information systems, stakeholder and community engagement, the purchase of new equipment for environmental analysis, and the development of geographic information systems and other analysis tools, techniques, and guidance to improve agency transparency, accountability, and public engagement.

SEC. 60116. LOW-EMBODIED CARBON LABELING FOR CONSTRUCTION MATERIALS. 42 USC 4321 note.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the Administrator of the Environmental Protection Agency for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available until September 30, 2026, for necessary administrative costs of the Administrator of the Environmental Protection Agency to carry out this section and to develop and carry out a program, in consultation with the Administrator of the Federal Highway Administration for construction materials used in transportation projects and the Administrator of General Services for construction materials used for Federal buildings, to identify and label construction materials and products that have substantially lower levels of embodied greenhouse gas emissions associated with all relevant Consultation.

stages of production, use, and disposal, as compared to estimated industry averages of similar materials or products, as determined by the Administrator of the Environmental Protection Agency, based on—

(1) environmental product declarations; or

Determinations.

(2) determinations by State agencies, as verified by the Administrator of the Environmental Protection Agency.

(b) DEFINITION OF GREENHOUSE GAS.—In this section, the term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

Subtitle B—Hazardous Materials

SEC. 60201. ENVIRONMENTAL AND CLIMATE JUSTICE BLOCK GRANTS.

The Clean Air Act is amended by inserting after section 137, as added by subtitle A of this title, the following:

42 USC 7438.

"SEC. 138. ENVIRONMENTAL AND CLIMATE JUSTICE BLOCK GRANTS.

"(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated to the Administrator for fiscal year 2022, out of any money in the Treasury not otherwise appropriated—

"(1) $2,800,000,000 to remain available until September 30, 2026, to award grants for the activities described in subsection (b); and

"(2) $200,000,000 to remain available until September 30, 2026, to provide technical assistance to eligible entities related to grants awarded under this section.

"(b) GRANTS.—

"(1) IN GENERAL.—The Administrator shall use amounts made available under subsection (a)(1) to award grants for periods of up to 3 years to eligible entities to carry out activities described in paragraph (2) that benefit disadvantaged communities, as defined by the Administrator.

"(2) ELIGIBLE ACTIVITIES.—An eligible entity may use a grant awarded under this subsection for—

"(A) community-led air and other pollution monitoring, prevention, and remediation, and investments in low- and zero-emission and resilient technologies and related infrastructure and workforce development that help reduce greenhouse gas emissions and other air pollutants;

"(B) mitigating climate and health risks from urban heat islands, extreme heat, wood heater emissions, and wildfire events;

"(C) climate resiliency and adaptation;

"(D) reducing indoor toxics and indoor air pollution; or

"(E) facilitating engagement of disadvantaged communities in State and Federal advisory groups, workshops, rulemakings, and other public processes.

Definition.

"(3) ELIGIBLE ENTITIES.—In this subsection, the term 'eligible entity' means—

"(A) a partnership between—

"(i) an Indian tribe, a local government, or an institution of higher education; and

"(ii) a community-based nonprofit organization;

"(B) a community-based nonprofit organization; or

"(C) a partnership of community-based nonprofit organizations.

"(c) ADMINISTRATIVE COSTS.—The Administrator shall reserve 7 percent of the amounts made available under subsection (a) for administrative costs to carry out this section.

"(d) DEFINITION OF GREENHOUSE GAS.—In this section, the term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.".

Subtitle C—United States Fish and Wildlife Service

SEC. 60301. ENDANGERED SPECIES ACT RECOVERY PLANS.

In addition to amounts otherwise available, there is appropriated to the United States Fish and Wildlife Service for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $125,000,000, to remain available until expended, for the purposes of developing and implementing recovery plans under paragraphs (1), (3), and (4) of subsection (f) of section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533(f)).

SEC. 60302. FUNDING FOR THE UNITED STATES FISH AND WILDLIFE SERVICE TO ADDRESS WEATHER EVENTS.

(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated to the United States Fish and Wildlife Service for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $121,250,000, to remain available until September 30, 2026, to make direct expenditures, award grants, and enter into contracts and cooperative agreements for the purposes of rebuilding and restoring units of the National Wildlife Refuge System and State wildlife management areas by—

(1) addressing the threat of invasive species;

(2) increasing the resiliency and capacity of habitats and infrastructure to withstand weather events; and

(3) reducing the amount of damage caused by weather events.

(b) ADMINISTRATIVE COSTS.—In addition to amounts otherwise available, there is appropriated to the United States Fish and Wildlife Service for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $3,750,000, to remain available until September 30, 2026, for necessary administrative expenses associated with carrying out this section.

Subtitle D—Council on Environmental Quality

SEC. 60401. ENVIRONMENTAL AND CLIMATE DATA COLLECTION.

In addition to amounts otherwise available, there is appropriated to the Chair of the Council on Environmental Quality for fiscal year 2022, out of any money in the Treasury not otherwise

appropriated, $32,500,000, to remain available until September 30, 2026—

(1) to support data collection efforts relating to—

(A) disproportionate negative environmental harms and climate impacts; and

(B) cumulative impacts of pollution and temperature rise;

(2) to establish, expand, and maintain efforts to track disproportionate burdens and cumulative impacts and provide academic and workforce support for analytics and informatics infrastructure and data collection systems; and

(3) to support efforts to ensure that any mapping or screening tool is accessible to community-based organizations and community members.

SEC. 60402. COUNCIL ON ENVIRONMENTAL QUALITY EFFICIENT AND EFFECTIVE ENVIRONMENTAL REVIEWS.

In addition to amounts otherwise available, there is appropriated to the Chair of the Council on Environmental Quality for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $30,000,000, to remain available until September 30, 2026, to carry out the Council on Environmental Quality's functions and for the purposes of training personnel, developing programmatic environmental documents, and developing tools, guidance, and techniques to improve stakeholder and community engagement.

Subtitle E—Transportation and Infrastructure

SEC. 60501. NEIGHBORHOOD ACCESS AND EQUITY GRANT PROGRAM.

(a) IN GENERAL.—Chapter 1 of title 23, United States Code, is amended by adding at the end the following:

23 USC 177.

"§ 177. Neighborhood access and equity grant program

"(a) IN GENERAL.—In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $1,893,000,000, to remain available until September 30, 2026, to the Administrator of the Federal Highway Administration for competitive grants to eligible entities described in subsection (b)—

"(1) to improve walkability, safety, and affordable transportation access through projects that are context-sensitive—

"(A) to remove, remediate, or reuse a facility described in subsection (c)(1);

"(B) to replace a facility described in subsection (c)(1) with a facility that is at-grade or lower speed;

"(C) to retrofit or cap a facility described in subsection (c)(1);

"(D) to build or improve complete streets, multiuse trails, regional greenways, or active transportation networks and spines; or

"(E) to provide affordable access to essential destinations, public spaces, or transportation links and hubs;

"(2) to mitigate or remediate negative impacts on the human or natural environment resulting from a facility

described in subsection (c)(2) in a disadvantaged or underserved community through—

"(A) noise barriers to reduce impacts resulting from a facility described in subsection (c)(2);

"(B) technologies, infrastructure, and activities to reduce surface transportation-related greenhouse gas emissions and other air pollution;

"(C) natural infrastructure, pervious, permeable, or porous pavement, or protective features to reduce or manage stormwater run-off resulting from a facility described in subsection (c)(2);

"(D) infrastructure and natural features to reduce or mitigate urban heat island hot spots in the transportation right-of-way or on surface transportation facilities; or

"(E) safety improvements for vulnerable road users; and

"(3) for planning and capacity building activities in disadvantaged or underserved communities to—

"(A) identify, monitor, or assess local and ambient air quality, emissions of transportation greenhouse gases, hot spot areas of extreme heat or elevated air pollution, gaps in tree canopy coverage, or flood prone transportation infrastructure; Assessment.

"(B) assess transportation equity or pollution impacts and develop local anti-displacement policies and community benefit agreements; Assessment.

"(C) conduct predevelopment activities for projects eligible under this subsection;

"(D) expand public participation in transportation planning by individuals and organizations in disadvantaged or underserved communities; or

"(E) administer or obtain technical assistance related to activities described in this subsection.

"(b) ELIGIBLE ENTITIES DESCRIBED.—An eligible entity referred to in subsection (a) is—

"(1) a State;

"(2) a unit of local government;

"(3) a political subdivision of a State;

"(4) an entity described in section 207(m)(1)(E);

"(5) a territory of the United States;

"(6) a special purpose district or public authority with a transportation function;

"(7) a metropolitan planning organization (as defined in section 134(b)(2)); or

"(8) with respect to a grant described in subsection (a)(3), in addition to an eligible entity described in paragraphs (1) through (7), a nonprofit organization or institution of higher education that has entered into a partnership with an eligible entity described in paragraphs (1) through (7).

"(c) FACILITY DESCRIBED.—A facility referred to in subsection (a) is—

"(1) a surface transportation facility for which high speeds, grade separation, or other design factors create an obstacle to connectivity within a community; or

"(2) a surface transportation facility which is a source of air pollution, noise, stormwater, or other burden to a disadvantaged or underserved community.

"(d) INVESTMENT IN ECONOMICALLY DISADVANTAGED COMMUNITIES.—

"(1) IN GENERAL.—In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $1,262,000,000, to remain available until September 30, 2026, to the Administrator of the Federal Highway Administration to provide grants for projects in communities described in paragraph (2) for the same purposes and administered in the same manner as described in subsection (a).

"(2) COMMUNITIES DESCRIBED.—A community referred to in paragraph (1) is a community that—

"(A) is economically disadvantaged, underserved, or located in an area of persistent poverty;

"(B) has entered or will enter into a community benefits agreement with representatives of the community;

"(C) has an anti-displacement policy, a community land trust, or a community advisory board in effect; or

"(D) has demonstrated a plan for employing local residents in the area impacted by the activity or project proposed under this section.

"(e) ADMINISTRATION.—

"(1) IN GENERAL.—A project carried out under subsection (a) or (d) shall be treated as a project on a Federal-aid highway.

"(2) COMPLIANCE WITH EXISTING REQUIREMENTS.—Funds made available for a grant under this section and administered by or through a State department of transportation shall be expended in compliance with the U.S. Department of Transportation's Disadvantaged Business Enterprise Program.

"(f) COST SHARE.—The Federal share of the cost of an activity carried out using a grant awarded under this section shall be not more than 80 percent, except that the Federal share of the cost of a project in a disadvantaged or underserved community may be up to 100 percent.

"(g) TECHNICAL ASSISTANCE.—In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $50,000,000, to remain available until September 30, 2026, to the Administrator of the Federal Highway Administration for—

"(1) guidance, technical assistance, templates, training, or tools to facilitate efficient and effective contracting, design, and project delivery by units of local government;

"(2) subgrants to units of local government to build capacity of such units of local government to assume responsibilities to deliver surface transportation projects; and

"(3) operations and administration of the Federal Highway Administration.

"(h) LIMITATIONS.—Amounts made available under this section shall not—

"(1) be subject to any restriction or limitation on the total amount of funds available for implementation or execution of programs authorized for Federal-aid highways; and

"(2) be used for a project for additional through travel lanes for single-occupant passenger vehicles.".

(b) CLERICAL AMENDMENT.—The analysis for chapter 1 of title 23, United States Code, is amended by adding at the end the following: 23 USC 101 prec.

"177. Neighborhood access and equity grant program.".

SEC. 60502. ASSISTANCE FOR FEDERAL BUILDINGS.

In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $250,000,000, to remain available until September 30, 2031, to be deposited in the Federal Buildings Fund established under section 592 of title 40, United States Code, for measures necessary to convert facilities of the Administrator of General Services to high-performance green buildings (as defined in section 401 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17061)).

SEC. 60503. USE OF LOW-CARBON MATERIALS.

(a) APPROPRIATION.—In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $2,150,000,000, to remain available until September 30, 2026, to be deposited in the Federal Buildings Fund established under section 592 of title 40, United States Code, to acquire and install materials and products for use in the construction or alteration of buildings under the jurisdiction, custody, and control of the General Services Administration that have substantially lower levels of embodied greenhouse gas emissions associated with all relevant stages of production, use, and disposal as compared to estimated industry averages of similar materials or products, as determined by the Administrator of the Environmental Protection Agency. Determination.

(b) DEFINITION OF GREENHOUSE GAS.—In this section, the term "greenhouse gas" means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.

SEC. 60504. GENERAL SERVICES ADMINISTRATION EMERGING TECHNOLOGIES.

In addition to amounts otherwise available, there is appropriated to the Administrator of General Services for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $975,000,000, to remain available until September 30, 2026, to be deposited in the Federal Buildings Fund established under section 592 of title 40, United States Code, for emerging and sustainable technologies, and related sustainability and environmental programs.

SEC. 60505. ENVIRONMENTAL REVIEW IMPLEMENTATION FUNDS.

(a) IN GENERAL.—Chapter 1 of title 23, United States Code, is further amended by adding at the end the following:

"§ 178. Environmental review implementation funds 23 USC 178.

"(a) ESTABLISHMENT.—In addition to amounts otherwise available, for fiscal year 2022, there is appropriated to the Administrator, out of any money in the Treasury not otherwise appropriated, $100,000,000, to remain available until September 30, 2026, for the purpose of facilitating the development and review of documents for the environmental review process for proposed projects through—

"(1) the provision of guidance, technical assistance, templates, training, or tools to facilitate an efficient and effective environmental review process for surface transportation projects and any administrative expenses of the Federal Highway Administration to conduct activities described in this section; and

"(2) providing funds made available under this subsection to eligible entities—

"(A) to build capacity of such eligible entities to conduct environmental review processes;

"(B) to facilitate the environmental review process for proposed projects by—

"(i) defining the scope or study areas;

"(ii) identifying impacts, mitigation measures, and reasonable alternatives;

"(iii) preparing planning and environmental studies and other documents prior to and during the environmental review process, for potential use in the environmental review process in accordance with applicable statutes and regulations;

"(iv) conducting public engagement activities; and

"(v) carrying out permitting or other activities, as the Administrator determines to be appropriate, to support the timely completion of an environmental review process required for a proposed project; and

"(C) for administrative expenses of the eligible entity to conduct any of the activities described in subparagraphs (A) and (B).

"(b) COST SHARE.—

"(1) IN GENERAL.—The Federal share of the cost of an activity carried out under this section by an eligible entity shall be not more than 80 percent.

"(2) SOURCE OF FUNDS.—The non-Federal share of the cost of an activity carried out under this section by an eligible entity may be satisfied using funds made available to the eligible entity under any other Federal, State, or local grant program.

"(c) DEFINITIONS.—In this section:

"(1) ADMINISTRATOR.—The term 'Administrator' means the Administrator of the Federal Highway Administration.

"(2) ELIGIBLE ENTITY.—The term 'eligible entity' means—

"(A) a State;

"(B) a unit of local government;

"(C) a political subdivision of a State;

"(D) a territory of the United States;

"(E) an entity described in section 207(m)(1)(E);

"(F) a recipient of funds under section 203; or

"(G) a metropolitan planning organization (as defined in section 134(b)(2)).

"(3) ENVIRONMENTAL REVIEW PROCESS.—The term 'environmental review process' has the meaning given the term in section 139(a)(5).

"(4) PROPOSED PROJECT.—The term 'proposed project' means a surface transportation project for which an environmental review process is required.".

(b) CLERICAL AMENDMENT.—The analysis for chapter 1 of title 23, United States Code, is further amended by adding at the end the following: 23 USC 101 prec.

"178. Environmental review implementation funds.".

SEC. 60506. LOW-CARBON TRANSPORTATION MATERIALS GRANTS.

(a) IN GENERAL.—Chapter 1 of title 23, United States Code, is further amended by adding at the end the following:

"§ 179. Low-carbon transportation materials grants 23 USC 179.

"(a) FEDERAL HIGHWAY ADMINISTRATION APPROPRIATION.—In addition to amounts otherwise available, there is appropriated for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $2,000,000,000, to remain available until September 30, 2026, to the Administrator to reimburse or provide incentives to eligible recipients for the use, in projects, of construction materials and products that have substantially lower levels of embodied greenhouse gas emissions associated with all relevant stages of production, use, and disposal as compared to estimated industry averages of similar materials or products, as determined by the Administrator of the Environmental Protection Agency, and for the operations and administration of the Federal Highway Administration to carry out this section.

"(b) REIMBURSEMENT OF INCREMENTAL COSTS; INCENTIVES.—

"(1) IN GENERAL.—The Administrator shall, subject to the availability of funds, either reimburse or provide incentives to eligible recipients that use low-embodied carbon construction materials and products on a project funded under this title.

"(2) REIMBURSEMENT AND INCENTIVE AMOUNTS.—

"(A) INCREMENTAL AMOUNT.—The amount of reimbursement under paragraph (1) shall be equal to the incrementally higher cost of using such materials relative to the cost of using traditional materials, as determined by the eligible recipient and verified by the Administrator. Determination. Verification.

"(B) INCENTIVE AMOUNT.—The amount of an incentive under paragraph (1) shall be equal to 2 percent of the cost of using low-embodied carbon construction materials and products on a project funded under this title.

"(3) FEDERAL SHARE.—If a reimbursement or incentive is provided under paragraph (1), the total Federal share payable for the project for which the reimbursement or incentive is provided shall be up to 100 percent.

"(4) LIMITATIONS.—

"(A) IN GENERAL.—The Administrator shall only provide a reimbursement or incentive under paragraph (1) for a project on a—

"(i) Federal-aid highway;

"(ii) tribal transportation facility;

"(iii) Federal lands transportation facility; or

"(iv) Federal lands access transportation facility.

"(B) OTHER RESTRICTIONS.—Amounts made available under this section shall not be subject to any restriction or limitation on the total amount of funds available for implementation or execution of programs authorized for Federal-aid highways.

"(C) SINGLE OCCUPANT PASSENGER VEHICLES.—Funds made available under this section shall not be used for

projects that result in additional through travel lanes for single occupant passenger vehicles.

Review. "(5) MATERIALS IDENTIFICATION.—The Administrator shall review the low-embodied carbon construction materials and products identified by the Administrator of the Environmental Protection Agency and shall identify low-embodied carbon construction materials and products—

"(A) appropriate for use in projects eligible under this title; and

"(B) eligible for reimbursement or incentives under this section.

"(c) DEFINITIONS.—In this section:

"(1) ADMINISTRATOR.—The term 'Administrator' means the Administrator of the Federal Highway Administration.

"(2) ELIGIBLE RECIPIENT.—The term 'eligible recipient' means—

"(A) a State;

"(B) a unit of local government;

"(C) a political subdivision of a State;

"(D) a territory of the United States;

"(E) an entity described in section 207(m)(1)(E);

"(F) a recipient of funds under section 203;

"(G) a metropolitan planning organization (as defined in section 134(b)(2)); or

"(H) a special purpose district or public authority with a transportation function.

"(3) GREENHOUSE GAS.—The term 'greenhouse gas' means the air pollutants carbon dioxide, hydrofluorocarbons, methane, nitrous oxide, perfluorocarbons, and sulfur hexafluoride.".

(b) CLERICAL AMENDMENT.—The analysis for chapter 1 of title 23, United States Code, is further amended by adding at the end the following:

23 USC 101 prec.

"179. Low-carbon transportation materials grants.".

TITLE VII—COMMITTEE ON HOMELAND SECURITY AND GOVERNMENTAL AFFAIRS

SEC. 70001. DHS OFFICE OF CHIEF READINESS SUPPORT OFFICER.

In addition to the amounts otherwise available, there is appropriated to the Secretary of Homeland Security for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $500,000,000, to remain available until September 30, 2028, for the Office of the Chief Readiness Support Officer to carry out sustainability and environmental programs.

SEC. 70002. UNITED STATES POSTAL SERVICE CLEAN FLEETS.

In addition to amounts otherwise available, there is appropriated to the United States Postal Service for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, the following amounts, to be deposited into the Postal Service Fund established under section 2003 of title 39, United States Code:

(1) $1,290,000,000, to remain available through September 30, 2031, for the purchase of zero-emission delivery vehicles.

(2) $1,710,000,000, to remain available through September 30, 2031, for the purchase, design, and installation of the requisite infrastructure to support zero-emission delivery vehicles at facilities that the United States Postal Service owns or leases from non-Federal entities.

SEC. 70003. UNITED STATES POSTAL SERVICE OFFICE OF INSPECTOR GENERAL.

In addition to amounts otherwise available, there is appropriated to the Office of Inspector General of the United States Postal Service for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $15,000,000, to remain available through September 30, 2031, to support oversight of United States Postal Service activities implemented pursuant to this Act.

SEC. 70004. GOVERNMENT ACCOUNTABILITY OFFICE OVERSIGHT.

In addition to amounts otherwise available, there is appropriated to the Comptroller General of the United States for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $25,000,000, to remain available until September 30, 2031, for necessary expenses of the Government Accountability Office to support the oversight of—

(1) the distribution and use of funds appropriated under this Act; and

(2) whether the economic, social, and environmental impacts of the funds described in paragraph (1) are equitable.

SEC. 70005. OFFICE OF MANAGEMENT AND BUDGET OVERSIGHT.

In addition to amounts otherwise available, there are appropriated to the Director of the Office of Management and Budget for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $25,000,000, to remain available until September 30, 2026, for necessary expenses to—

(1) oversee the implementation of this Act; and

(2) track labor, equity, and environmental standards and performance.

SEC. 70006. FEMA BUILDING MATERIALS PROGRAM.

Through September 30, 2026, the Administrator of the Federal Emergency Management Agency may provide financial assistance under sections 203(h), 404(a), and 406(b) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5133(h), 42 U.S.C. 5170c(a), 42 U.S.C. 5172(b)) for— Time period.

(1) costs associated with low-carbon materials; and

(2) incentives that encourage low-carbon and net-zero energy projects.

SEC. 70007. FEDERAL PERMITTING IMPROVEMENT STEERING COUNCIL ENVIRONMENTAL REVIEW IMPROVEMENT FUND MANDATORY FUNDING.

In addition to amounts otherwise available, there is appropriated to the Federal Permitting Improvement Steering Council Environmental Review Improvement Fund, out of any money in the Treasury not otherwise appropriated, $350,000,000 for fiscal year 2023, to remain available through September 30, 2031.

TITLE VIII—COMMITTEE ON INDIAN AFFAIRS

SEC. 80001. TRIBAL CLIMATE RESILIENCE.

(a) TRIBAL CLIMATE RESILIENCE AND ADAPTATION.—In addition to amounts otherwise available, there is appropriated to the Director of the Bureau of Indian Affairs for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $220,000,000, to remain available until September 30, 2031, for Tribal climate resilience and adaptation programs.

(b) BUREAU OF INDIAN AFFAIRS FISH HATCHERIES.—In addition to amounts otherwise available, there is appropriated to the Director of the Bureau of Indian Affairs for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $10,000,000, to remain available until September 30, 2031, for fish hatchery operations and maintenance programs of the Bureau of Indian Affairs.

(c) ADMINISTRATION.—In addition to amounts otherwise available, there is appropriated to the Director of the Bureau of Indian Affairs for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $5,000,000, to remain available until September 30, 2031, for the administrative costs of carrying out this section.

(d) COST-SHARING AND MATCHING REQUIREMENTS.—None of the funds provided by this section shall be subject to cost-sharing or matching requirements.

(e) SMALL AND NEEDY PROGRAM.—Amounts made available under this section shall be excluded from the calculation of funds received by those Tribal governments that participate in the "Small and Needy" program.

(f) DISTRIBUTION; USE OF FUNDS.—Amounts made available under this section that are distributed to Indian Tribes and Tribal organizations for services pursuant to a self-determination contract (as defined in subsection (j) of section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5304(j))) or a self-governance compact entered into pursuant to subsection (a) of section 404 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5364(a))—

(1) shall be distributed on a 1-time basis;

(2) shall not be part of the amount required by subsections (a) through (b) of section 106 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5325(a)–(b)); and

(3) shall only be used for the purposes identified under the applicable subsection.

SEC. 80002. NATIVE HAWAIIAN CLIMATE RESILIENCE.

(a) NATIVE HAWAIIAN CLIMATE RESILIENCE AND ADAPTATION.—In addition to amounts otherwise available, there is appropriated to the Senior Program Director of the Office of Native Hawaiian Relations for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $23,500,000, to remain available until September 30, 2031, to carry out, through financial assistance, technical assistance, direct expenditure, grants, contracts, or cooperative agreements, climate resilience and adaptation activities that serve the Native Hawaiian Community.

(b) ADMINISTRATION.—In addition to amounts otherwise available, there is appropriated to the Senior Program Director of the Office of Native Hawaiian Relations for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $1,500,000, to remain available until September 30, 2031, for the administrative costs of carrying out this section.

(c) COST-SHARING AND MATCHING REQUIREMENTS.—None of the funds provided by this section shall be subject to cost-sharing or matching requirements.

SEC. 80003. TRIBAL ELECTRIFICATION PROGRAM.

(a) TRIBAL ELECTRIFICATION PROGRAM.—In addition to amounts otherwise available, there is appropriated to the Director of the Bureau of Indian Affairs for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $145,500,000, to remain available until September 30, 2031, for—

(1) the provision of electricity to unelectrified Tribal homes through zero-emissions energy systems;

(2) transitioning electrified Tribal homes to zero-emissions energy systems; and

(3) associated home repairs and retrofitting necessary to install the zero-emissions energy systems authorized under paragraphs (1) and (2).

(b) ADMINISTRATION.—In addition to amounts otherwise available, there is appropriated to the Director of the Bureau of Indian Affairs for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $4,500,000, to remain available until September 30, 2031, for the administrative costs of carrying out this section.

(c) COST-SHARING AND MATCHING REQUIREMENTS.—None of the funds provided by this section shall be subject to cost-sharing or matching requirements.

(d) SMALL AND NEEDY PROGRAM.—Amounts made available under this section shall be excluded from the calculation of funds received by those Tribal governments that participate in the "Small and Needy" program.

(e) DISTRIBUTION; USE OF FUNDS.—Amounts made available under this section that are distributed to Indian Tribes and Tribal organizations for services pursuant to a self-determination contract (as defined in subsection (j) of section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5304(j))) or a self-governance compact entered into pursuant to subsection (a) of section 404 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5364(a))—

(1) shall be distributed on a 1-time basis;

(2) shall not be part of the amount required by subsections (a) through (b) of section 106 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. 5325(a)–(b)); and

(3) shall only be used for the purposes identified under the applicable subsection.

SEC. 80004. EMERGENCY DROUGHT RELIEF FOR TRIBES.

(a) EMERGENCY DROUGHT RELIEF FOR TRIBES.—In addition to amounts otherwise available, there is appropriated to the Commissioner of the Bureau of Reclamation for fiscal year 2022, out of any money in the Treasury not otherwise appropriated, $12,500,000, to remain available until September 30, 2026, for near-term drought relief actions to mitigate drought impacts for Indian Tribes that

are impacted by the operation of a Bureau of Reclamation water project, including through direct financial assistance to address drinking water shortages and to mitigate the loss of Tribal trust resources.

(b) COST-SHARING AND MATCHING REQUIREMENTS.—None of the funds provided by this section shall be subject to cost-sharing or matching requirements.

Approved August 16, 2022.

LEGISLATIVE HISTORY—H.R. 5376:

HOUSE REPORTS: No. 117–130 (Comm. on the Budget).
CONGRESSIONAL RECORD:
Vol. 167 (2021): Nov. 18, 19, considered and passed House.
Vol. 168 (2022): Aug. 6, considered and passed Senate, amended.
Aug. 12, House concurred in Senate amendment.
DAILY COMPILATION OF PRESIDENTIAL DOCUMENTS (2022):
Aug. 16, Presidential remarks.

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Independent Statistics and Analysis
U.S. Energy Information Administration

Annual Energy Outlook

AEO2023

The U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy (DOE), prepared this report. By law, our data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government. The views in this report do not represent those of DOE or any other federal agencies.

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Administrator's Foreword

After a 23-year hiatus, I am reintroducing the Administrator's Foreword as part of the *Annual Energy Outlook* (AEO). The Foreword affords me an opportunity to provide context and outline future directions for one of our flagship products.

The U.S. energy system is rapidly changing. In recent years, technology innovation has accelerated the deployment of renewable energy, expanded markets for electric vehicles, and established record-high levels of petroleum and natural gas production. Heightened geopolitical risks have also influenced the energy system. And this year, recent federal legislation authorizes historic levels of investment in clean energy technology.

Ideally, we would model these dynamics to produce precise numerical forecasts that demonstrate how energy prices, technology deployment, and emissions will shift over time. Unfortunately, such precise forecasts are not possible. The 30-year decision landscape we model is too complex and uncertain. Thus, our objective must be to identify robust insights rather than precise numbers—think ranges and trends, not predictions and point estimates.

The AEO includes a series of projections—which we refer to as *cases*—each with different input assumptions that represent alternative views of how uncertainty may be resolved in the future. The Reference case represents our best guess under nominal conditions, which presumes no new policy or laws over the modeled time horizon. It's best to think of the Reference case as the experimental control: a baseline against which we can judge the other cases. Although the Reference case serves as an important benchmark, judgments about energy futures should never be based on a single projection. The AEO side cases represent plausible variations in key input assumptions that tend to drive the largest changes in projected outputs from the Reference case. This year's AEO narrative focuses on the full set of modeled cases in order to derive insights about our collective energy future.

Among the uncertainties we must confront, the timing, structure, and targets associated with yet-to-be-developed policy are the most uncertain. We only consider current laws and regulations across all modeled cases in this AEO. For some readers, this approach may be unsatisfying because policy rarely remains static for long periods. But this AEO should be considered part of an iterative policymaking process rather than apart from it; it gives decision-makers an opportunity to peer into a future without new policy. If the projected outcomes are undesirable from their viewpoint, they can effect change.

Changes to This Year's Edition

This year's edition of the *Annual Energy Outlook* includes three enhancements that improve the characterization of future uncertainty and provide more technical details on the model results.

Combination cases

Although the AEO core side cases address key uncertainties, each case represents a one-factor change to the Reference case. But, real energy markets often surprise us in more ways than one, particularly over the decades-long timeframes modeled in the AEO. In this year's edition, we include cases that combine assumptions from our macroeconomic and zero-carbon technology cost cases. These new cases reflect a combination of demand-side changes (macroeconomic growth affecting energy demand) and supply-side changes (renewables costs affecting generating capacity deployment) to expand the range of projections in the *Annual Energy Outlook*.

Visualizing uncertainty

Running a set of cases is not enough: how we present and discuss them within the report affects the insights that our readers draw from the analysis. Although the Reference case is an important benchmark, each case represents a possible alternative. So, in each of the figures in this report, you will see shaded areas that represent the range of results obtained across the modeled cases. Uncertainty can be characterized in many other ways beyond the analysis of multiple cases. One way, presented in the discussion section, uses deviations between realized and projected values drawn from previous AEO editions to derive a cone of uncertainty for future energy-related CO_2 emissions. Looking ahead, you should expect to see more innovation in how we treat uncertainty.

Technical notes

The narrative tends to focus on model-based results. We recognize that some readers want a deeper technical explanation around key issues. Although we describe our modeling approach elsewhere, how the model formulation and input assumptions influence the results is not always clear. To better explain key results, we included a series of technical notes in the narrative that focus on heat pump deployment, cost projections for renewables, electric vehicle deployment, and crude oil trade.

Future Work

At EIA, we are also pursuing broader changes to our long-term modeling efforts. I would like to highlight three such efforts.

Open-source code

One of our priorities at EIA is to make our data and model-based analysis as transparent and accessible as possible. We are working to make the National Energy Modeling System (NEMS) publicly available in GitHub under a permissive, open-source license, and we hope to complete this effort later this year. Making our models open source allows users to examine, reuse, and redistribute our code under clear legal guidelines. Giving you this kind of access is important to the learning and discovery process associated with energy modeling.

Expanded scenario range

Building on the combination cases in this year's AEO, we are expanding our capability to model a wider range of future scenarios using NEMS. In particular, decision makers need objective and rigorous assessments of net zero emissions pathways to inform ongoing policy discussions. We are working to incorporate novel fuel and technology pathways into NEMS and to appropriately treat uncertainty around technologies with limited commercial deployment.

A next-generation, open-source modeling framework

Although regularly updated, we have been using NEMS to produce the AEO since 1994—a span of nearly three decades that has born witness to significant changes in the real energy system, energy modeling methods, and software development practices. Moving forward, we need a flexible, next-generation modeling framework that can rapidly assess the cost, emissions, reliability, security, and community-level impacts associated with a number of contemporary energy issues. Some of these issues include pathways to a net-zero energy system, supply chain risks, rapid technology innovation, and shifting trade patterns. This modeling system will also be open source to promote transparency and encourage innovation within the modeling community. We've begun discussing this new framework, and I look forward to sharing our progress throughout my tenure as EIA Administrator.

In Closing

I'd like to thank our long-term modelers for their willingness to take on new directions and their tremendous effort to produce this year's AEO. I am very excited by the future work outlined above, and I feel privileged to help lead such a talented team of energy modelers.

Executive Summary

Our *Annual Energy Outlook* 2023 (AEO2023) explores long-term energy trends in the United States. Since last year's AEO, much has changed, most notably the passage of the Inflation Reduction Act (IRA), Public Law 117–169, which altered the policy landscape we use to develop our projections.

We project that U.S. energy-related CO_2 emissions drop 25% to 38% below the 2005 level by 2030. For reference, the United States' *nationally determined contribution* (NDC), submitted as part of the Paris Agreement, calls for a target of 50% to 52% of net greenhouse gas emissions below the 2005 level by 2030.[1] We only consider energy-related CO_2 emissions, which does not cover the full NDC scope. Total energy-related CO_2 emissions in 2050 declined by 17% in this year's Reference case compared with last year's. Some of the primary factors that contributed to the change in our base case include the IRA, updates to technology costs and performance across the energy system, and changes in the macroeconomic outlook. All AEO2023 cases assume current laws and regulations, and compared with last year's AEO, there is a significant shift toward lower future emissions. The IRA represents a complex piece of legislation, and we could not model all provisions given model structure and uncertainty over select implementation details. The appendix includes a detailed accounting of IRA provisions and how we addressed them. To further explore possible emissions reductions, we also derive a cone of uncertainty based on an empirical analysis of our past projections and find that the energy-related CO_2 emissions reduction can be as high as 45% below 2005 levels in 2030.

Energy-related CO_2 emissions fall across all AEO2023 cases because of increased electrification, higher equipment efficiencies, and more zero-carbon electricity generation.

Overall, our lower projected U.S. energy-related CO_2 emissions is driven by increased electrification, equipment efficiency, and renewable technologies for electricity generation. However, emissions reductions are limited by longer-term growth in U.S. transportation and industrial activity. As a result, these projected emissions reductions are most sensitive to our assumptions regarding economic growth and the cost of zero-carbon generation technology.

[1] The *nationally determined contribution* (NDC) is a formal submission to the United Nations Framework Convention on Climate Change. The United States submitted, "To achieve an economy-wide target of reducing its net greenhouse gas emissions by 50-52 percent below 2005 levels in 2030."

In AEO2023, we see stable growth in U.S. electric power demand through 2050 in all cases we considered because of increasing electrification and ongoing economic growth. The combination of declining capital costs and government subsidies, including IRA initiatives, drive rising renewable technologies for electricity generation, such as solar and wind. Once built and when the resource is available, wind and solar are the least cost resources to operate to meet electricity demand because they have zero fuel costs. Over time, the combined investment and operating cost advantage increases the share of zero-carbon electricity generation. As a result, in AEO2023, we see renewable generating capacity growing in all regions of the United States in all cases. Across all cases, compared with 2022, solar generating capacity grows by about 325% to 1019% by 2050, and wind generating capacity grows by about 138% to 235%. We see growth in installed battery capacity in all cases to support this growth in renewables. Across the span of AEO cases, relative to 2022, natural gas generating capacity ranges from an increase of between 20% to 87% through 2050.

Renewable generating capacity grows in all regions of the United States in all AEO2023 cases, supported by growth in installed battery capacity.

Technological advancements and electrification drive projected decreases in demand-side energy intensity.

Not only is the U.S. electric power sector's composition changing, but we see increased electrification in the end-use sectors. We project more heat pumps and electric vehicles, as well as electric arc furnaces increasingly deployed in the iron and steel industry. In the residential and commercial sectors, higher equipment efficiencies and stricter building codes extend ongoing declines in energy intensity. Despite the growth in adopting heat pumps, natural gas-fired heating equipment, including furnaces and boilers, continue to account for the largest share of energy consumption for space heating in U.S. residential and commercial buildings across all cases through 2050. In the transportation sector, light-duty vehicle energy demand declines through 2045 as more electric vehicles are deployed and stricter Corporate Average Fuel Economy (CAFE) standards largely offset the continued growth in travel demand. The energy demand then increases as rising travel overcomes increasing efficiency. Across all cases, light-duty vehicle energy demand decreases by 3% to 28% in 2050 relative to 2022.

High international demand leads to continued growth in U.S. production, and combined with relatively little growth in domestic consumption, allows the United States to remain a net exporter of petroleum products and natural gas through 2050 in all AEO2023 cases.

Despite no significant change in domestic petroleum and other liquids consumption through 2040 across most AEO2023 cases, we expect U.S. production to remain historically high as exports of finished products grow in response to growing international demand. Despite the shift toward renewable sources and batteries in electricity generation, domestic natural gas consumption remains relatively stable—ending recent growth in most cases. Natural gas production, however, in some cases continues to grow in response to international demand for liquefied natural gas, supported by associated natural gas produced along with crude oil. Given the combination of relatively little growth in domestic consumption and continued growth in production, we project that the United States will remain a net exporter of petroleum products and natural gas through 2050 in all AEO2023 cases.

Introduction

The *Annual Energy Outlook* 2023 (AEO2023) explores long-term energy trends in the United States. Since we released the last AEO in early 2022, passage of the Inflation Reduction Act (IRA), Public Law 117–169, altered the policy landscape we use to develop our projections. The Appendix in this report explains our assumptions around IRA implementation and how we implemented the IRA in our AEO2023 cases. We are also releasing a separate *Issues in Focus* paper that explores how these assumptions affect our model-based projections. We have seen significant national and international short-term market volatility associated with economic growth as the world reemerges from the COVID-19 pandemic and political instability associated with Russia's full-scale invasion of Ukraine. We continuously monitor such developments and consider how they may affect our long-term projections.

AEO2023 includes a Reference case and 12 side cases that explore key areas of uncertainty about how energy markets will develop. We retooled our graphs to emphasize the range of results, denoted by shaded areas, across the full suite of modeled cases. We derive our key analytical insights by assessing the results across cases and examining how overall trends may vary under different assumptions. This year, we've added a discussion section focused on sources of uncertainty in the AEO2023 projections. We also now derive a cone of uncertainty associated with future energy-related CO_2 emissions using deviations between past projections and realized values.

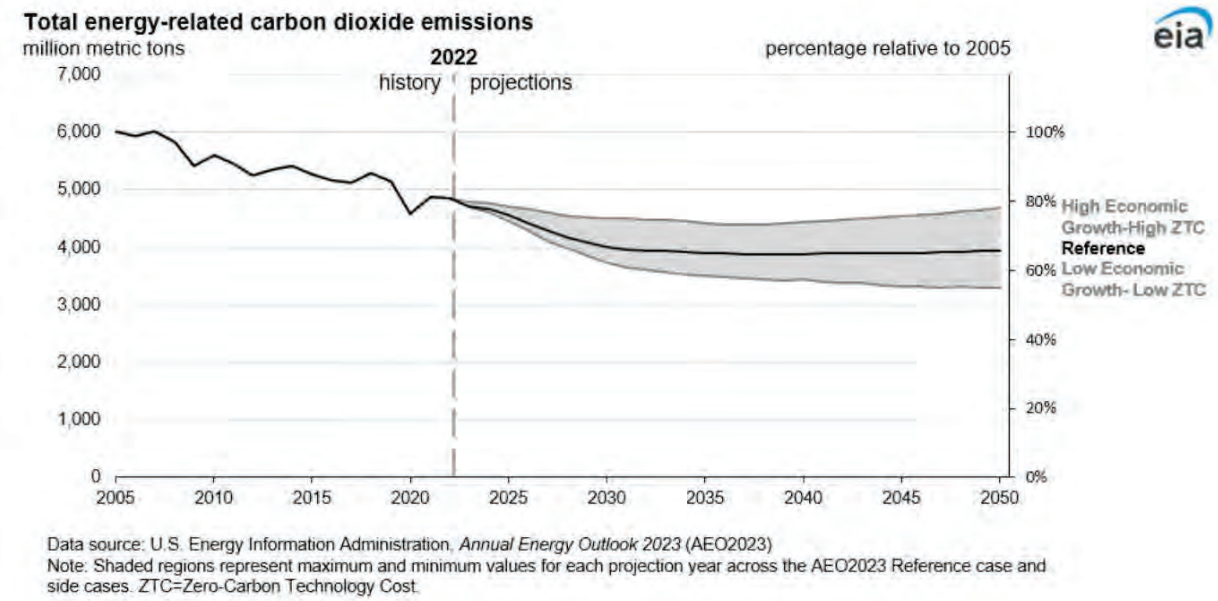
By 2030, energy-related CO_2 emissions fall 25% to 38% below 2005 levels, depending on case assumptions

Under the Paris Agreement, the United States set a goal to reduce economy-wide greenhouse gas emissions by 50% to 52% of 2005 levels by 2030. We only consider energy-related CO_2 emissions, which does not cover the full NDC scope. We project lower U.S. energy-related CO_2 emissions in 2030 relative to 2005 in the AEO2023 Reference case and all side cases (Figure 1). CO_2 emissions are most sensitive to economic growth and assumptions related to the cost of zero-carbon generation technology. Combinations of these two sets of assumptions form the upper and lower bounds of projected CO_2 emissions. Emissions decrease by 25% in 2030 relative to 2005 under the combined high economic growth and high zero-carbon technology cost assumptions and by as much as 38% under low economic growth and low zero-carbon technology cost assumptions. Both of these cases hinge on specific assumptions regarding the relationship between economic growth and zero-carbon technology development.[2] In the High Economic Growth case, emissions fall initially and then begin to increase

[2] The purpose of the combination cases was to explore a wider range of outcomes. We did not explicitly consider the correlation or interaction between zero-carbon technology costs and economic growth. The High Economic Growth and High Zero-Carbon Technology Cost case assume this higher growth rate takes place without declining zero-carbon technology costs. Similarly, slower economic growth accompanies declining technology costs in the Low Economic Growth and Low Zero-Carbon Technology Cost case.

again in 2040 as industrial activity and travel (measured in vehicle miles traveled) increase, surpassing emissions reductions from the electric power sector.

Figure 1.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost.

The largest variations in projected U.S. CO_2 emissions across cases occur in the electric power, transportation, and industrial sectors. Although economic growth assumptions affect consumption and, in turn, projected CO_2 emissions in all sectors, different case-specific assumptions affect sectors differently. For example, emissions from the electric power sector are particularly responsive to assumptions about the cost of zero-carbon technologies, and transportation sector emissions are sensitive to assumptions about fossil fuel supply and cost, particularly oil and petroleum products.

1

The Electricity Mix in the United States Shifts from Fossil Fuels to Renewables

In this section, we discuss renewables displacing fossil fuels in the electric power sector.

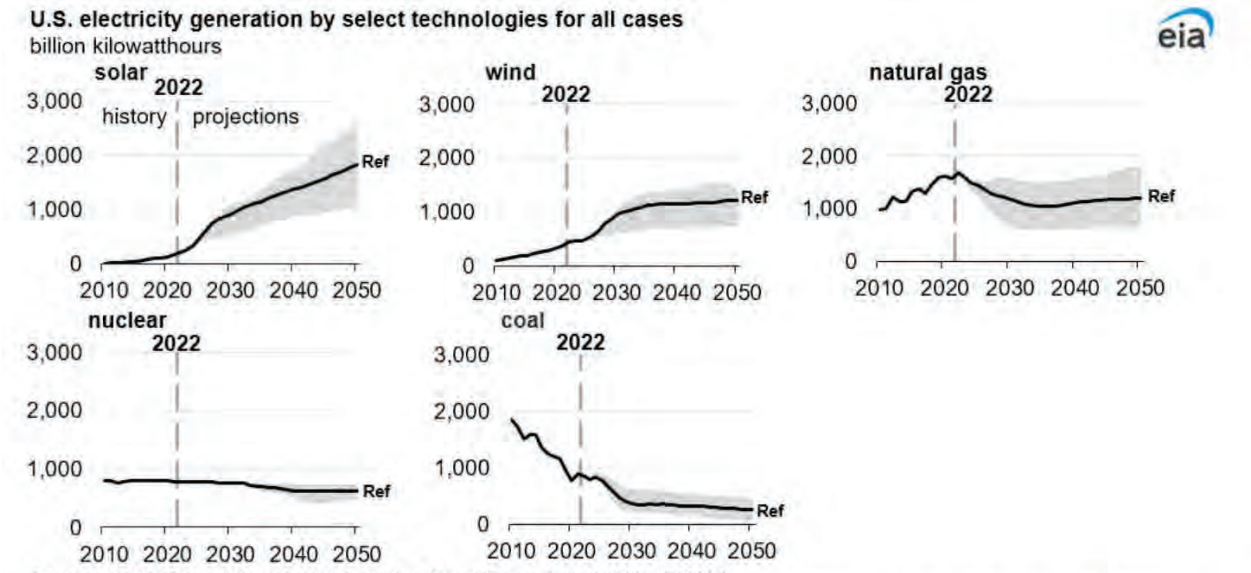
Renewables displace fossil fuels in the electric power sector due to declining renewable technology costs and rising subsidies for renewable power

Economic growth paired with increasing electrification in end-use sectors results in stable growth in U.S. electric power demand through 2050 in all cases. Declining capital costs for solar panels, wind turbines, and battery storage, as well as government subsidies such as those included in the IRA, result in renewables becoming increasingly cost effective compared with the alternatives when building new power capacity.

Power demand is increasingly met by renewables throughout the projection period.

Renewables are increasingly meeting power demand throughout the projection period (Figure 2). Natural gas, coal, and nuclear generation shares decline. Renewable power outcompetes nuclear power, even in the Low Zero-Carbon Technology Cost (ZTC) case, which evaluates the impact of more aggressive cost declines for nuclear and renewables than the Reference case. Most natural gas-fired generation comes from combined-cycled power plants as opposed to simple-cycle combustion turbines. Uncertainty in natural gas prices across cases leads to various projections for combined-cycle units in the short term, but in the long term, natural gas demand from the electric power sector stabilizes across all cases.

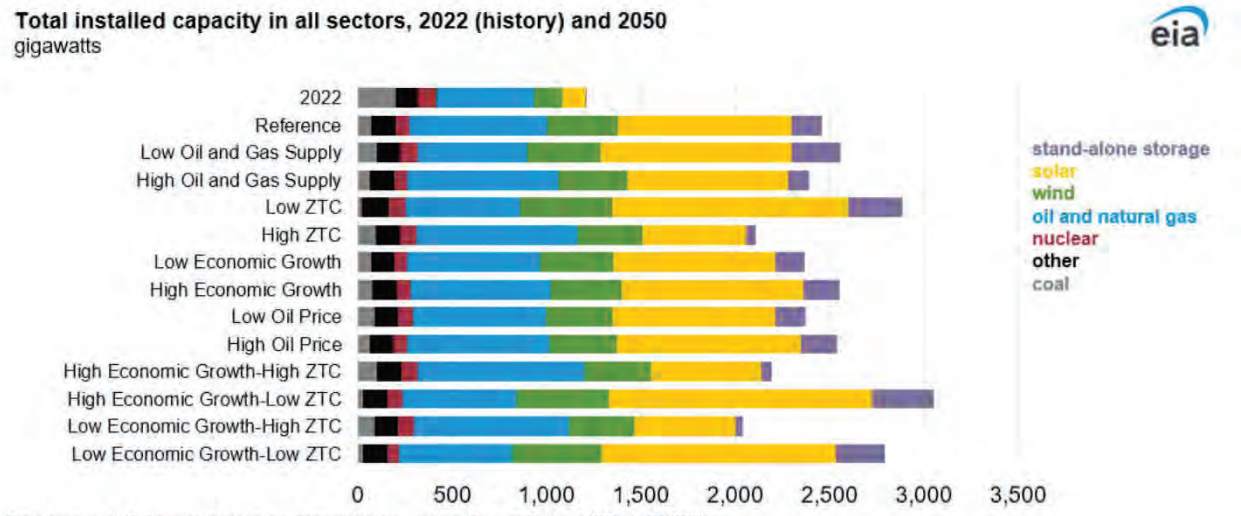
Figure 2.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. Ref=Reference case.

In order to meet increasing demand for electric power throughout the projection, total installed power capacity close to doubles across most cases, even in the Low Economic Growth case (Figure 3). Cases with a higher share of renewables in the generation mix have higher total grid capacity due to the inherently lower capacity factors of solar and wind compared with coal, nuclear, and combined-cycle plants.

Figure 3.

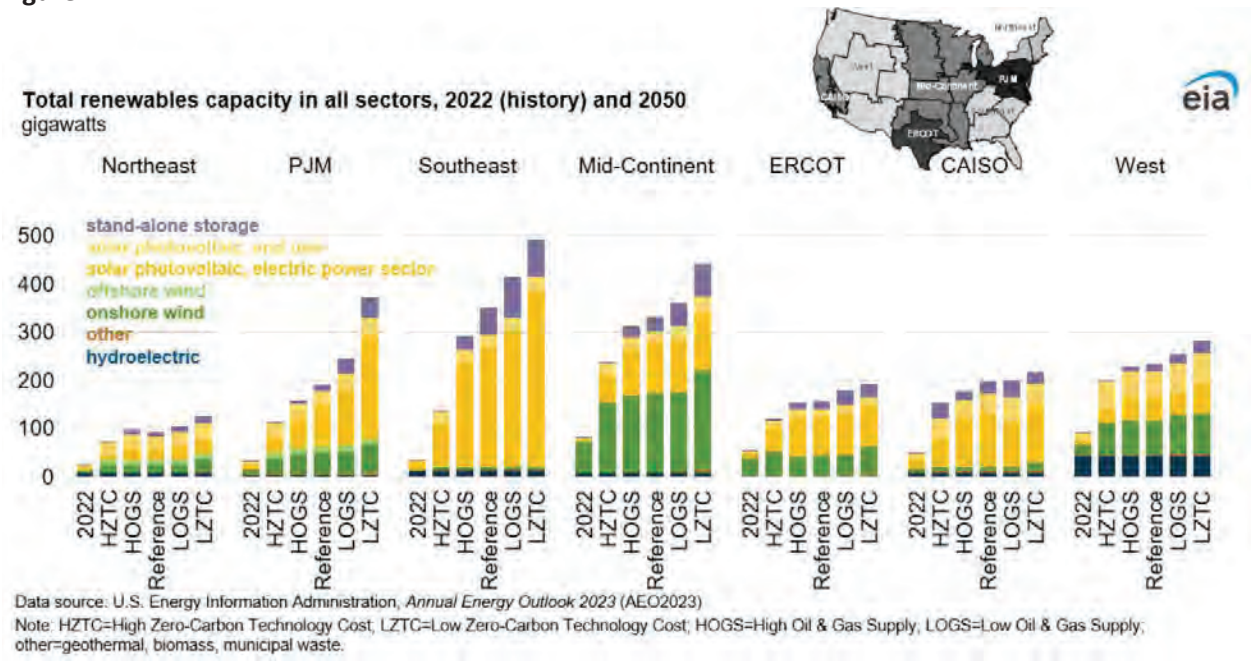


Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: ZTC=Zero-Carbon Technology Cost; other=geothermal, biomass, municipal waste, fuel cells, hydroelectric, pumped hydro storage.

We project that renewable power capacity will increase in all regions of the United States in all AEO2023 cases, although regional resource availability results in varying renewable resource mixes across regions (Figure 4). Across all cases, between 40%-60% of the renewable power capacity in the Mid-Continent region in 2050 comes from wind, and the Southeast and the region managed by the California

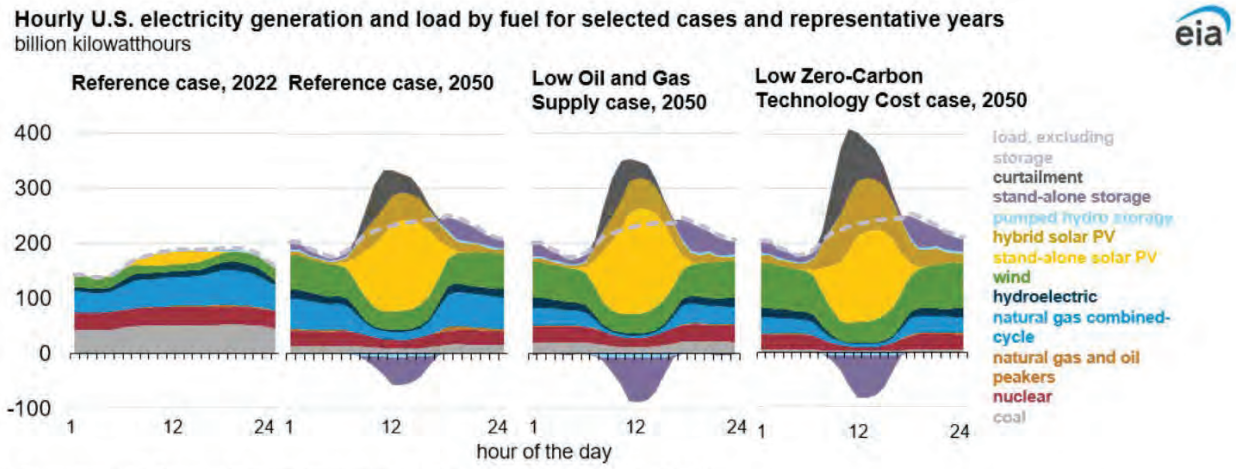
Independent System Operator (CAISO) have large shares of solar and a small amount of wind power capacity in all cases.

Figure 4.



Once built and when the resource is available, wind and solar generation outcompete other technologies for system dispatch because they have zero fuel costs. Across all AEO2023 cases, some renewable generation is left unused and curtailed, typically midday when solar generation can exceed demand in some regions and seasons. Battery capacity is built in all cases to store and dispatch some of this otherwise unused generation in later hours, decreasing reliance on fossil fuel capacity, such as natural gas-fired peaking units or load-following combined-cycle units (Figure 5). Battery storage is also used to replace natural gas-fired capacity to provide reserve capacity. In the Reference case in 2050, 160 gigawatts (GW) of standalone battery storage capacity will be deployed, and deployment varies between 40 GW and 260 GW in the other cases.

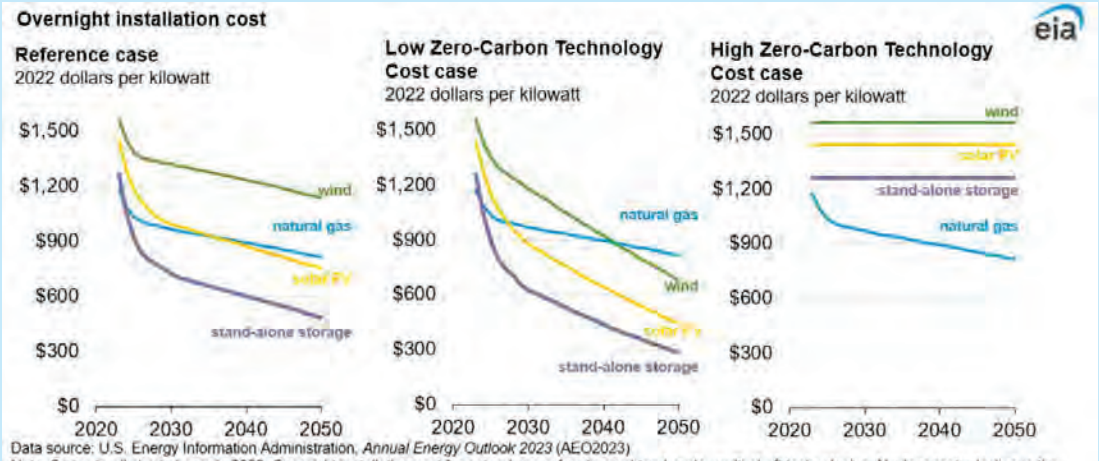
Figure 5.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Negative generation represents charging of energy storage technologies such as pumped hydro storage and battery storage. Hourly dispatch estimates are illustrative and are developed to determine curtailment and storage operations; final dispatch estimates are developed separately and may differ from total utilization as this figure shows. Standalone solar photovoltaic (PV) includes both utility-scale and end-use PV electricity generation.

Technical Note 1: Renewable costs and deployment

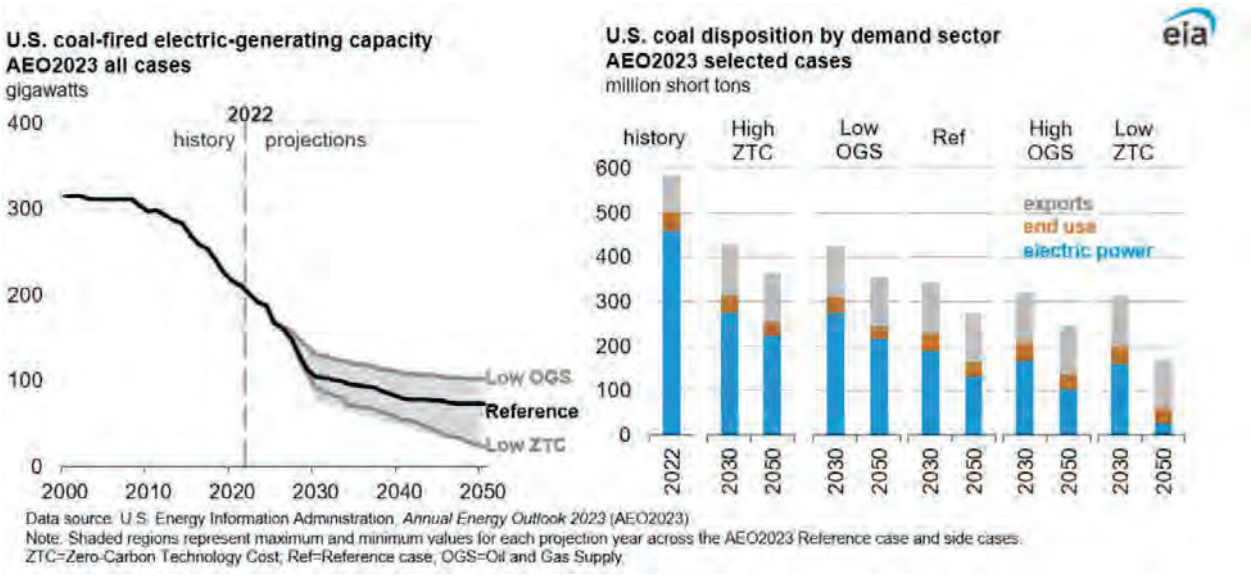
Continued decline of renewable technology costs relative to natural gas-fired generating technologies contributes to the change in generation mix in our projection period. In addition to recent policies that also favor renewables in the generation mix, we use learning factors to represent learning by doing, which reduces capital costs. Learning factors are calculated independently for each of the major design components of the technology, and they increase based on how much new capacity is deployed. For details on renewable costs in the ZTC cases, please see the Appendix. New, untested components decrease at a more rapid initial rate than mature components or conventional designs. More details can be found in the NEMS Electricity Market Module documentation.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Series in all charts begin in 2023. Overnight installation cost for natural gas refers to combined-cycle, multi-shaft technologies. Nuclear costs decline in the Reference and Low Zero-Carbon Technology cases, but they are not shown given the large differences in absolute cost compared with renewables. In the Reference case, nuclear begins at $7,900 per kilowatt (kW) and declines to $5,000/kW in 2050. In the Low Zero-Carbon Technology case, the cost of nuclear declines to $3,000/kW in 2050. Solar PV=stand-alone solar photovoltaic

As a result of renewables growth, we project that U.S. coal-fired generation capacity will decline sharply by 2030 to about 50% of current levels (about 200 GW) with a more gradual decline thereafter. We project between 23 GW and 103 GW of coal-fired capacity operating in 2050 (Figure 6). The IRA provides additional incentives to wind and solar power generation, which accelerates the near-term decline of electric power sector coal-fired generating capacity and hastens the timeline for retirement in the U.S. coal fleet.

Figure 6.

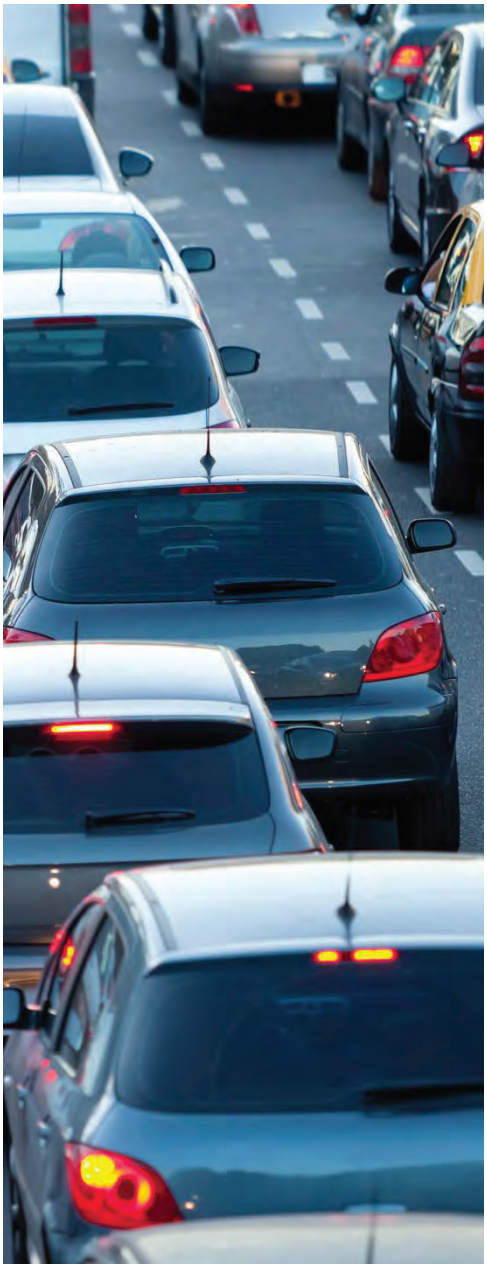


Coal consumption in the U.S. electric power sector in the Reference case drops to 189 million short tons (MMst) in 2030 and to 131 MMst in 2050 from 458 MMst in 2022. Coal disposition, which includes exports and consumption by the electric power sector and other end-use sectors, declines to a low of 170 MMst in 2050 in the Low ZTC case. In a high natural gas price environment, such as in the Low Oil and Gas Supply case, coal disposition could remain as high as 350 MMst in 2050. In all cases, annual coal exports average about 110 MMst in 2050, and end-use coal demand averages about 36 MMst. The ratio of coal exports to domestic coal consumption generally increases through the projection period in all cases. The majority of domestically produced coal is exported by 2050 in the Low ZTC case, 45% is exported in the High Oil and Gas supply case, which are the two cases that have the least coal demand from the electric power sector. Even in cases with more aggressive retirement of coal-fired power plants, such as the Low ZTC case, some of the relatively newer and more efficient coal power plants remain online across the United States because they can provide cheap dispatchable power to the grid.

The electric power sector is also decreasing its reliance on natural gas in favor of renewables, which we will discuss in Section 3.

2

Technological Advancements and Electrification Decrease Demand-Side Energy Intensity



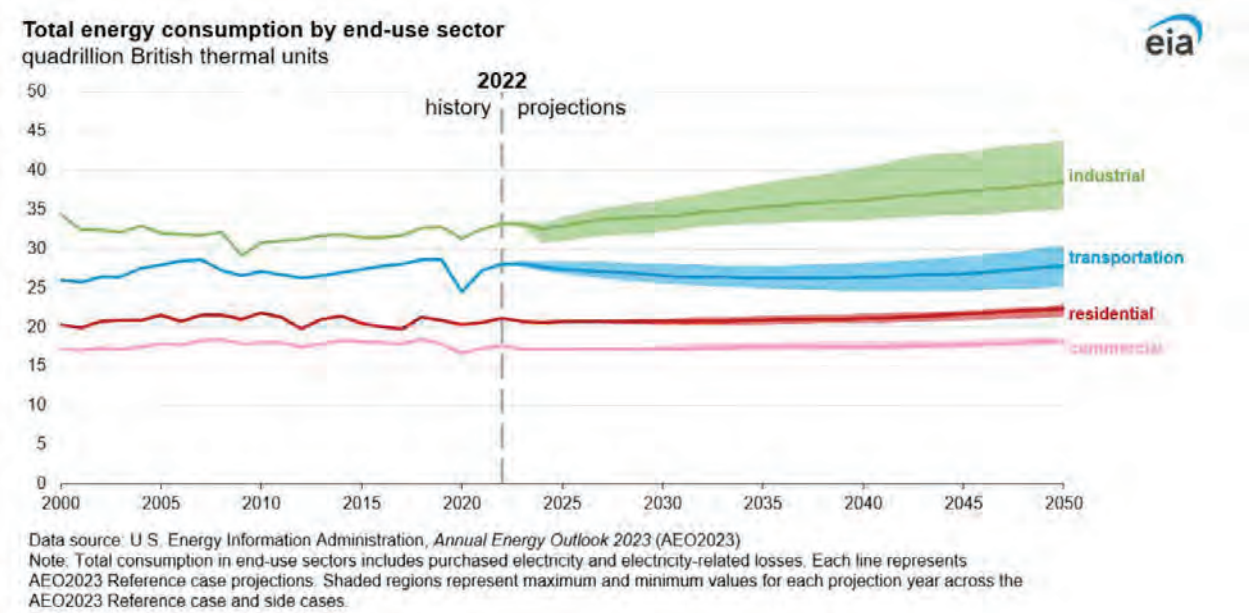
Moderate growth in U.S. energy consumption is the result of economic growth, population growth, and increased travel offsetting continued energy efficiency improvements. Demand-side energy intensity—the measure of energy consumed per household or per square foot of commercial floorspace—decreases as a result of changes in technology, policy, consumer behavior, demographics, and fuel mix. In this section, we quantify the decreases in CO_2 emissions intensity and demand-side energy intensity, and we discuss equipment changes in the buildings sector, electrification in iron and steel production, and technological advancements and government standards in the transportation sector.

U.S. energy consumption increases through 2050, and electricity plays an increasingly large role

U.S. energy consumption increases in many end-use sectors across all AEO2023 cases. Total energy consumption, including electricity use and electricity-related losses, increases by as much as 15% from 2022 to 2050 across the AEO2023 Reference case and side cases (Figure 7). The largest increases, in percentage terms, are in the industrial sector where energy consumption increases as much as 32% and in the transportation sector where energy consumption increases as much as 8%. Energy consumption in the residential and commercial sectors are the least sensitive to changes in assumptions across cases.

Total energy consumption, including electricity use and electricity-related losses, increases by as much as 15% from 2022 to 2050 across the AEO2023 Reference case and side cases.

Figure 7.



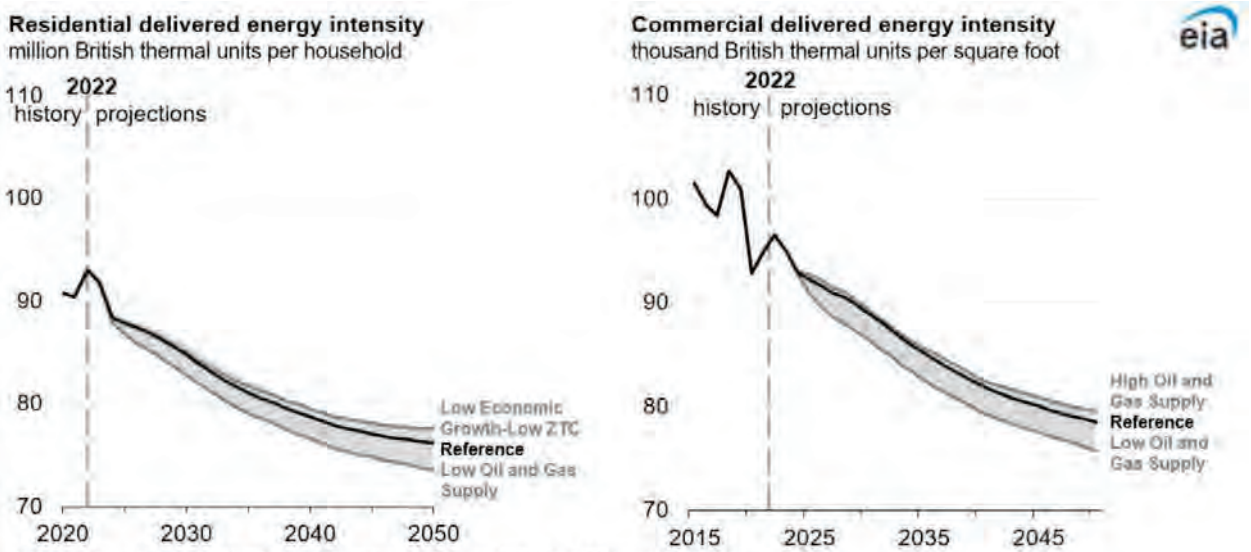
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Total consumption in end-use sectors includes purchased electricity and electricity-related losses. Each line represents AEO2023 Reference case projections. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

In addition to macroeconomic growth assumptions, which affect energy consumption in all sectors, many sectors are also highly responsive to zero-carbon technology cost assumptions. Increasing energy consumption, improving end-use and electric power sector technology and efficiency, and declining costs for zero-carbon generation technologies, which, in turn, leads to cheaper electricity, all lead to increased electrification in the end-use sectors. The share of electricity in the residential and transportation sectors increase the most as demand for space cooling increases and electric vehicles gain a larger market share. The residential sector purchased 5.1 quadrillion British thermal units (quads) of electricity in 2022, and residential consumption of purchased electricity increases between about 14% and 22% from 2022 to 2050 across all cases, reaching between 5.9 and 6.3 quads. Electricity purchased for transportation reaches between about 0.6 quads and 1.3 quads in 2050, from 0.1 quads of purchased electricity in 2022, an increase of between 892% and 2,038% across all cases. Electricity purchased in the industrial sector is most influenced by economic growth assumptions, increasing by about 3%, from 3.5 quads in 2022 to about 3.6 quads in 2050 in low economic growth cases and by about 36% to 38%, to about 4.7 quads, in high economic growth cases.

Greater heating equipment efficiency reduces fossil fuel use in buildings

Despite modest growth in total energy consumption in the residential and commercial sectors, due to a growing number of households and expanding commercial floorspace, average energy intensity declines through 2050 across all cases (Figure 7 and Figure 8). Building envelope efficiency improves as states and localities adopt newer building energy codes and some existing households and commercial spaces receive additional insulation, air sealing, and other weatherization upgrades.

Figure 8.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.
ZTC=Zero-Carbon Technology Cost.

An established trend toward warmer winters and population shifts toward warmer and drier areas of the United States reduce energy consumption for space heating in all cases. At the same time, the established trend toward warmer summers leads to increasing electricity consumption for space cooling.

Technical Note 2: Modeling growth in residential heat pump installations

Our projections of residential heat pumps, like all major end-use equipment, begin with the census division-level stocks from our 2015 Residential Energy Consumption Survey (RECS). We use data from the most recent U.S. Census Bureau's Survey of Construction to further align recent space heating equipment shares in newly built housing units. Equipment purchase decisions account for federal and non-federal subsidies that further reduce installed costs of high-efficiency equipment such as air- and ground-source heat pumps or high-efficiency natural gas furnaces. These subsidies include national tax credits extended by the Inflation Reduction Act (IRA) and utility rebates to end users at the census-division level. Technology performance and energy prices are considered as well. Some provisions of the IRA—such as those targeting low-income households—are not explicitly included in our modeling. Refer to the Appendix for additional details.

Natural gas-fired heating equipment, including furnaces and boilers, continue to account for the largest share of energy consumption for space heating in U.S. residential and commercial buildings across all cases throughout the projection period. Over time, older heating equipment is replaced by newer, more efficient equipment that meets updated federal minimum energy efficiency standards.

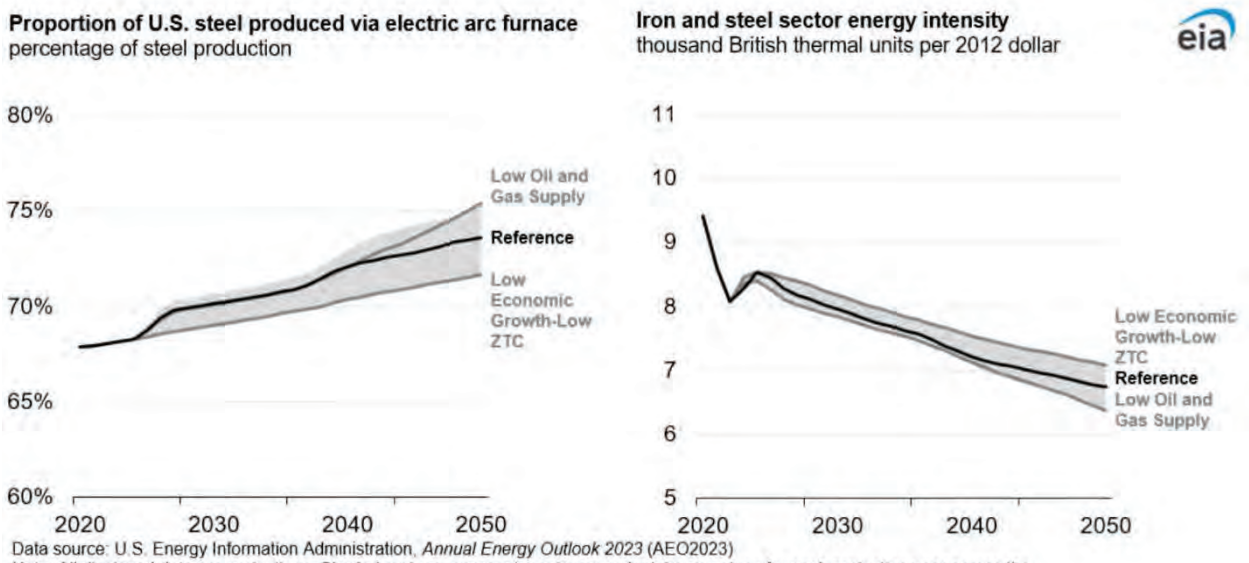
Federal and non-federal subsidies both encourage homes and businesses to adopt high-efficiency natural gas and electric equipment, including heat pumps. Electric heat pumps, including ground-source heat pumps, gain market share over the projection period, increasing from 11% of households in 2022 to between 14% and 15% of households in 2050 across all cases; however, their growth is limited by:

- A large existing market share for non-heat pump equipment that lasts a long time
- The high cost of purchasing and switching technologies, including electrical upgrades to accommodate electric heating and cooling and new ductwork when replacing boilers
- The higher price of electricity versus natural gas per million British thermal units, despite heat pump efficiency that may be multiple times higher than fossil fuel-fired equipment
- Reduced overall demand for space heating as building efficiency improves and heating degree days decrease

Electricity increasingly powers production in the iron and steel industry, decreasing energy intensity and CO_2 emissions

Steel production is an energy-intensive industry, but the choice of production technology significantly affects its energy and emission intensity. U.S. manufacturers continue to transition away from the combustion-powered, integrated steel mill process to steel produced by electric-arc furnaces, which have a lower energy intensity and make up about 68% of U.S. steel produced in 2022. Over the projection period, the share of U.S. steel produced by the electric-arc furnace process increases by 4% to 7% across the range of cases (Figure 9). The energy intensity of U.S. steel production continues to fall across all cases, declining between 12% and 21% across all cases (Figure 9). In 2018, steel production accounted for 1.3% of U.S. energy demand, and we project total energy demand for iron and steel production to fall relative to total U.S. energy demand, after peaking in 2027.

Figure 9.

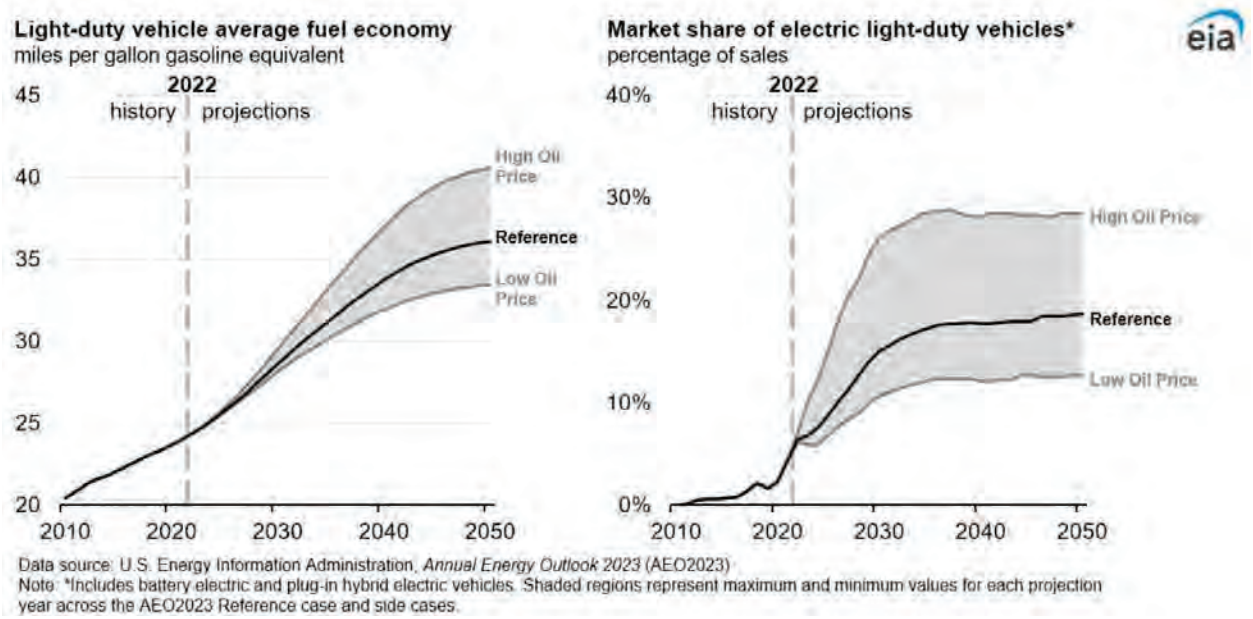


Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: All displayed data are projections. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost.

Technological advancements, including electrification, for light-duty vehicles reduce energy intensity and fossil fuel use

In the transportation sector, light-duty vehicle (LDV) fuel economy increases due to rising Corporate Average Fuel Economy (CAFE) standards and electric vehicle (EV) sales. In addition to required fuel economy increases, consumer purchase decisions are also influenced by fuel prices. Consumer interest in EVs, which are significantly more efficient than internal combustion engine vehicles, and the impact EV adoption has on average light-duty vehicle fuel economy are sensitive to the price of gasoline (Figure 10).

Figure 10.



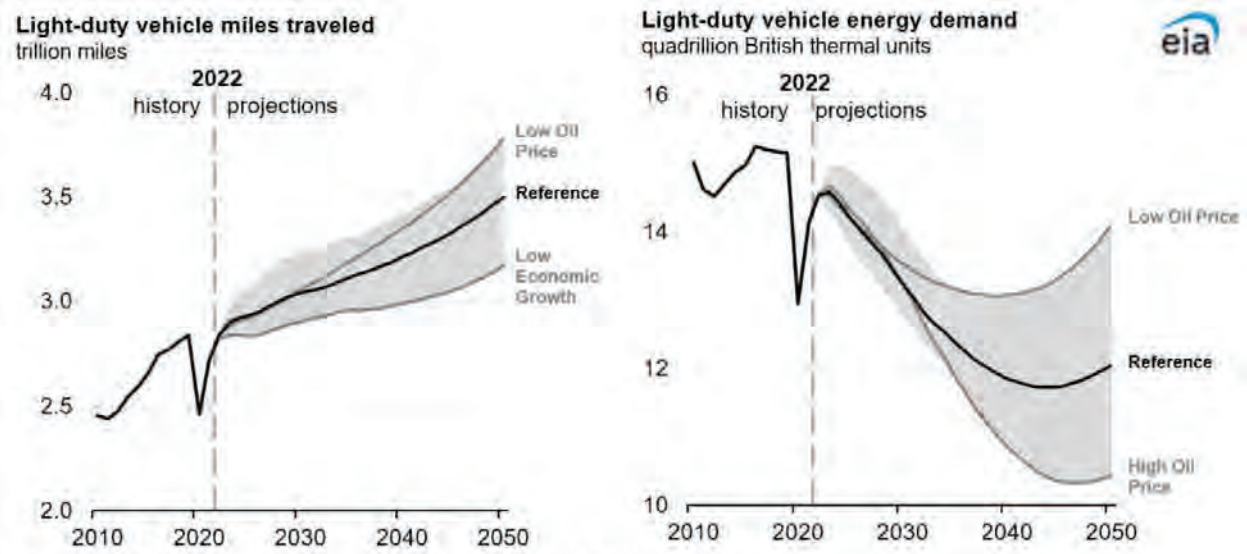
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: *Includes battery electric and plug-in hybrid electric vehicles. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

The updated CAFE standard, which applies to model years 2024 through 2026, significantly increases average new vehicle fuel economy requirements. By 2026, the updated CAFE standard is 28% higher than the Safer Affordable Fuel-Efficient (SAFE) standard for new vehicles it replaced, resulting in an increase from 37 miles per gallon (mpg) to 47 mpg by 2026. In addition to improved conventional vehicle fuel efficiency, EV sales increase through 2050, increasing EVs on the road. The CAFE standard, which offers credits to EV manufacturers, and decreasing battery prices help drive this increase in EV sales.

U.S. passenger vehicle-miles traveled increases steadily with population and income throughout the projection period, growing between 12% and 33% across all cases. In the Reference case, 23% more vehicle miles are traveled in 2050 than in 2022 (Figure 11). We project LDV energy consumption to fall through the early 2040s as a result of fuel economy improvements but then to rise due to increasing vehicle miles traveled for the remainder of the projection period (Figure 11).

We project LDV energy consumption to fall through the early 2040s as a result of fuel economy improvements but then to rise due to increasing vehicle miles traveled for the remainder of the projection period.

Figure 11.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. Right hand chart includes delivered energy, specifically energy consumed on board the vehicle; it does not include losses between car and charger.

Technical Note 3: Electric vehicle (EV) deployments

Projected declines in EV vehicle component costs, along with federal and state policies that provide incentives for EV purchases or require minimum sales, drive EV sales growth in our model projection. We derive cost declines for EV powertrain components and batteries by using learning rates based on cumulative production, resulting in increased projected driving range and a continual decline in EV prices over the projection period. We derive EV sales shares at the census-division level using a consumer choice model based on preference data and calibrated to align with historical sales data. In addition to other vehicle attributes, our consumer choice model captures the impact of vehicle price, cost to drive, access to refueling, and the effect that availability of vehicle propulsion options has on consumer purchase decisions. All of these factors contribute to the attractiveness of EVs to consumers and increases EV deployment relative to internal combustion engine vehicles. We assume Corporate Average Fuel Economy standards result in technological improvements and increased EV adoption because of declining cost and favorable fuel economy credits. The clean vehicle credit in the 2022 Inflation Reduction Act, which varies from $3,750 to $7,500 per vehicle, drives additional EV sales. Our Transportation Demand Model also ensures legally enforceable state minimum EV sales requirements are met in each census division and EV prices adjust to account for tax credits at purchase. In addition, other factors, such as a rising number of charging stations, affect our EV sales projections. We base our model projections on these data, assumptions, and current enforceable laws and regulations and do not assume that state and federal stated goals for EV sales are met. These details are available in our model documentation.

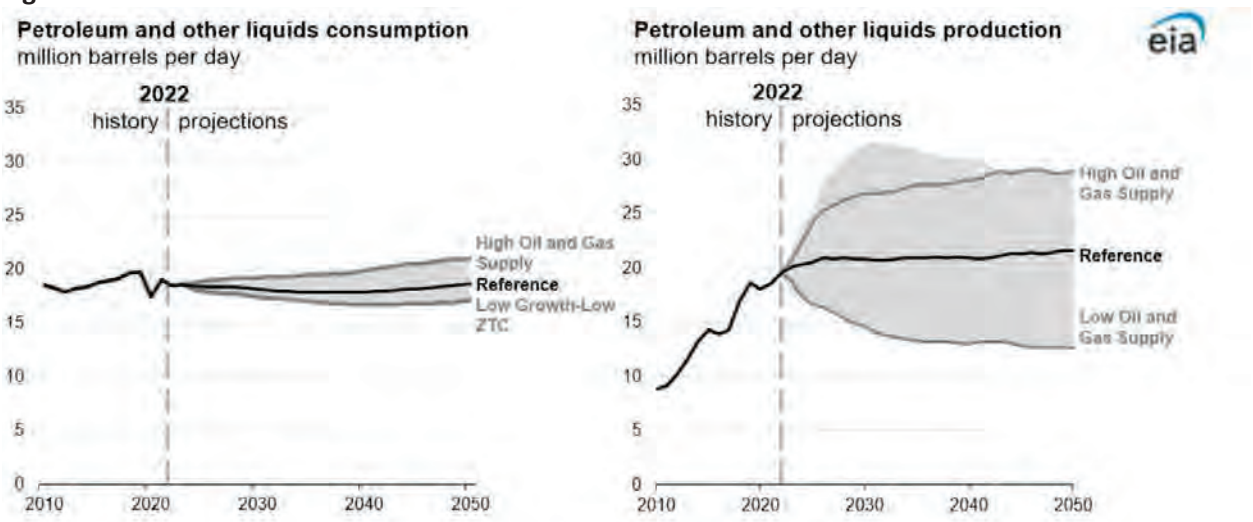
3

International Demand for Petroleum and Natural Gas Drives U.S. Production, While Domestic Consumption Either Grows Slowly or Decreases

Although U.S. consumption of petroleum products remains relatively flat, international demand supports U.S. exports of petroleum and other liquids (Figure 12). The dynamics of international trade affect domestic production of natural gas and of petroleum and other liquids.

International demand drives petroleum and other liquids production

Figure 12.



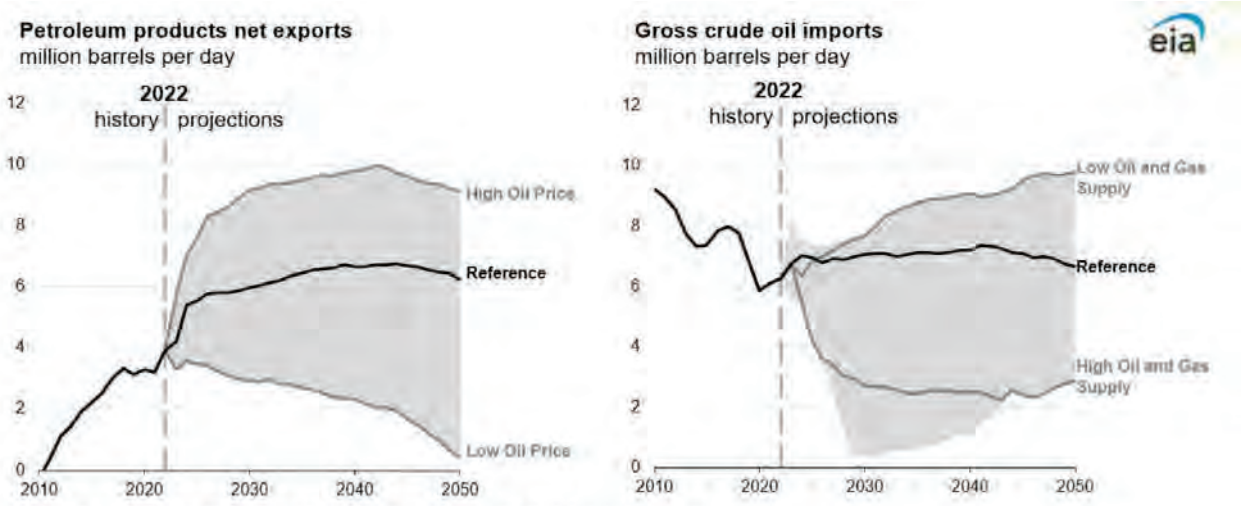
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Biofuels are not included in *petroleum and other liquids* production or consumption. Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost

In all cases, we project that the United States will remain a net exporter of petroleum products through 2050.

Although domestic consumption of petroleum and other liquids does not increase through 2040 across most cases, U.S. petroleum and other liquids production remains high because of increased exports of finished products in response to growing international demand (Figure 13). In all cases, we project that the United States will remain a net exporter of petroleum products through 2050. In the High Oil Price case, increased production leads to the most exports among all cases over the projection period. The Low Oil Price case shows the opposite: decreased production along with the lowest export volumes.

Crude oil imports remain relatively flat in the Reference case but vary widely in the side cases (Figure 13); the Low Oil and Gas Supply case leads to the greatest level of imports throughout the forecast period while the High Oil and Gas Supply case leads to the lowest imports (Figure 13). This wide range in imports is mainly due to the tradeoff between domestic production and imports. In the Low Oil and Gas Supply case, crude oil imports increase significantly, partially to account for falling domestic crude oil production. The opposite occurs in the High Oil and Gas Supply case, in which increased domestic production balances lower crude oil imports.

Figure 13.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

In the High Oil Price case, U.S. crude oil imports initially decline but begin to increase starting in 2030 because of changing trends in domestic crude oil production. In the early years, domestic crude oil production increases rapidly due to high prices. However, crude oil production begins to fall after 2030 because wells are drilled increasingly close to one another, resulting in well productivity declines. As wells are drilled closer together, they produce less crude oil and eventually become unprofitable, at which point new drilling stops. Crude oil imports decline early in the High Oil Price case as crude oil production increases; imports increase after 2030 as well productivity and crude oil production declines.

Because international demand for finished petroleum products keeps exports high, U.S. refinery runs remain strong as the U.S. refinery sector remains competitive in the global market through 2050. Refinery capacity remains relatively constant through 2050, and refinery capacity utilization remains high, at around 90% or higher, under favorable economic conditions.

Technical Note 4: Crude oil trade dynamics

Crude oil is a global commodity, and the United States participates in the global market as both an importer and exporter of crude oil and its associated products. Because of logistical, regulatory, and quality considerations, both exporting and importing petroleum often makes economic sense. For example, a refiner in the Gulf Coast may find it more profitable to export motor gasoline to Mexico rather than shipping it to the East Coast because cheaper gasoline imports from Europe may be available to the East Coast.

The chemical makeup of the imported or exported product also affects crude oil trade. The type of crude oil—light or heavy, low-sulfur (sweet) or high-sulfur (sour)—helps determine the processes that refine it into a petroleum product such as distillate fuel oil or propane. In short, the United States imports different types of crude oil to optimize production across its various refineries.

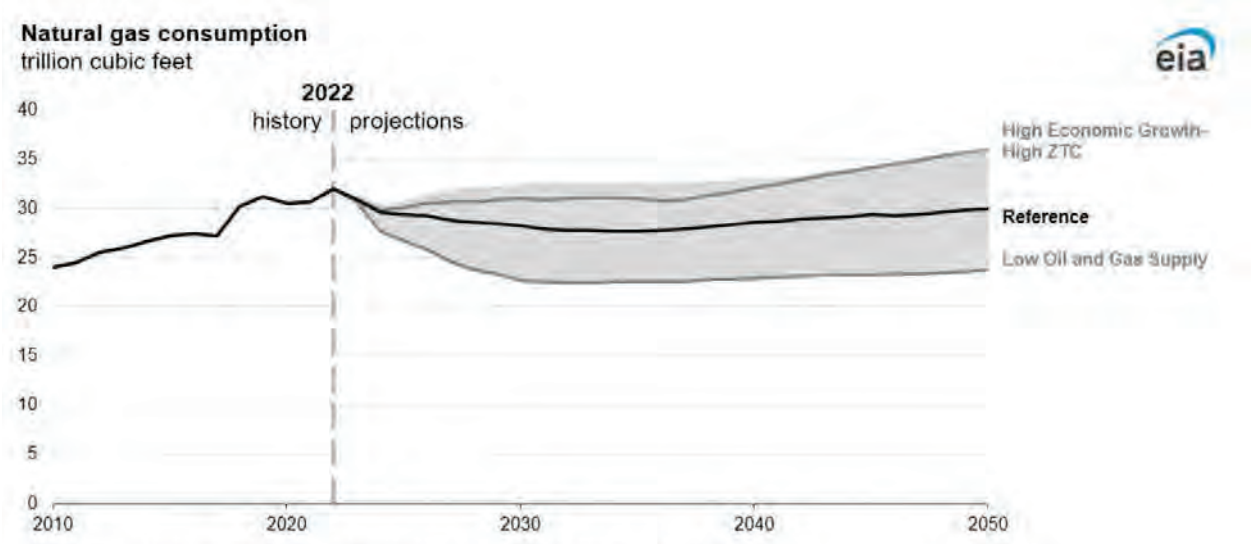
The World Oil Price path is an exogenous assumption to the model and affects domestic crude oil production and international trade. For each year of the projection period, NEMS computes the Brent crude oil price, provides a supply curve of world crude oil-like liquids, and provides supply curves for each foreign crude oil type considered. NEMS also provides, for each year of the projection period, exogenous supply and demand curves for U.S. import and export of petroleum products.

In response to Russia's full-scale invasion of Ukraine in early 2022, the United States banned petroleum imports from Russia. AEO2023 projections reflect this policy change. However, we assume that equivalent imports from other countries substitute for U.S. crude oil imports (especially unfinished oil imports) from Russia, minimizing effects on domestic markets.

Natural gas consumption in end-use sectors is variable

In the United States, electrification is displacing combustion fuels in the demand sectors. As electricity generation shifts to using more renewable and battery sources, domestic natural gas consumption for electricity generation is likely to decrease by 2050 relative to 2022, which contrasts with relatively stable growth over the past decade (Figure 14).

Figure 14.



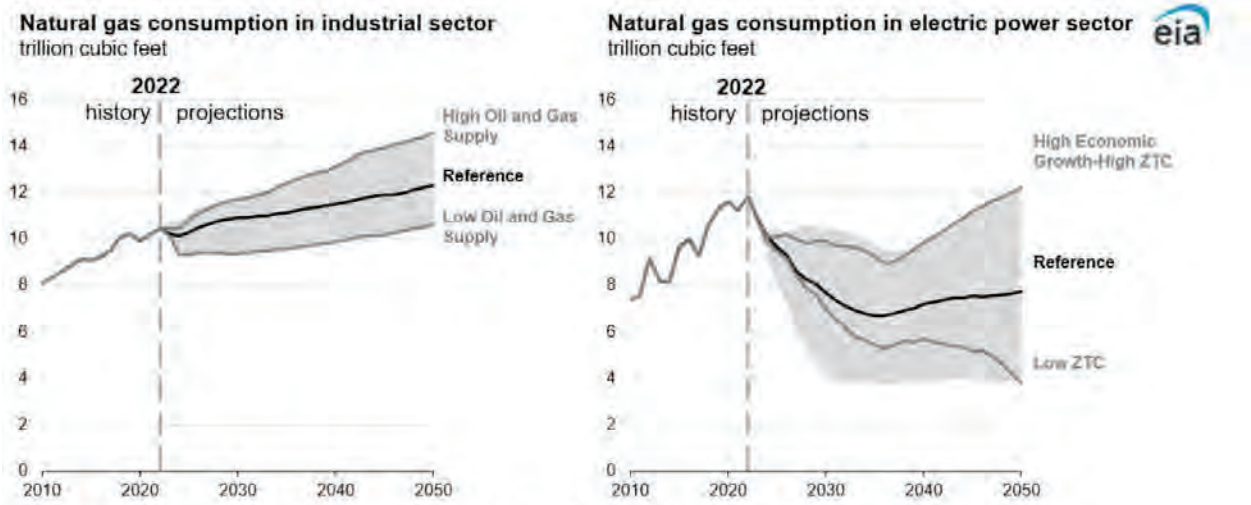
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost

More natural gas is consumed in the industrial or electric power sectors than in any other sectors of the U.S. economy. Projected consumption in both sectors is very sensitive to changes in our side case assumptions, particularly in the Oil and Gas Supply cases (Figure 15). These cases, which result in the most and the least natural gas consumption in the industrial sector, vary widely due to differences in resource extraction assumptions. By 2050, natural gas consumption in the industrial sector diverges from the Reference case by 14% in the Low Oil and Gas Supply case and 18% in the High Oil and Gas Supply case.

In the electric power sector, our projections for natural gas consumption generally fall but range widely, with consumption in 2050 diverging from the Reference case by over 50% in the bounding cases (Figure 15). Natural gas consumption remains below the peak in 2022, at nearly 12 trillion cubic feet, through 2050 across all side cases except the High Economic Growth and High ZTC case. In the Low ZTC case, lower costs for renewables makes natural gas less competitive, resulting in a larger decrease in natural gas consumption compared with the Reference case. In the High Economic Growth and High ZTC case, increased economic activity drives increased end-use demand, which results in more natural gas consumption. Higher costs for renewables make natural gas a more competitive option in that case, further increasing natural gas consumption in the electric power sector.

In the electric power sector, our projections for natural gas consumption generally fall but range widely, with consumption in 2050 diverging from the Reference case by over 50% in the bounding cases.

Figure 15.

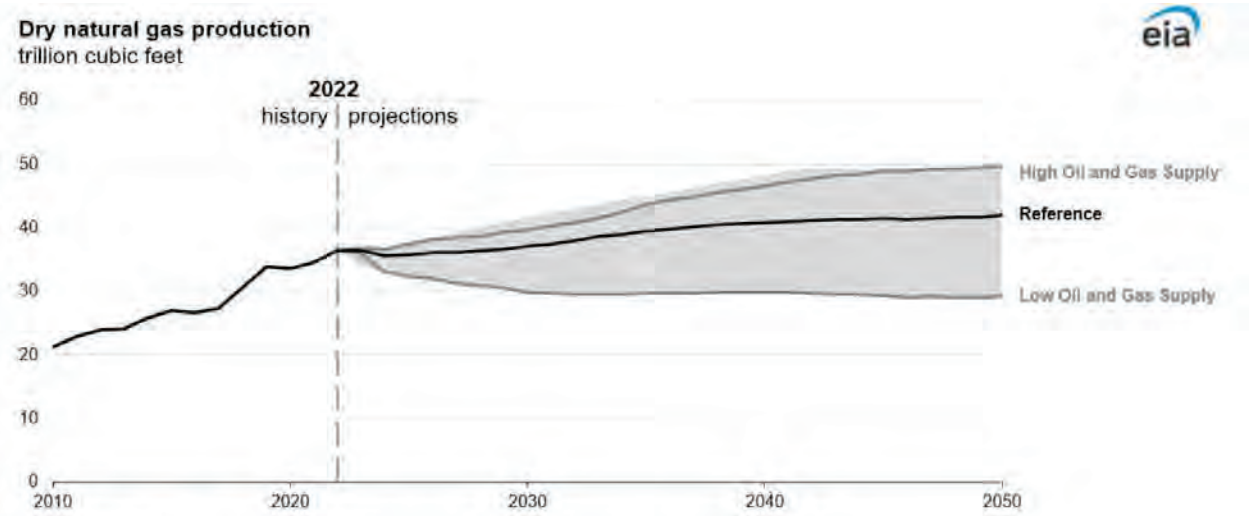


Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases. ZTC=Zero-Carbon Technology Cost.

Under favorable economic, supply, and oil price assumptions, U.S. natural gas production continues to grow

In the Reference case, U.S. natural gas production increases by 15% from 2022 to 2050, and consumption decreases by 6% from its peak in 2022 (Figure 16). Across all cases, domestic production outpaces domestic consumption; production increases across all side cases except in the Low Oil and Gas Supply case and the Low Oil Price case.

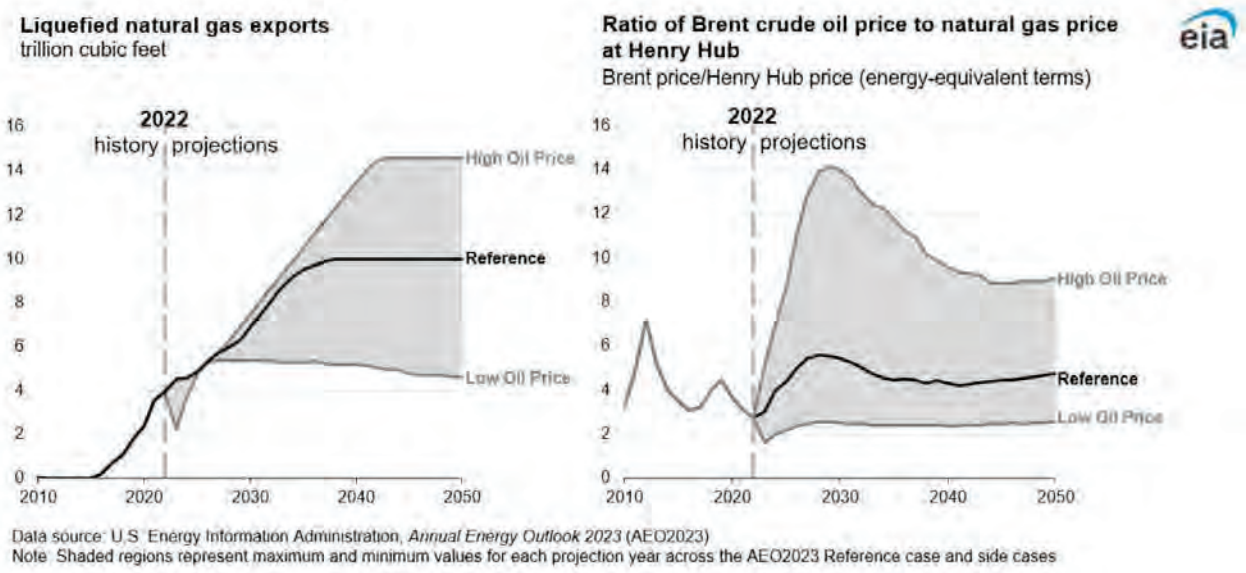
Figure 16.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

In some cases, exports to satisfy growing international demand for natural gas encourage growth in domestic natural gas production. A significant portion of production growth is due to liquefied natural gas (LNG) export demand, which drives the overall increase in natural gas exports (Figure 17).

Figure 17.

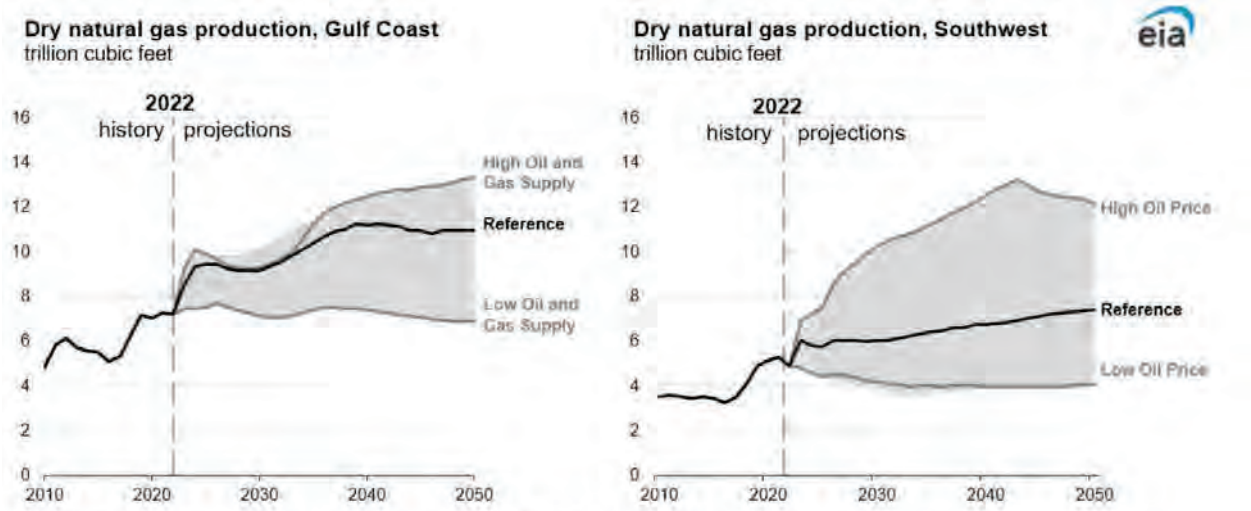


Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases

Historically, most LNG was traded under long-term, oil price-linked contracts because a global LNG price benchmark did not exist and because oil could substitute for natural gas in industry and for power generation, which was especially common in Asia. These factors supported highly correlated international natural gas and oil prices. With growth in more market based-LNG, the strength of the relationship between international natural gas prices and oil prices has eroded. However, we expect that future oil prices will still affect additional LNG export capacity and overall export levels. When the Brent price is high relative to the U.S. Henry Hub price, like in the High Oil Price case, building more LNG export capacity and exporting LNG are more economical than when the Brent price is lower relative to Henry Hub. In the Low Oil Price case, the Brent price is lower, and the Henry Hub price is higher, which curtails LNG exports to below current volumes in the near term and causes LNG capacity to be underutilized near the end of the projection period.

International demand for LNG exports results in rising natural gas production, favoring areas that have better access to terminals. In AEO2023, dry natural gas production grows in the Southwest, which has easy pipeline transport to the Gulf Coast, where LNG is exported. Production in the Gulf Coast also generally increases across the projection period, due to its proximity to LNG export terminals, in all cases except the Low Oil and Gas Supply case (Figure 18).

Figure 18.



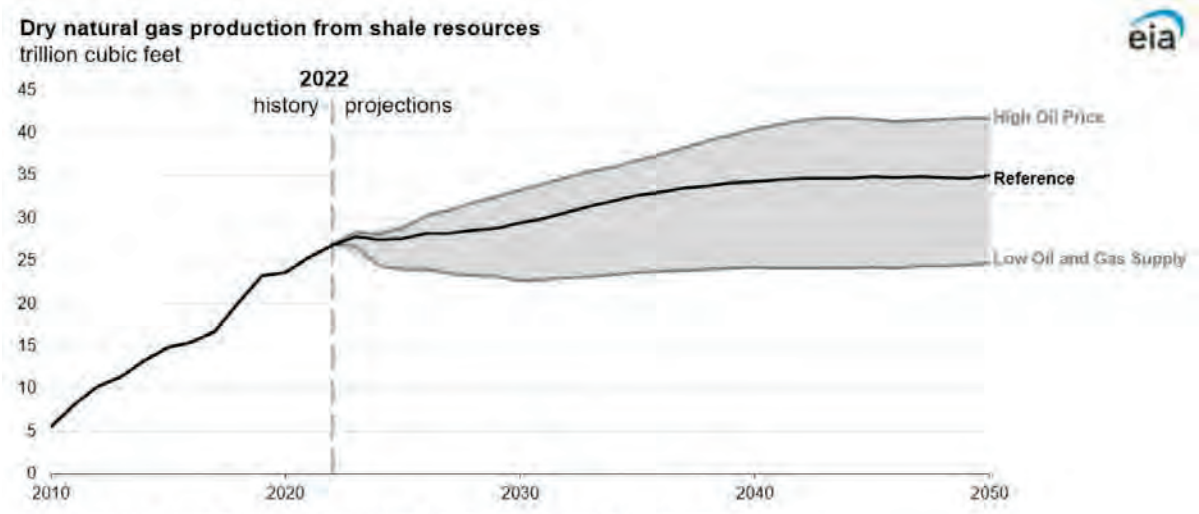
Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

Associated natural gas is a major source of natural gas production

In AEO2023, shale gas and associated dissolved natural gas from oil formations are the primary sources of long-term growth of domestic natural gas production through 2050. Increased production wells in the Permian Basin (Southwest region) is the primary driver behind associated dissolved natural gas growth. Increases in shale gas production mainly comes from the Texas-Louisiana Salt Basin (Gulf Coast Region) and the Appalachian Basin (East Region).

In the High Oil Price case and High Oil and Gas Supply case, oil production growth leads to increased associated dissolved natural gas and shale production (Figure 19). The opposite occurs in the Low Oil Price case and Low Oil and Gas Supply case.

Figure 19.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Shaded regions represent maximum and minimum values for each projection year across the AEO2023 Reference case and side cases.

Discussion

Sources of uncertainty

Energy market projections are inherently uncertain because many of the events that will shape future energy markets—including developments in policy, technology, demographics, and resources—are not known. To illustrate the role of uncertainty, AEO2023 includes a baseline Reference case and several side cases that systematically vary important underlying assumptions. Many sources of uncertainty exist beyond the ones we test explicitly, including new policy, unforeseen geopolitical events, and rapid technology innovation, particularly around technologies that are in the earliest stages of development.

Policy

Our key assumptions in the Reference case provide a baseline for exploring long-term trends, based on current laws and regulations as of November 2022. These assumptions include provisions of the IRA; however, we were unable to model all provisions, as indicated in the appendix. Any future legislation would further affect technology trajectories and emissions pathways. We publish the current laws and regulations considered in the AEO2023 on the AEO website.

Geopolitical events

We account for current events that affect the energy markets with the information available at the time we prepare this publication. However, we cannot foresee future events such as wars, supply disruptions, pandemics, or other such issues that could having lasting impacts on the U.S. energy system.

Rapid technology innovation

The technologies considered in the AEO2023 include only well-documented trends in energy innovation. Additional breakthroughs not considered here might occur. Examples of the kind of breakthrough we don't consider include early-developmental-stage technologies such as hydrogen, enhanced geothermal, and fusion, as well as other technologies currently unknown or not well characterized.

Quantifying uncertainty using statistical errors from past projections

The sources of uncertainty described above, among others, result in observed values that are different than our projected values. To explore some key uncertainties, we include a number of side cases that incorporate plausible alternatives to assumptions in the Reference case. We can also develop a sense of future uncertainty by calculating the differences (or *statistical errors*[3]) between realized values and our Reference case projections from previous AEO editions. Given constantly evolving modeling techniques and a dynamic energy landscape replete with non-linear relationships, statistical errors from past projections will not necessarily provide an accurate basis for estimating uncertainty in current projections. Nevertheless, using statistical errors from past projections implicitly captures real world factors that were difficult to anticipate in past AEO editions.

[3] Here we use "error" in a statistical sense to denote the difference between projected and real-world values. Because our Reference case is not intended to serve as a forecast, deviations from reality should not be interpreted as errors.

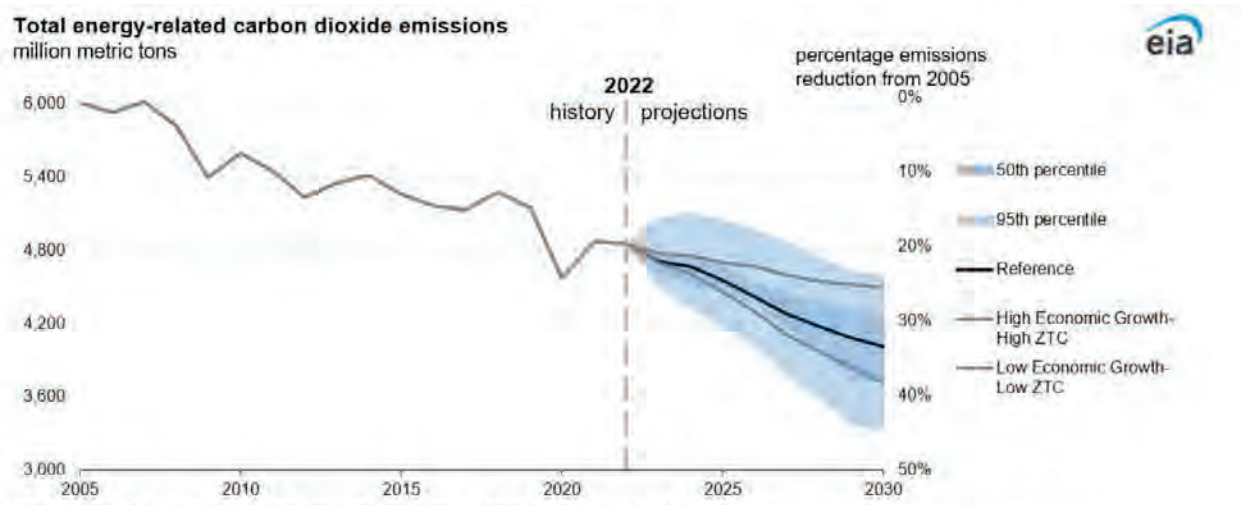
In the 2022 edition of our *Annual Energy Outlook Retrospective Review* (AEO Retrospective), we quantified the statistical errors associated with past Reference cases over several key output metrics and projection timeframes, ranging from 1 to 15 years. Building on the work from the AEO Retrospective and following the NP2 method (a methodology detailed in a 2017 paper by researchers Lynn H. Kaack, Jay Apt, M. Granger Morgan, and Patrick McSharry), we can use statistical errors from past projections to develop a *cone of uncertainty*—similar to those used by the National Oceanic and Atmospheric Administration (NOAA) to produce hurricane path cones—which we can apply to the AEO2023 projections. Employing statistical errors from past projections along with side case projections can help us better assess the possible range of uncertainty in the AEO results.

For example, we can use the statistical errors from past AEO Reference case projections to project future uncertainty in U.S. energy-related CO_2 emissions produced by the AEO2023 Reference case until 2030 (Figure 20). Figure 20 includes two uncertainty cones for total energy-related CO_2 emissions, representing statistical error estimations where the narrower and wider cones capture 50% and 95% of the historical projection errors around the Reference case, respectively. Our Reference case projection has a wide range of future uncertainty in total energy-related CO_2 emissions, which in some instances goes beyond the bounds explored in our most extreme side cases.

Because the AEO Reference case includes only laws and regulations current at the time it is developed, past Reference case projections of total energy-related CO_2 emissions tend to be higher than actual because they don't include subsequent public policies that further reduce emissions. The uncertainty cones capture these over-projected statistical errors in total energy-related CO_2 emissions and show the possibility for lower emissions compared with our most extreme side case with the lowest total energy-related CO_2 emissions. We see the possibility of total energy-related CO_2 emissions increasing in the short term before falling in the long term, both in our High Economic Growth and High Zero-Carbon Technology Cost case and the upper 95th percentile of statistical errors from past projections.

We will continue to explore our use of this technique, as well as other ways to quantify uncertainty, in future analyses.

Figure 20.



Data source: U.S. Energy Information Administration, *Annual Energy Outlook 2023* (AEO2023)
Note: Cone of uncertainty associated with total energy-related CO_2 emissions using empirical projection intervals. Historical values and AEO2023 Reference case are displayed as solid black line. The projection error density forecast by blue shaded areas. The different shades correspond to the 50th and 95th percentiles. AEO2023 envelope side cases are in solid grey lines. ZTC=Zero-Carbon Technology Cost.

Appendix

Case Descriptions

AEO2023 Reference Case

In the AEO2023 Reference case, we assess how U.S. and world energy markets would operate through 2050 under current laws and regulations as of November 2022 under evolutionary technological growth assumptions. Our key assumptions in the Reference case provide a baseline, or experimental control, for exploring long-term trends. An overview of the laws and regulations included in AEO2023 is available on the AEO website. This Appendix addresses the Inflation Reduction Act and how we incorporated it into the Reference case and side cases.

High and Low Oil Price cases

Global market balances, primarily international supply and demand factors, will drive future crude oil prices. To account for these factors, oil prices are an exogenous assumption in our analysis. In the AEO2023 High Oil Price case, the price of Brent crude oil, in 2022 dollars, reaches $190 per barrel (b) by 2050, compared with $101/b in the Reference case and $51/b in the Low Oil Price case.

High and Low Oil and Gas Supply cases

Compared with the Reference case, the High Oil and Gas Supply case assumes that the estimated ultimate recovery per well for tight oil, tight gas, or shale gas in the United States is 50% higher. Similarly, this case assumes that undiscovered resources in Alaska and the offshore Lower 48 states are 50% greater than assumed in the Reference case. Technological improvement rates that reduce costs and increase productivity of oil and natural gas production in the United States are also 50% higher than assumed in the Reference case. Conversely, the Low Oil and Gas Supply case assumes that the estimated ultimate recovery per well for tight oil, tight gas, or shale gas in the United States; the undiscovered resources in Alaska and the offshore Lower 48 states; and rates of technological improvement are all 50% lower than assumed in the Reference case.

High and Low Zero-Carbon Technology Cost cases

The High Zero-Carbon Technology Cost case and the Low Zero-Carbon Technology Cost case examine the sensitivities around capital costs for electricity-generating technologies that produce zero emissions, which include renewables, nuclear (a zero-carbon technology included in these cases for the first time in this AEO), and diurnal storage technologies. We assume capital costs decline over time from learning by doing as commercialization expands and construction and manufacturing experience accelerates. The High Zero-Carbon Technology Cost case assumes no cost reductions from learning by doing. The Low Zero-Carbon Technology Cost case assumes faster, exogenously determined technology cost declines through 2050, resulting in about a 40% cost reduction by 2050 compared with the Reference case for each zero-carbon technology. In addition, we assume fixed operating and maintenance costs will decline along with the capital cost from technology improvement. These cases replace the Low and High

Renewable Cost cases from prior AEOs and now reflect the zero-carbon technology suite, as represented in our models, which is targeted by incentives in the Inflation Reduction Act.

High and Low Economic Growth cases

The High Economic Growth case and Low Economic Growth case address the effects of economic assumptions on energy consumption modeled in the AEO2023. From 2022 to 2050, the High Economic Growth case assumes the compound annual growth rate for U.S. GDP is 2.3%, and the Low Economic Growth case assumes a 1.4% rate. By contrast, the Reference case assumes the U.S. GDP annual growth rate is 1.9% over the projection period.

Economic Growth and Zero-Carbon Technology Cost Combination cases

In addition to our eight standard core cases, we have added four combination cases for AEO2023. These cases simultaneously vary economic growth and zero-carbon technology cost assumptions. The four combinations are:

- High Economic Growth and High Zero-Carbon Technology Cost
- High Economic Growth and Low Zero-Carbon Technology Cost
- Low Economic Growth and High Zero-Carbon Technology Cost
- Low Economic Growth and Low Zero-Carbon Technology Cost

Inflation Reduction Act assumptions in the Reference case and core side cases

The Inflation Reduction Act (IRA), or Public Law 117-169, that took effect on August 16, 2022, includes energy- and climate-related provisions.[4] We reviewed the law for directives that would influence energy consumption, production, and trade in the U.S. economy as modeled in NEMS. We incorporated provisions of this law into the Reference case and side cases, unless otherwise noted. Case assumptions were frozen in mid-November 2022, and AEO2023 does not include regulatory guidance or provisions issued after that time.

This document summarizes the energy- and climate-related provisions from the IRA as incorporated into the AEO2023 Reference and side cases. This document does not cover details about provisions included in the Low and High Uptake cases, which vary the number of bonus tax credits and incentives applied to eligible technologies. Those case definitions and results are discussed in the *Issues in Focus: Inflation Reduction Act Cases in the AEO2023*. Further details about how we modeled the IRA provisions are also in the NEMS Assumptions documents. The No IRA case assumes the same economic outlook as the Reference case but excludes the IRA provisions.

All cases use the macroeconomic outlook from S&P Global IHS Markit as of September 2022.

Although all provisions of the IRA are current law, some are not explicitly included in the NEMS version used for AEO2023. We did not include these provisions for one of three reasons:

1. Guidance is not yet available on how federal agencies will implement some provisions, and without that guidance, we lack the details to analyze their effect. We will analyze these provisions in the future as we receive more clarity.
2. A number of provisions require significant modifications to NEMS that were not possible in this timeframe, and we will consider ways to include these provisions in a future outlook to the extent possible.
3. Other provisions do not align with our analytic resolution. For instance, NEMS does not model individual electricity transmission lines, and therefore, we do not model the IRA-driven impacts related to the planning or construction of transmission lines through financial appropriations in the form of assistance or loans.

Some provisions are not listed in the following table because they are not relevant to this analysis or had minor impacts to the energy system. In the *Excluded* column of Table 1, the numbers in bold correspond to one or more of the reasons listed above. The use of -- indicates that a certain column is not applicable.

[4] Inflation Reduction Act, Public Law 117-169, (August 16, 2022), https://www.congress.gov/bill/117th-congress/house-bill/5376.

Table 1. Included and excluded Inflation Reduction Act (IRA) provisions in NEMS

Section	Provision	Description	Included	Excluded
Title I Committee on Finance				
13101 and 13102	Extension and Modification of Credits Produced from Certain Renewable Resources Extension and Modification of Energy Tax Credit	These provisions include extensions of the Internal Revenue Service Code Section 45[i] production tax credit (PTC) and Section 48[ii] investment tax credit (ITC) for certain energy properties.	We assume the tax credit extensions and modified tax credit values. We also assume the prevailing wage and apprenticeship requirements are met by the most eligible technologies, except certain combined-heat-and-power systems, and the domestic content requirements are met by certain technologies.	We exclude certain technologies such as small-scale energy storage (called behind-the-meter storage). Further details about the technologies we model are in the NEMS Assumptions documents. We exclude the *energy communities* bonus credit. **(1,2,3)**
13103	Increase in Energy Credit for Solar and Wind Facilities Placed in Service in Connection with Low-Income Communities	This provision allows qualified solar and wind projects located in low-income communities to qualify for *environmental justice solar and wind capacity* credits.	--	**(1,3)**
13104	Extension and Modification of Credit for Carbon Oxide Sequestration	This provision extends the carbon oxide capture credit under IRS section 45Q.[iii]	We assume the tax credit extensions and modified tax credit values. We also assume the prevailing wage and apprenticeship requirements are met.	We exclude the new tax credit for direct air capture (DAC). **(2)**

Section	Provision	Description	Included	Excluded
13105	Zero-Emission Nuclear Power Production Credit	This provision creates a production credit for qualified nuclear power generation.	We assume the prevailing wage requirements are met.	--
13201	Extension of Incentives For Biodiesel, Renewable Diesel and Alternative Fuels	This provision extends the biodiesel and renewable diesel credit and an alternative fuel credit.	We extended the existing biomass-based diesel credit through 2027.	--
13202	Extension of Second Generation Biofuel Incentives	This provision extends a tax credit for second-generation biofuel production.	We extended the credit through 2027.	--
13203	Sustainable Aviation Fuel Credit	This provision creates a sustainable aviation fuel credit equal to $1.25 per gallon.	We implemented a simplified version of this credit that extends the credit through 2027	We did not assume the supplementary amount when the fuel meets certain lifecycle greenhouse gas (GHG) requirements. **(2)**
13204	Clean Hydrogen	This provision creates a new tax credit for the qualified production of clean hydrogen.	--	**(2)**
13301	Extension, Increase, and Modifications of Nonbusiness Energy Property Credit	This provision extends tax credits under IRS Section 25C[iv] for home energy efficiency improvements and modifies the tax credit for qualified energy efficiency improvements.	We assume the tax credit extensions and modified tax credit values through 2032.	We do not explicitly model service panel replacement, wiring upgrades, or home energy audits. **(3)**
13302	Residential Clean Energy Credit	This provision extends the credit under IRS Section 25D[v] for the cost of qualified residential energy efficiency expenditures and projects.	We assume the tax credit extensions and modified tax credit values, including phaseout, through 2034.	We do not explicitly model residential clean energy technologies such as residential battery storage. Further details about the

Section	Provision	Description	Included	Excluded
				technologies we model are in the NEMS Assumptions documents. **(2,3)**
13303	Energy Efficient Commercial Buildings Deduction	This provision amends IRS Section 179D[vi] and allows expenses associated with qualifying commercial building efficiency costs to be deductible expenses if they meet certain requirements.	--	**(1,3)**
13304	Extension, Increase, and Modifications of New Energy Efficient Home Credit	This provision extends Section 45L[vii] credits for new energy-efficient homes through December 31, 2032, and increases the credit if qualified projects meet prevailing wage and apprenticeship requirements.	We assume a $500–$2,500 tax credit for new properties meeting or exceeding ENERGY STAR specifications.	We do not explicitly model zero-energy ready homes ($5,000 credit), and we exclude the *energy communities* bonus credit. **(1,3)**
13401	Clean Vehicle Credit	This provision extends the Section 30D[viii] vehicle tax credit through December 31, 2032, and updates the credit value. This provision also contains vehicle assembly requirements, battery component requirements, vehicle price limits, and income limits for vehicle buyers.	We do not explicitly model this provision, but we assume the total number of vehicles that qualify for the clean vehicle tax credit based on an analysis of official U.S. government IRA expenditure estimates from the Congressional Budget Office.[ix]	--
13402	Credit for Previously-Owned Clean Vehicles	This section creates a new tax credit for used clean vehicles.	--	**(1,3)**

Section	Provision	Description	Included	Excluded
13403	Qualified Commercial Clean Vehicles	This provision provides a clean vehicle credit for vehicles not powered by internal combustion engines.	--	**(1,3)**
13404	Alternative Fuel Refueling Property Credit	This section extends and modifies a tax credit for qualified alternative-fuel refueling properties.	--	**(1,3)**
13501	Extension of the Advanced Energy Project Credit	This provision funds qualifying investments in advanced energy projects, such as facilities that manufacture electric vehicles.	--	**(1,3)**
13502	Advanced Manufacturing Production Credit	This provision provides production credits for domestic manufacturing of key components for clean energy technologies.	--	**(1,2)**
13701	Clean Electricity Production Credit	This provision creates a new production tax credit for qualified domestically produced electricity that does not emit GHG emissions.	We assume the prevailing wage and apprenticeship requirements and the domestic content requirements are met by certain technologies.	We exclude the bonus credits for qualified projects located in an *energy community*. **(1,2)**
13702	Clean Electricity Investment Credit	This provision creates a new investment tax credit for eligible clean energy technologies.	We assume the prevailing wage and apprenticeship requirements and the domestic content requirements are met by certain technologies.	We exclude the bonus credits for qualified projects located in an *energy community*. We do not model certain technologies, such as small-scale energy storage projects (called behind-the-meter storage). Further details

Section	Provision	Description	Included	Excluded
				about the technologies we model are in the NEMS Assumptions documents. **(1,2)**
13703	Cost Recovery for Qualified Facilities, Qualified Property, and Energy Storage Technology	The provision updates the definition of a *five-year property* to include facilities that qualify for the clean electricity production credit, property that qualifies for the clean energy investment tax credit, and any energy storage technology for accelerated cost recovery.	We assume the extension of the modified accelerated cost recovery system, or MACRS, for certain commercial end-use equipment and for applicable technologies in the electric power sector.	We do not explicitly model energy storage in the residential and commercial buildings sectors. Further details about the technologies we model are in the NEMS Assumptions documents. **(2,3)**
13704	Clean Fuel Production Tax Credit	This provision creates a tax credit for domestic clean fuel production, including a credit for sustainable aviation fuel, produced after December 1, 2024, and sold before December 31, 2027.	We implemented a simplified version of this credit for certain qualified fuels.	We did not model the credit values based on the lifecycle carbon emissions or emissions factor associated with qualified fuels. **(2,3)**
Part 8 13801–13802	Credit Monetization and Appropriations	These sections include provisions[x] that allow a taxpayer to transfer eligible credits to another taxpayer.	--	**(3)**
Title II Committee on Agriculture, Nutrition, and Forestry				
20001– 23005	Subtitles A–D	These sections fund the U.S. Department Forestry and U.S. Department of Agriculture for climate mitigation and restoration projects. Section 22003 focuses on	--	**(1,3)**

Section	Provision	Description	Included	Excluded
		biofuel infrastructure and agriculture product market expansion.		
Title III Committee on Banking, Housing, and Urban Affairs				
30001	Enhanced Use of Defense Production Act of 1950	This provision funds the acceleration of domestic production of clean energy technologies.	--	**(1,3)**
30002	Improving Energy Efficiency or Water Efficiency or Climate Resilience of Affordable Housing	This section funds projects that improve energy efficiency, water efficiency, or climate resilience for eligible properties.	--	**(1,3)**
Title IV Committee on Commerce, Science, and Transportation				
40007	Alternative Fuel and Low-Emission Aviation Technology Program	This section funds grants issued by the U.S. Department of Transportation for projects that produce, transport, blend, or store sustainable aviation fuel or that develop, demonstrate, or apply low-emission aviation technologies.	--	**(1)**
Title V Committee on Energy and Natural Resources				
50121	Home Energy Performance-Based, Whole-House Rebates	This section funds DOE's grants to state energy offices for rebates called Home Owner Managing Energy Savings, or HOMES.	--	**(1)**
50122	High-Efficiency Electric Home Rebate Program	This section funds DOE's financial support for state energy offices' and	--	**(1)**

Section	Provision	Description	Included	Excluded
		tribal governments' high-efficiency electric home rebate programs.		
50123	State-Based Home Energy Efficiency Contractor Training Grants	This section funds education and training for energy efficiency contractors.	--	**(3)**
50131	Assistance for Latest and Zero Building Energy Code Adoption	This section pays states and local governments to adopt the latest residential and commercial building energy codes and adopt residential and commercial building energy codes that exceed specific industry standards.	--	**(1)**
50141	Funding for DOE Loan Programs Office	This section raises the loan guarantee commitment authority to $40 billion for the DOE Title XVII Innovative Technology Loan Guarantee Program.	--	**(1)**
50142	Advanced Technology Vehicle Manufacturing	This section funds DOE's direct loans for establishing or expanding domestic manufacturing facilities for low- or no-emitting vehicles.	--	**(1)**
50143	Domestic Manufacturing Conversion Grants	This section provides grants for domestic production of electric vehicles and hydrogen fuel cell vehicles.	--	**(1)**

Section	Provision	Description	Included	Excluded
50144	Energy Infrastructure Reinvestment Financing	This section provides additional loan guarantee authority under the Energy Policy Act of 2005 for energy infrastructure that reduces air pollution.	--	**(1)**
50145	Tribal Energy Loan Guarantee Program	This provision funds the DOE's Tribal Loan Guarantee Program.	--	**(1,3)**
Part 5 50151–50153	Electric Transmission	These provisions fund DOE programs that facilitate certain transmission lines or transmission siting and planning.	--	**(1,3)**
50161	Advanced Industrial Facilities Deployment Program	This section makes about $5.8 billion available to DOE's Office of Clean Energy Demonstrations for advanced industrial technologies.	--	**(1,3)**
Part 7 50171–50173	Other Energy Matters	These sections fund the DOE laboratory infrastructure and the fabrication and enrichment facilities for special nuclear material.	--	**(1)**
50251	Leasing on the Outer Continental Shelf	This provision authorizes the U.S. Department of Interior (DOI) to conduct wind lease sales in the Outer Continental Shelf and in areas within an exclusive economic zone.	--	**(1,3)**
50261	Offshore Oil and Gas Royalty Rate	This provision increases the minimum royalty rate for new offshore fossil fuel leases.	We assume the updates to the minimum royalty rates.	--

Section	Provision	Description	Included	Excluded
50262	Mineral Leasing Act Modernization	This provision updates the onshore oil and natural gas royalty rates.	We assume the updates to the onshore oil and natural gas production royalty rates.	We exclude the adjustments to federal leases. **(3)**
50263	Royalties on All Extracted Methane	This provision modifies the royalties paid for natural gas produced on federal land and on the Outer Continental Shelf, including natural gas lost through upstream equipment.	--	**(3)**
50264	Lease Sales Under the 2017–2022 Outer Continental Shelf Leasing Program	This provision requires the completion of the 2017–2022 Outer Continental Shelf leasing program.	We assume the Outer Continental Shelf Leasing Program is completed.	--
50265	Ensuring Energy Security	This provision requires the DOI to conduct oil and natural gas lease sales annually for 10 years prior to issuing leases or rights-of-way for any new solar or wind energy projects.	--	**(3)**
Title VI Committee on Environment and Public Works				
60101	Clean Heavy-Duty Vehicles	This provision funds communities to help them replace eligible vehicles with zero-emission vehicles.	--	**(1,3)**
60103	Greenhouse Gas Reduction Fund	This section funds deployment of zero-emission technologies in low-	--	**(1,3)**

Section	Provision	Description	Included	Excluded
		income and disadvantaged communities.		
60104	Diesel Emissions Reductions	This section provides funding to identify and reduce diesel emissions from *goods movement facilities*.	--	**(1,3)**
60113	Methane Emissions Reduction Program	This section creates a methane emissions charge for qualified petroleum and natural gas systems.	--	**(1,3)**
60114	Climate Pollution Reduction Grants	This section funds the EPA's GHG air pollution implementation grants and GHG air pollution planning and implementation	--	**(1,3)**
Subtitle E 60501–60506	Transportation and Infrastructure	These sections include assistance for using low-carbon materials for constructing or altering federal buildings; for low-carbon transportation materials grants; and for a neighborhood access and equity grant program.	--	**(3)**
Title VII Committee on Homeland Security and Governmental Affairs				
70006	FEMA Building Materials Program	This section funds the Federal Emergency Management Agency's (FEMA) costs for low-carbon materials and incentives for net-zero energy projects.	--	**(3)**
Title VIII Committee on Indian Affairs				

Section	Provision	Description	Included	Excluded
80001	Tribal Climate Resilience	This section adds funds to the Bureau of Indian Affairs (BIA) for tribal climate resilience and adaptation programs.	--	**(1,3)**

[i] Electricity produced from certain renewable resources, etc., 26 U.S. Code § 45 (2022)
[ii] Energy credit, 26 U.S. Code § 48 (2022)
[iii] Credit for carbon oxide sequestration, 26 U.S. Code § 45Q (2022)
[iv] Energy efficient home improvement credit, 26 U.S. Code § 25C (2022)
[v] Residential clean energy credit, 26 U.S. Code § 25D (2022)
[vi] Energy efficient commercial buildings deduction, 26 U.S. Code § 179D (2022)
[vii] New energy efficient home credit, 26 U.S. Code § 45L (2022)
[viii] Clean vehicle credit, 26 U.S. Code § 30D (2022)
[ix] U.S. Congressional Budget Office, "Summary Estimated Budgetary Effects of H.R. 5376, the Inflation Reduction Act of 2022," August 5, 2022, https://www.cbo.gov/system/files/2022-08/hr5376_IR_Act_8-3-22.pdf
[x] Front Matter, 26 U.S. Code Chapter 65 § 6418 (2022)

November U.S. Release: Mon, Dec 8, 2025, 11:00 AM EST

Report: National Climate Report

Year: 2021 Month: June View

National Climate Report
June 2021

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All-time Heat Records Set in June

The tables below contain preliminary results for the all-time warmest maximum temperatures that were broken during the warm-air outbreak in late June across the Northwest U.S. A station's record is compared with its history prior to 2021. For the most current records listings, please visit our U.S Records Summary page.

Highest Maximum Temperatures

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
ALDER RIDGE WASHINGTON, WA US	6/29/2021	98	8/10/2018	96	35	
ARBUCKLE MOUNTAIN, OR US	6/29/2021	92	8/5/1990	91	32	
ARLINGTON, OR US	6/30/2021	117	8/4/1961	115	128	
ASHLAND, OR US	6/29/2021	112	8/8/1981	108	129	
BARING, WA US	6/29/2021	107	7/31/2009	101	51	
BATTLE GROUND, WA US	6/29/2021	112	7/20/1956	107	90	
BELLINGHAM INTERNATIONAL AIRPORT, WA US	6/28/2021	99	7/29/2009	96	72	
BEND, OR US	6/30/2021	107	7/27/1939	104	119	
BOARD HOLLOW OREGON, OR US	6/29/2021	104	7/12/2002	99	34	
BONNERS FERRY, ID US	6/30/2021	108	8/11/2018	105	114	
BONNEVILLE DAM, OR US	6/30/2021	111	7/22/2006	107	83	
BONNEVILLE DAM, OR US	6/30/2021	111	7/22/2006	107	83	
BOULDER CREEK OREGON, OR US	6/28/2021	104	8/16/2008	104	35	
BOUNDARY DAM, WA US	6/30/2021	111	6/29/2015	105	55	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
BREMERTON, WA US	6/28/2021	102	8/17/2020	101	122	
BRUSH CREEK OREGON, OR US	6/28/2021	106	7/28/2009	102	35	
BUCKEYE OREGON, OR US	6/28/2021	112	8/2/2017	108	36	
BUMPING RIDGE, WA US	6/29/2021	96	7/26/1998	94	32	
BUNCHGRASS MDW, WA US	6/29/2021	96	7/22/2006	93	31	
CAMP 4 WASHINGTON, WA US	6/29/2021	108	7/31/2020	103	34	
CANNIBAL MOUNTAIN OREGON, OR US	6/27/2021	105	8/13/2002	103	36	
CASCADE LOCKS, OR US	6/29/2021	109	7/15/1941	108	126	
CASCADE LOCKS, OR US	6/29/2021	109	7/15/1941	108	126	
CEDAR LAKE, WA US	6/29/2021	101	9/3/1988	101	112	
CHELAN, WA US	6/30/2021	111	6/29/2015	110	63	
CHILOQUIN OREGON, OR US	6/28/2021	102	7/21/2003	102	35	
CLE ELUM, WA US	6/30/2021	108	8/15/1967	105	122	
CLEAR LAKE, OR US	6/29/2021	98	7/12/2002	98	35	
CLEARBROOK, WA US	6/28/2021	106	7/27/1958	102	118	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
CORRAL PASS, WA US	6/29/2021	90	7/21/2006	89	32	
COTTAGE GROVE 2 E, OR US	6/28/2021	105	8/14/2002	105	104	
COUGAR 6 E, WA US	6/29/2021	112	7/22/2006	107	62	
COUGAR MOUNTAIN WASHINGTON, WA US	6/28/2021	102	7/28/1998	96	36	
CUSHMAN POWERHOUSE NUMBER 2, WA US	6/29/2021	105	8/10/1981	97	47	
DALLESPORT AIRPORT, WA US	6/28/2021	118	7/27/1998	111	73	
DALLESPORT AIRPORT, WA US	6/28/2021	118	7/27/1998	111	73	
DAVENPORT, WA US	6/30/2021	107	7/26/1928	105	128	
DETROIT DAM, OR US	6/29/2021	111	9/3/1988	107	66	
DIABLO DAM, WA US	6/28/2021	110	8/1/1965	106	106	
DOUGLAS INGRAM RIDGE WASHINGTO, WA US	6/29/2021	104	6/28/2015	100	36	
DRY CREEK WASHINGTON, WA US	6/29/2021	104	8/16/2008	100	34	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
EDEN OREGON, OR US	6/29/2021	104	7/5/2007	104	31	
ELLENSBURG BOWERS FIELD, WA US	6/29/2021	114	6/27/2015	108	81	
EMIGRANT SPRINGS, OR US	6/29/2021	102	7/5/2007	100	37	
ENTIAT FISH HATCHERY, WA US	6/30/2021	113	6/28/2015	109	32	
EPHRATA AIRPORT, WA US	6/29/2021	116	8/4/1961	115	72	
ESTACADA 2 SE, OR US	6/29/2021	117	7/30/2009	109	112	
EUGENE MAHLON SWEET FIELD, OR US	6/27/2021	111	8/9/1981	108	83	
EVERETT, WA US	6/29/2021	101	8/17/2020	100	106	
FENN RANGER STATION, ID US	6/29/2021	110	6/29/2015	110	82	
FIRST BUTTE WASHINGTON, WA US	6/29/2021	97	7/23/2006	96	36	
FISH HOOK IDAHO, ID US	6/30/2021	100	7/1/2013	96	36	
FISH LAKE, WA US	6/29/2021	99	7/26/1998	99	33	
FORKS 1 E, WA US	6/28/2021	110	8/9/1981	102	113	
FOSTER DAM, OR US	6/29/2021	112	7/29/2009	106	51	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
GOLDENDALE, WA US	6/30/2021	113	7/27/1998	110	115	
GOODWIN PEAK OREGON, OR US	6/27/2021	103	8/15/2020	101	36	
HARTS PASS, WA US	6/29/2021	85	7/23/1994	83	31	
HAYSTACK OREGON, OR US	6/29/2021	108	8/16/2008	105	36	
HOLDEN VILLAGE, WA US	6/30/2021	101	7/31/1965	101	59	
HORSE CREEK OREGON, OR US	6/28/2021	104	7/11/1990	97	36	
HOWARD PRAIRIE DAM, OR US	6/29/2021	100	7/31/2003	100	60	
ILLINOIS VALLEY AIRPORT OREGON, OR US	6/27/2021	112	7/29/2003	112	36	
KENT, WA US	6/28/2021	106	7/30/2009	104	109	
KING MOUNTAIN, OR US	6/28/2021	98	8/13/2002	97	31	
KLAMATH FALLS INTERNATIONAL AIRPORT, OR US	6/28/2021	103	7/2/2013	101	61	
LA GRANDE, OR US	6/30/2021	108	7/13/2002	108	55	
LACOMB 3 NNE, OR US	6/29/2021	113	7/29/2009	105	48	
LEABURG 1 SW, OR US	6/28/2021	113	8/14/2002	108	87	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
LEWISTON AIRPORT, ID US	6/29/2021	115	8/4/1961	115	73	
LIND 3 NE, WA US	6/30/2021	114	6/29/2021	114	90	
LIND 3 NE, WA US	6/29/2021	114	8/4/1961	113	90	
LONGMIRE RAINIER NPS, WA US	6/30/2021	105	7/22/2006	102	42	
LOOKOUT POINT DAM, OR US	6/28/2021	111	8/10/1981	106	65	
LOST CREEK DAM, OR US	6/29/2021	114	8/9/1981	112	51	
MARION FORKS FISH HATCHERY, OR US	6/29/2021	108	8/7/1972	105	73	
MARION FORKS, OR US	6/28/2021	102	7/10/2002	101	35	
MAZAMA, WA US	6/30/2021	112	8/1/2020	103	52	
MEDFORD INTERNATIONAL AIRPORT, OR US	6/28/2021	115	7/20/1946	115	93	
MORO, OR US	6/30/2021	113	7/27/1939	111	123	
MORSE LAKE, WA US	6/29/2021	91	8/16/2008	87	31	
MOSES LAKE GRANT CO AIRPORT, WA US	6/29/2021	114	6/28/2015	112	72	
MOUNT ADAMS RANGER STATION, WA US	6/30/2021	109	8/10/1981	108	97	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
MOUNT CRAG, WA US	6/29/2021	94	7/11/1990	87	31	
MOUNT HOOD TEST SITE, OR US	6/29/2021	91	7/12/2002	87	38	
MOUNT YONCALLA OREGON, OR US	6/27/2021	107	7/28/2009	106	32	
MUD RIDGE, OR US	6/29/2021	98	8/4/1998	94	35	
NEWHALEM, WA US	6/29/2021	113	8/1/1965	108	62	
NORTH POLE RIDGE OREGON, OR US	6/29/2021	106	7/2/2015	97	30	
NORTHPORT, WA US	6/30/2021	113	7/28/1934	110	122	
ODESSA, WA US	6/30/2021	115	8/4/1961	112	118	
OLYMPIA AIRPORT, WA US	6/28/2021	110	7/29/2009	104	80	
OREGON CITY, OR US	6/28/2021	114	7/29/2009	108	73	
PARADISE, WA US	6/29/2021	90	7/10/2002	88	31	
PATJENS OREGON, OR US	6/29/2021	113	7/2/2015	103	30	
PENDLETON BRANCH EXPERIMENTAL STATION, OR US	6/30/2021	115	8/4/1961	115	88	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
PENDLETON E OR REGIONAL AIRPORT, OR US	6/29/2021	117	7/25/1928	114	93	
PIGTAIL PEAK, WA US	6/29/2021	87	8/4/1998	86	32	
PLAIN, WA US	6/30/2021	109	7/27/1939	104	84	
POLLYWOG OREGON, OR US	6/29/2021	104	7/31/2015	101	36	
POPE RIDGE, WA US	6/29/2021	99	7/24/1994	97	31	
PORTHILL, ID US	6/30/2021	107	8/18/2020	103	128	
PORTLAND INTERNATIONAL AIRPORT, OR US	6/28/2021	116	8/10/1981	107	83	
PORTLAND KGW TV, OR US	6/28/2021	114	8/10/1981	106	47	
POTATO HILL, WA US	6/29/2021	95	8/4/1998	91	32	
PRIEST RIVER EXPERIMENTAL STATION, ID US	6/29/2021	108	8/10/2018	105	123	
PROSSER, WA US	6/30/2021	114	7/14/2002	111	95	
PROVOLT SEED ORCHARD OREGON, OR US	6/27/2021	113	8/2/2017	109	36	
QUARTZ PEAK, WA US	6/29/2021	97	7/13/2002	96	34	
RED BOX OREGON, OR US	6/28/2021	106	8/16/2008	106	36	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
RED HILL, OR US	6/29/2021	95	7/12/2002	94	32	
REDMOND AIRPORT, OR US	6/29/2021	112	8/7/1972	108	72	
REPUBLIC, WA US	6/30/2021	109	7/2/1924	108	121	
RIDDLE, OR US	6/28/2021	111	8/17/1977	110	108	
ROARING RIVER, OR US	6/28/2021	96	8/16/2008	94	31	
ROSEBURG REGIONAL AIRPORT, OR US	6/27/2021	114	8/15/2020	109	90	
ROSS DAM, WA US	6/29/2021	108	7/22/2006	103	60	
ROUND MOUNTAIN OREGON, OR US	6/29/2021	98	7/5/2007	91	31	
RUCH, OR US	6/28/2021	112	8/8/1981	111	58	
SALEM AIRPORT MCNARY FIELD, OR US	6/28/2021	117	8/9/1981	108	128	
SALMON MEADOWS, WA US	6/29/2021	97	7/23/1994	92	32	
SALT CREEK PRINVILLE OREGON, OR US	6/29/2021	105	8/9/2018	105	35	
SANDPOINT EXPERIMENTAL STATION, ID US	6/30/2021	106	7/24/1994	104	110	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
SANTIAM JUNCTION, OR US	6/29/2021	101	8/4/1998	99	34	
SEATTLE SAND POINT WEATHER FORECAST OFFICE, WA US	6/28/2021	107	7/29/2009	105	34	
SEATTLE TACOMA AIRPORT, WA US	6/28/2021	108	7/29/2009	103	73	
SEINE CREEK, OR US	6/28/2021	99	7/27/1998	99	37	
SEXTON SUMMIT, OR US	6/28/2021	100	8/13/2002	97	73	
SHEEP CANYON, WA US	6/28/2021	94	7/27/1998	91	39	
SHERWIN, ID US	6/30/2021	107	8/10/2018	106	31	
SKAMANIA FISH HATCHERY, WA US	6/29/2021	111	7/22/2006	108	56	
SLIDE MOUNTAIN OREGON, OR US	6/29/2021	95	7/28/2020	95	35	
SPOKANE INTERNATIONAL AIRPORT, WA US	6/29/2021	109	8/4/1961	108	131	
STARTUP 1 E, WA US	6/29/2021	106	6/25/1925	106	97	
STEVENS PASS, WA US	6/29/2021	97	8/16/2008	94	31	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
SUGARLOAF OREGON, OR US	6/28/2021	101	9/2/2003	101	35	
TACOMA NUMBER 1, WA US	6/29/2021	97	7/19/2015	94	39	
THREE LYNX, OR US	6/29/2021	113	7/21/1946	107	96	
THUNDER BASIN, WA US	6/29/2021	96	7/26/1998	94	32	
TIMOTHY OREGON, OR US	6/29/2021	96	7/22/2003	96	36	
TOKETEE OREGON, OR US	6/28/2021	107	7/29/2003	103	36	
TROUGH, WA US	6/29/2021	91	7/23/2006	87	32	
TROUT CREEK OREGON, OR US	6/28/2021	112	9/2/1988	112	35	
TROUTDALE, OR US	6/28/2021	116	8/18/1977	108	73	
TUPPER OREGON, OR US	6/29/2021	104	7/12/2002	102	34	
UPPER BAKER DAM, WA US	6/29/2021	110	5/30/1983	102	55	
VILLAGE CREEK OREGON, OR US	6/27/2021	106	7/21/2006	105	35	
WALLA WALLA REGIONAL AIRPORT, WA US	6/29/2021	116	7/10/1975	114	72	
WAMIC MILL OREGON, OR US	6/29/2021	104	7/23/2006	104	35	

STATION	DATE	RECORD	PREV. DATE	PREV. RECORD	NUMBER OF YEARS	DIFF
WENATCHEE PANGBORN MEMORIAL AIRPORT, WA US	6/29/2021	114	6/28/2015	109	61	
WENATCHEE, WA US	6/30/2021	113	7/18/1941	110	90	
WHITE PASS E.S., WA US	6/29/2021	94	8/4/1998	92	31	
WHITMAN MISSION, WA US	6/30/2021	114	8/5/1998	110	58	
WILBUR, WA US	6/30/2021	110	7/3/1922	110	121	
WINCHESTER, OR US	6/28/2021	112	8/4/2017	107	31	
WINTHROP 1 WSW, WA US	6/29/2021	107	7/27/1939	106	115	
YAKIMA AIRPORT, WA US	6/29/2021	113	8/10/1971	110	74	
YELLOWSTONE MOUNTAIN OREGON, OR US	6/28/2021	108	8/24/1996	106	35	

Citing This Report

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November U.S. Release: Mon, 8 Dec 2025, 11:00 AM EST

In alignment with evolving priorities, statutory mandates, and staffing changes, NOAA's National Centers for Environmental Information (NCEI) will no longer be updating the Billion Dollar Weather and Climate Disasters product. Additional details and the opportunity to submit comments are available at the NESDIS Notice of Changes website. All past reports, spanning 1980-2024, and their underlying data remain authoritative, archived, and available via the Billion-Dollar Disasters dataset landing page.

Menu

Overview

The U.S. sustained 403 weather and climate disasters from 1980–2024 where overall damages/costs reached or exceeded $1 billion (including CPI adjustment to 2024). **The total cost of these 403 events exceeds $2.915 trillion**.

View summary data in Summary Stats

2024 in Summary...

In 2024, there were 27 confirmed weather/climate disaster events with losses exceeding $1 billion each to affect United States. These events included 1 drought event, 1 flooding event, 17 severe storm events, 5 tropical cyclone events, 1 wildfire event, and 2 winter storm events. The 1980–2024 annual average is 9.0 events (CPI-adjusted); the annual average for the most recent 5 years (2020–2024) is 23.0 events (CPI-adjusted).

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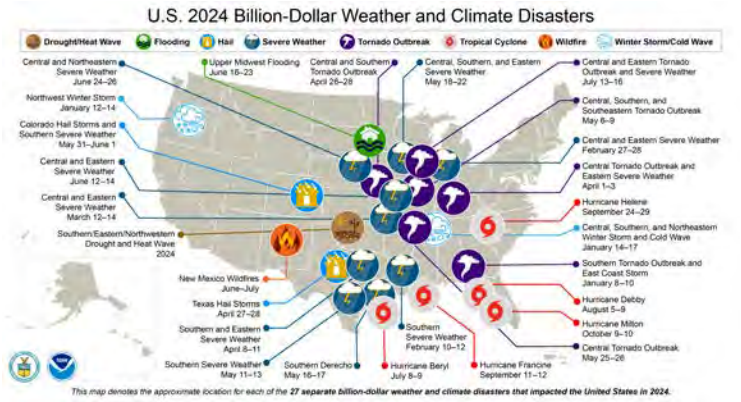


All Disasters | Drought

Flooding | Freeze

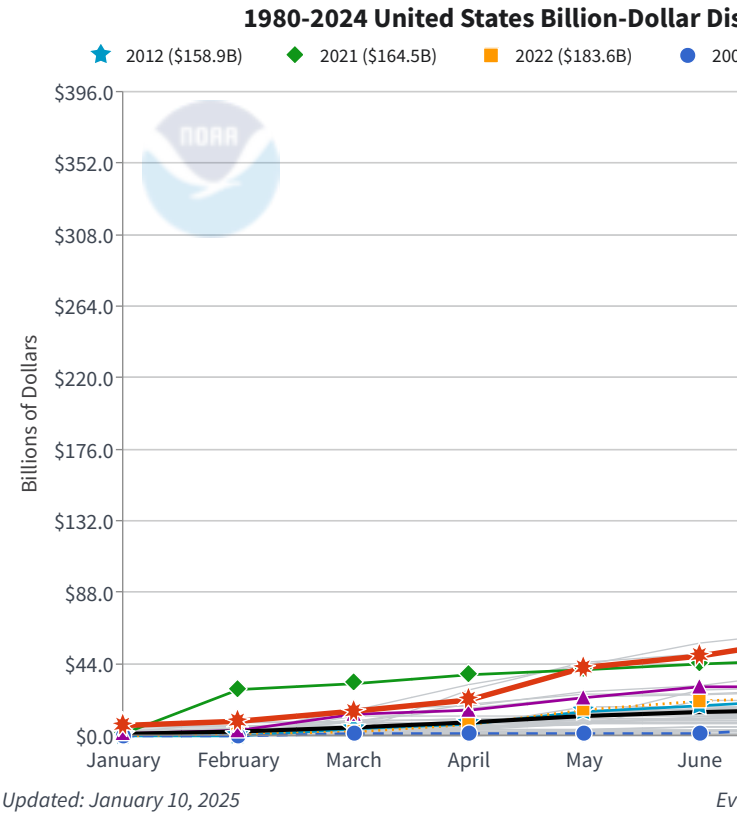
Severe Storm | Tropical Cyclone

Wildfire | Winter Storm

United States | Cost

Update

CPI-Adjusted | Unadjusted



Updated: January 10, 2025 *Ev*

US Summary

Methodology and Data Sources

The National Centers for Environmental Information (NCEI) is the Nation's Scorekeeper in terms of addressing severe weather and climate events in their historical perspective. As part of its responsibility of monitoring and assessing the climate, NCEI tracked and evaluated climate events in the U.S. and globally from 1980-2024 that had great economic and societal impacts. NCEI is frequently called upon to provide summaries of global and U.S. temperature and precipitation trends, extremes, and comparisons in their historical perspective. The Billion-dollar disasters product is intended to show the impact of extreme weather and climate events on the economy in inflation adjusted dollars. We cannot control how others use the product, but we consistently note that disaster impacts are a combination of increased risk and the possible impacts of climate variability. For example, the increase in population and material wealth over the last several decades are an important cause for the rising costs. These trends are further complicated by the fact that much of the growth has taken place in vulnerable areas like coasts, the wildland-urban interface, and river floodplains. Vulnerability is especially high where building codes are insufficient for reducing damage from extreme events. This is part of the reason that the 2010s decade is far costlier than the 2000s, 1990s, or 1980s (all inflation adjusted to 2024 dollars). The methodology and data sets are documented in the peer reviewed literature and on the NCEI website. This product has no focus on climate event attribution. The number and cost of weather and climate disasters increased over time in the United States due to a combination of increased exposure (i.e., more assets at risk), vulnerability (i.e., how much damage a hazard of given intensity -wind speed, or flood depth, for example - causes at a location), and the fact that changes in the frequency of some types of extremes that lead to billion-dollar disasters (i.e., National Academies of Sciences, Engineering, and Medicine. Compounding Disasters in Gulf Coast Communities 2020-2021: Impacts, Findings, and Lessons (2024); Multi-Hazard Mitigation Council. Natural Hazard Mitigation Saves (2019)). We also know from research using other kinds of climate and weather data that climate variability can alter the frequency and intensity of certain types of extreme weather that lead to billion-dollar disasters - most notably the rise in vulnerability to drought, lengthening wildfire seasons in the Western states, and the potential for extremely heavy rainfall becoming more common in

the eastern states. Sea level rise can worsen hurricane storm surge flooding (Fifth U.S. National Climate Assessment (2023)).

In 2012, NCEI -- then known as National Climatic Data Center (NCDC) -- reviewed its methodology on how it develops Billion-dollar Disasters. NCEI held a workshop with economic experts (May, 2012) and worked with a consulting partner to examine possible inaccuracy and biases in the data sources and methodology used in developing the loss assessments (mid-2013). This ensured more consistency with the numbers NCEI provided on a yearly basis and gave more confidence in the year-to-year comparison of information. Another outcome of the workshop was a published peer-reviewed article "U.S. Billion-dollar Weather and Climate Disasters: Data Sources, Trends, Accuracy and Biases" (Smith and Katz, 2013). This research found the net effect of all biases appears to be an underestimation of average loss. In particular, it is shown that the factor approach can result in an underestimation of average loss of approximately 10–15%. This bias was corrected during a reanalysis of the loss data to reflect new loss totals.

It is also known that the uncertainty of loss estimates differs by disaster event type reflecting the quality and completeness of the data sources used in our loss estimation. In 2024, seven of the 27 separate billion-dollar events (i.e., five tropical cyclones, Upper Midwest Flooding and the multi-region drought and heatwave) had higher potential uncertainty values around the loss estimates due to less coverage of insured assets and data latency. The remaining 20 events (i.e., the winter storms and severe storm events producing tornado, hail and high wind damage) had lower potential uncertainty surrounding their estimate due to more complete insurance coverage and data availability. One approach to understanding cost uncertainty is discussed in the peer-reviewed article "Quantifying Uncertainty and Variable Sensitivity within the U.S. Billion-dollar Weather and Climate Disaster Cost Estimates" (Smith and Matthews, 2015).

In performing these disaster cost assessments these statistics were developed using the most comprehensive public and private sector sources and represent the estimated total costs of these events -- that is, the costs in terms of dollars that would not have been incurred had the event not taken place. More than one dozen public and private sector data sources help capture the total, direct costs (both insured and uninsured) of the weather and climate events. These costs include: physical damage to residential, commercial, and municipal buildings;

material assets (content) within buildings; time element losses such as business interruption or loss of living quarters; damage to vehicles and boats; public assets including roads, bridges, levees; electrical infrastructure and offshore energy platforms; agricultural assets including crops, livestock, and commercial timber; and wildfire suppression costs, among others. However, these disaster costs do not take into account losses to: natural capital or environmental degradation; mental or physical healthcare related costs, the value of a statistical life (VSL); or supply chain, contingent business interruption costs. Therefore, our estimates should be considered conservative with respect to what is truly lost, but cannot be completely measured due to a lack of consistently available data. Sources include the National Weather Service, the Federal Emergency Management Agency, U.S. Department of Agriculture, National Interagency Fire Center, U.S. Army Corps, individual state emergency management agencies, state and regional climate centers and insurance industry estimates, among others.

Links to key public sector data sources include FEMA Public Assistance, FEMA Individual Assistance, USDA Risk Management Agency Crop Indemnity, the USDA National Agricultural Statistics Service, the National Interagency Fire Center wildfire data, the National Flood Insurance Program claims data and the NOAA Storm Events Database. We also reference state insurance services such as CalFire and FLOIR, the U.S. Department of Defense disaster impact reports, the Federal Highway Administration damage reports and private property insurance data as part of this event analysis. We also examined insurance penetration rates for vehicle insurance, home insurance, flood insurance, crop insurance, and business coverage, to better understand insured and uninsured assets. As a point of comparison for robustness, NCEI assessed 28 separate billion-dollar disaster events in 2023. For 12 of these events, the NCEI damage estimates were smaller than those in other sources, such as Gallagher Re, AON, and Munich Re. For the other 16 events, the NCEI estimates fell within the range of the other reports such as Gallagher Re, Munich Re and AON 2023 disaster cost reports. Below is a breakdown of the public and private data sources referenced for the 2024 BDD events:

- the **17 severe storm events** (i.e., tornado, hail and high wind damage) reference data from:
  - NOAA Storm Events Database
  - National Flood Insurance Program claims data
  - FEMA Public Assistance
  - FEMA Individual Assistance

    - USDA Risk Management Agency Crop Indemnity
    - Property Claim Services
    - NOAA Storm Prediction Center
- the **2 winter storm events** reference data from:
    - NOAA Storm Events Database
    - National Flood Insurance Program claims data
    - FEMA Public Assistance
    - FEMA Individual Assistance
    - USDA Risk Management Agency Crop Indemnity
    - Property Claim Services
    - NOAA Storm Prediction Center
- the **five landfalling tropical cyclones** (Beryl, Debby, Francine, Helene and Milton) reference data from:
    - National Flood Insurance Program claims data
    - FEMA Public Assistance
    - FEMA Individual Assistance
    - NOAA Storm Events Database
    - Property Claim Services
    - Florida- Hurricane Milton Report on Agriculture Losses and Damages
    - Georgia Hurricane Helene Report on Economic losses to agriculture and forestry
    - North Carolina Helene Damage and Needs Assessment
- the **one New Mexico wildfire event** references data from:
    - FEMA Public Assistance
    - FEMA Individual Assistance
    - NOAA Storm Events Database
    - Property Claim Services
    - National Interagency Fire Center wildfire data
- the **one multi-regional drought and heat wave event** references data from:
    - USDA Risk Management Agency Crop Indemnity
    - USDA National Agricultural Statistics Service
    - National Integrated Drought Information System
    - USDA Secretarial Drought Designations
    - NOAA Storm Events Database
- the **one Upper Midwest flooding event** references data from:
    - National Flood Insurance Program claims data
    - FEMA Public Assistance
    - FEMA Individual Assistance
    - USDA Risk Management Agency Crop Indemnity
    - Property Claim Services
    - NOAA Storm Events Database

In the (Risk Mapping) section of our site, we also incorporate socioeconomic risk information from the Census American Community Surveys, the CDC Social Vulnerability Index, among

others that provide additional spatial context of hazard risk. For more information on risk, here is a presentation: Smith, A., 2022: 2021 U.S. Billion-dollar weather and climate disasters in historical context and new hazard and socioeconomic risk mapping. *April 2022, AMS Washington Forum*, Washington, DC.

For a more recent analysis, the following report offers a summary on the 2024 - An active year of U.S. billion-dollar weather and climate disasters.

Citing this information:

NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2025). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Sixth Oregon Climate Assessment

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Sixth Oregon Climate Assessment • January 2023
Executive Summary

Established and emerging understanding of observed and projected climate change in Oregon, and knowledge of the opportunities and risks that climate change poses to natural and human systems, may serve as a resource for actions such as equitable planning for mitigation of climate-related natural hazards and implementation of Oregon's 2021 Climate Change Adaptation Framework.

State of Climate Science

Temperature and precipitation. Oregon's annual average temperature increased by about 2.2°F per century since 1895. If greenhouse gas emissions continue at current levels, annual temperature in Oregon is projected to increase by 5°F by the 2050s and 8.2°F by the 2080s, with the greatest seasonal increases in summer. Precipitation is projected to increase during winter and decrease during summer, and the number and intensity of heavy winter precipitation events is projected to increase. Furthermore, the proportion of precipitation falling as rain rather than snow is expected to increase.

Arctic amplification. The contribution to severe weather in Oregon from disproportionately rapid warming in the Arctic (Arctic amplification) is uncertain, but is likely to be small. Some evidence suggests that midlatitude westerly winds are becoming wavier, allowing Arctic air to move south, and that loss of sea ice contributes to extreme winter precipitation. There is greater certainty that Arctic amplification is contributing to summer heat waves and hot, dry autumn weather.

Wind speeds. Wind patterns affect provision of electricity, transportation safety, and the spread of wildfires and pollutants. Mean wind speeds in Oregon are projected to decrease slightly, but extreme winter wind speeds may increase, especially in western Oregon. The frequency of strong easterly winds during summer and autumn, however, is projected to decrease slightly.

Current climate models. Most projections and analysis of future climate impacts still are based on the suite of global climate models from the fifth phase of the Coupled Model Intercomparison Project (CMIP5), and inferences based on these models remain valid and useful. Projections from models in the sixth phase (CMIP6), which reflect slightly different assumptions about emissions and improved understanding of the Earth system, are being evaluated and are becoming more accessible. As the CMIP6 models are refined, it may become worthwhile to update climate impacts assessments.

Climate-Related Natural Hazards

Extreme temperatures. The number of days that are warmer than 90°F and nights that are warmer than 65°F is increasing across Oregon, although extreme cold will still be possible in the coming decades. The Oregon Occupational Safety and Health Administration's new regulations on workplace heat exposure are based on thresholds of the heat index, which accounts for both air temperature and relative humidity. Warming over extensive areas, rather than increases in relative humidity, is the main driver of projected future increases in extreme heat index values in Oregon.

Drought. Over the past 20 years, the incidence, extent, and severity of drought in the Northwest increased. Low precipitation contributed to each drought, but temperature and snowpack also affected drought severity and impacts on agriculture, fisheries, and other sectors. As summers in Oregon continue to become warmer and drier and mountain snowpack decreases, the frequency of droughts, particularly snow droughts, is likely to increase.

Changes in the water cycle. Since the mid-late 1900s, 20 of Oregon's glaciers disappeared; none remain in the Wallowa Mountains. Glacier retreat accelerated during the past 30 years, in part due to human-caused climate change. Public participation in science, or community science, is a powerful means of filling data gaps and improving models of precipitation and water availability. The Community Collaborative Rain, Hail and Snow network (CoCoRaHS), Community Snow Observations (CSO), and Mountain Rain or Snow are compelling illustrations of public contributions to advancing climate science and its applications.

Wildfire. Total annual area burned in Oregon has increased during the last 35 years. As aridity increases,

the likelihood of extreme fire weather is increasing, and the area burned by lightning-caused fires in central Oregon is projected to increase. Following extensive wildfires in 2020, Oregonians took personal action and also assisted their communities in becoming more resilient. Survey results suggest relative high levels of support for climate mitigation and adaptation policies. Survey results also indicate widespread concerns about the impacts of smoke on personal health and highlight potential benefits of providing public smoke-related information and distributing protective equipment.

Coastal hazards. Relative sea-level rise rates are slower in Oregon than in many other coastal regions of the United States. Nevertheless, sea-level rise threatens buildings and offshore and coastal transportation networks. Additionally, local erosion and flooding along the Oregon coast tends to be high during major winter storm seasons. Adaptation measures being implemented or considered in coastal Oregon include hard structures, natural structures, and nonstructural policies and regulations, such as zoning restrictions and relocation of communities.

Adaptation Sectors

Economics. Understanding the magnitude of the economic effects of climate change is critical for evaluating trade-offs of mitigation and adaptation policies. Climate change may significantly affect the availability and use of water and irrigation in Oregon's agricultural sector and change the composition of Oregon's timberlands. Financial incentives could encourage forest landowners to sequester carbon in a cost-effective manner. Oregon's oceans and coasts can harness wave and offshore wind energy while generating sustained economic profit and job opportunities.

Natural systems. Responses of species and ecosystems to climate change and its interactions with other environmental changes are highly variable. Extreme heat can reduce tree growth and increase tree mortality, but trees' susceptibility is affected by topography, acclimation, water availability, and other factors. The near-term and long-term causes and consequences of foliage scorch and heat stress remain uncertain. Conservation priorities for cold-water fishes, such as salmon and native trout, have tended to discount low elevation, seasonally warm waters. However, water bodies that are too warm for salmonids during summer may be ideal during other seasons. Use of both seasonally cold and warm waters may support growth and persistence of Oregon's native fishes.

Built environment. Because land-use laws control development, they affect mitigation of and resilience to climate change. Recent reforms of Oregon's land-use and housing laws, and related regulations and policy, support reduction of greenhouse gas emissions, carbon sequestration, increasing community resilience, and more equitably distributing environmental benefits and burdens. Full integration of climate science and equity considerations into land-use plans and actions could enable Oregon to respond to climate change even more effectively.

Public health. The composition of wildfire smoke, and therefore its effects on public health, is highly variable. Exposure to wildfire smoke can lead to mortality and adverse respiratory and cardiovascular outcomes, and may affect pregnancy and birth outcomes. Increasing co-occurrence of wildfire smoke and surface ozone during summer can exacerbate negative health outcomes. Such exposures and associated hospital admissions also stress the capacity of the health care system.

Tribal resilience. Climate change places disproportionately high stresses on tribal communities, yet tribal adaptation to environmental and social change over millennia can enable unusually high resilience. Early career tribal citizens and their communities are responding to climate change via ceremony, political action, workforce development, environmental stewardship, and youth education and fellowship, thereby exercising self-determination and reclaiming sovereignty despite inequities.

Social systems. Visual artists are informing viewers about climate change, engaging audiences in conversation and information sharing, and catalyzing cultural evolution and transformation. In Oregon's agricultural sector, efforts to restore and sustainably manage degraded soils (practices often referenced as regenerative agriculture) are expanding. Under some circumstances, these practices also can increase short-term or long-term carbon sequestration.

The full Sixth Oregon Climate Assessment is available at blogs.oregonstate.edu/occri/oregon-climate-assessments.

Introduction

Consistent with its charge under Oregon House Bill 3543, the Oregon Climate Change Research Institute (OCCRI) conducts a biennial assessment of the state of climate change science, including biological, physical, and social science, as it relates to Oregon and the likely effects of climate change on Oregon. This sixth Oregon Climate Assessment builds on the previous assessments by continuing to evaluate past and projected future changes in Oregon's climate and water supply. Like the fifth assessment, it is structured with the goal of supporting the state's mitigation planning for natural hazards and implementation of the 2021 Oregon Climate Change Adaptation Framework.

The first section of this assessment, *State of Climate Science*, reflects OCCRI's sustained appraisal of observed trends and future projections of temperature, precipitation, and other major climate variables. Previous key messages about projected changes in Oregon's climate, such as warmer temperatures, drier summers, and an increase in the frequency, duration, and severity of drought, remain consistent. *State of Climate Science* summarizes emerging evidence related to potential effects of Arctic warming on the state's climate and explores the likelihood of changes in annual and seasonal wind speeds. The section also compares the latest two generations of global climate models, including their assumptions about emissions of greenhouse gases and their accessibility.

The second section of this Oregon Climate Assessment delves into the expected effects of climate change on natural hazards, including extreme temperatures, drought, changes in the water cycle, wildfire, and coastal flooding and erosion. Glaciers and perennial snowfields in Oregon retreated rapidly during the past 30 years, reducing storage of water that otherwise would be released during late summer. The section details the contributions of tens of thousands of weather stations to PRISM, the most widely used source of mapped climate data in the United States, and explains how public participation in science is becoming a powerful means of filling data gaps and improving models of precipitation and water availability. The increasing incidence and size of wildfires, whether ignited by human activity or lightning, are strongly linked to episodic drought and long-term increases in aridity. Two surveys conducted after extensive wildfires in 2020 suggest relatively high support among Oregonians for climate mitigation and adaptation policies. Survey results also indicate widespread concerns about the impacts of smoke on personal health and desires for greater access to smoke-related information and protective equipment.

The third section of this assessment addresses six sectors within which Oregon's 2021 Climate Change Adaptation Framework aggregates vulnerabilities and strategic responses: economy, natural world, built environment and infrastructure, public health, cultural heritage, and social systems. The section begins with a robust discussion of economic concepts and tools relevant to understanding climate challenges and opportunities, and highlights recent insights on the effects of climate change on economic activity in Oregon. Contributions related to natural systems underscore that observations of short-term ecological stress from climate extremes, such as foliage scorch, may or may not indicate long-term effects on mortality and nutrient and water cycles. Furthermore, new research questions whether salmonids in the Pacific Northwest may be more tolerant of high water temperatures than previously assumed. Next, the section investigates how reforms of Oregon's land-use and housing laws are supporting reduction of greenhouse gas emissions, increases in community resilience, and more-equitable distribution of environmental benefits and burdens.

Contributions related to public health in this assessment concentrate on the effects of wildfire smoke on human health and the health care system, and the fact that wildfire smoke and high

surface ozone levels increasingly tend to occur on the same days during summer. The health risks of exposure to fine particulate matter ($PM_{2.5}$) are fairly well understood, but many other uncertainties remain, such as the health effects of repeated smoke exposure and relations between health responses and the composition of smoke. Early career tribal citizens share the ways in which their communities are responding to climate change, exercising self-determination and reclaiming sovereignty despite historic and contemporary inequities. The section also explores how visual artists are communicating with the public about climate change, engaging audiences in conversation and encouraging creative problem-solving. Furthermore, the section examines regenerative agriculture, an increasingly popular set of practices that aims to restore and sustainably manage degraded soils.

Both the Climate Change Adaptation Framework and this assessment recognize that the myriad interactions and feedbacks among natural and human systems are complex and can be difficult to differentiate. An iterative assessment process can indicate the extent to which natural hazards may affect adaptation sectors, and inform selection of actions to maximize livelihoods and well-being.

Observed and Projected Trends in Climate

Oregon is becoming warmer and, despite relatively stable long-term precipitation totals, drier. Most projections and analysis of future climate still are based on the suite of global climate models from the fifth phase of the Coupled Model Intercomparison Project (CMIP5; Taylor et al. 2012), an initiative of the World Climate Research Programme that aims to increase understanding of past, present, and future natural and human-caused changes in climate. Later in this section, we describe major differences between models included in the fifth and sixth phases of CMIP. These differences notwithstanding, fundamental projections of future climate have not changed appreciably in the two years since publication of the fifth Oregon Climate Assessment (Dalton and Fleishman 2021).

	2050s		2080s	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Annual	3.6 (1.8, 5.4)	5.0 (2.9, 6.9)	4.6 (2.1, 6.7)	8.2 (4.8, 10.7)
Winter	3.3 (1.6, 5.1)	4.5 (2.4, 6.5)	4.2 (1.8, 6.5)	7.4 (4.2, 9.8)
Spring	3.1 (1.4, 5.0)	4.1 (2.0, 5.9)	3.8 (1.7, 6.0)	6.7 (3.8, 9.2)
Summer	4.5 (2.2, 6.8)	6.3 (3.6, 8.9)	5.5 (2.7, 8.3)	10.2 (6.5, 13.9)
Autumn	3.7 (1.5, 5.4)	5.2 (2.6, 7.0)	4.7 (2.0, 6.9)	8.6 (4.6, 11.4)

Table 1. Projected future changes in mean annual and seasonal temperature (°F) in Oregon from the historical baseline (1970–1999) for the 2050s (2040–2069) and 2080s (2070–2099) under RCP 4.5 and RCP 8.5. Values are the average changes from 35 global climate models and the 5th to 95th percentile range across those models. Table reproduced from Dalton et al. 2017, with data for Oregon from Rupp et al. 2017. Winter includes December, January, and February; spring includes March, April, and May; summer includes June, July, and August; autumn includes September, October, and November.

Oregon's average annual temperature increased at a rate of 2.2°F (1.2°C) per century from 1895–2021 (NCEI 2022). Oregon's temperatures are projected to increase in all seasons, particularly summer. If current levels of emissions of greenhouse gases continue throughout the twenty-first century—a scenario referenced by CMIP5 as representative concentration pathway (RCP) 8.5—Oregon's annual average temperature is projected to increase by 5°F (2.8°C) by the 2050s and 8.2°F (4.6°C) by the 2080s (Table 1, Figure 1a). Summer temperatures are projected to increase by 6.3°F (3.7°C) by the 2050s and 10.2°F (5.7°C) by the 2080s under RCP 8.5 (Table 1). A second emissions scenario reflected in these projections, RCP 4.5, represents moderate reductions in global greenhouse gas emissions, with a peak near mid-century.

Oregon's annual precipitation varies considerably among years, and has not changed significantly over the observational record (increase of 0.30 in [0.76 cm] per century from 1895–2021) (NCEI 2022). Some statistically significant increases in heavy precipitation have been documented

	2050s		2080s	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Annual	1.9 (-4.9, 9.0)	2.7 (-6.0, 11.4)	3.4 (-5.6, 15.3)	6.3 (-5.2, 19.9)
Winter	4.9 (-6.4, 16.5)	7.9 (-4.7, 24.3)	7.3 (-6.3, 19.9)	14.5 (-2.8, 37.1)
Spring	1.9 (-8.9,12.1)	2.7 (-7.2, 17.4)	3.4 (-7.7, 14.9)	3.6 (-9.4, 15.6)
Summer	-6.3 (-28.5, 16.1)	-8.7 (-33.1, 22.5)	-4.6 (-24.2, 22.3)	-7.7 (-38.7, 33.5)
Autumn	0.5 (-17.0, 14.4)	-0.8 (-17.1, 14.9)	1.5 (-15.0, 18.1)	1.9 (-17.2, 24.2)

Table 2. Projected future relative changes in total annual and seasonal precipitation (%) in Oregon from the historical baseline (1970–1999) for the 2050s (2040–2069) and 2080s (2070–2099) under RCP 4.5 and RCP 8.5. Values are the average changes from 35 global climate models and the 5th to 95th percentile range across those models. Table reproduced from Dalton et al. 2017, with data for Oregon from Rupp et al. 2017. Winter includes December, January, and February; spring includes March, April, and May; summer includes June, July, and August; autumn includes September, October, and November.

in Oregon (Dalton et al. 2017). However, the relatively small sample sizes and substantial variability in intense precipitation makes it difficult to detect long-term observed trends, and results often depend on location, time frame, and definition of heavy precipitation (Mote et al. 2013). Annual variability is expected to continue to dominate annual precipitation, with a slight increasing trend (Table 2, Figure 1b). Precipitation is expected to increase during the wet season and decrease during summer in the Columbia River basin (Rupp et al. 2017) and, on average, across Oregon as a whole (Table 2). In general, the intensity of heavy precipitation events during the twenty-first century in Oregon is projected to increase, although not uniformly across the state (Dalton et al. 2017, Cooley and Chang 2021).

Recent Advances in Climate Science

Whether disproportionate warming of the Arctic contributes to severe weather at lower latitudes has become a subject of considerable interest and inquiry in recent years. Accordingly, in the next contribution in this section, Rupp and Schmittner examine whether Arctic amplification may affect Oregon's climate.

This section then addresses potential future changes in local wind speeds across Oregon, a topic highly relevant to the risks of wildfires and wildfire smoke. Mean near-surface wind speeds are expected to decrease slightly, but the mean is not necessarily indicative of the maximum speed. Therefore, Rupp investigates drivers, projections, and uncertainties related to wind patterns across the state. Dalton and Bachelet conclude the section by discussing the newest generation of climate models and projections.

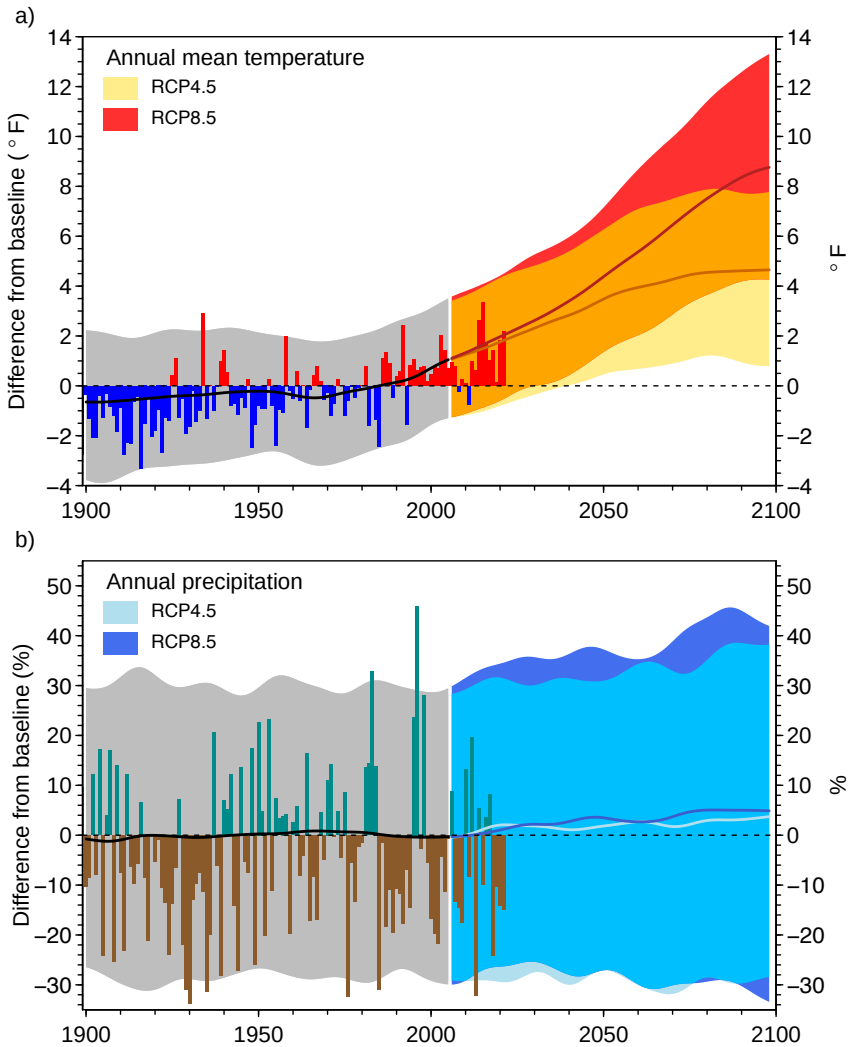

Figure 1. Observed, simulated, and projected changes in Oregon's mean annual (a) temperature and (b) precipitation relative to 1970–1999 (baseline) under RCP 4.5 and RCP 8.5. Colored bars are observed values from the National Centers for Environmental Information. The solid lines are the mean values of simulations from 35 climate models for the years 1900–2005, which were based on observed climate forcings (black line), and 2006–2099. Shading indicates the range in values from all models. The mean and range were smoothed to emphasize long-term variability.

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Arctic Amplification

David E. Rupp and Andreas Schmittner

The Arctic is warming faster than other latitudes. This phenomenon, Arctic amplification, is largely a consequence, and a cause, of disappearing sea ice (Figure 1). As atmospheric concentrations of anthropogenic greenhouse gases and air temperatures increase, existing sea ice melts and formation of new sea ice is inhibited. This process leads to yet more warming because the exposed ocean reflects much less solar energy back to space than sea ice (e.g., Cohen et al. 2020). Another cause of Arctic amplification is the increase in equator-to-pole transport of water vapor that occurs as global temperatures increase. This additional water vapor brings more latent heat northward, and the heat is released when the water vapor condenses in the colder polar air (e.g., Schmittner and Stocker 1999, Siler et al. 2018).

Figure 1. Sea ice off Alaska. Source: U.S. Bureau of Ocean Energy Management.

There is no doubt that Arctic amplification is occurring. But whether it contributes to severe weather at latitudes below the Arctic (below about 66.5°N), particularly in the midlatitudes (roughly 30–60°N), is uncertain. Such a contribution first was hypothesized about a decade ago. Because Arctic amplification decreases the difference in temperature between the equator and pole, a difference that drives the midlatitude westerly winds, it was hypothesized that the intensity of the westerlies will weaken, leading circulation of the air around the planet at the midlatitudes to become slower and wavier or more sinuous. Such planetary waves in the flow of air around the Northern Hemisphere would allow warm air from the south to move northward and cold air from the north to move southward. Therefore, it was hypothesized that the incidence of more-extreme weather, including heat waves and cold snaps, will increase, especially when a large wave persists in place for a long period of time (Francis and Vavrus 2012). However, the decrease in the equator-to-pole temperature gradient may be limited to the lower troposphere, the lowest part of the atmospheric layer that is closest to Earth's surface. In contrast, a robust modeled response to increasing greenhouse gas concentrations is an equator-to-pole temperature gradient that increases in the upper troposphere because the upper troposphere over the tropics warms more quickly than the upper troposphere over the Arctic. Because any effect on planetary waves of the decrease in the temperature gradient in the lower troposphere may be negated by the increase in the temperature gradient in the upper troposphere, the intensity and waviness of the westerlies may not change much (Lee et al. 2021).

A second, more complex hypothesis about the effect of Arctic amplification involves the stratospheric polar vortex, a band of strong westerly winds circling the North Pole in winter at an altitude of 16–48 km (10–30 mi). These strong winds help to retain cold stratospheric air (air in the layer above the troposphere) within the vortex. If changes in sea ice and regional snow weaken or disrupt the stratospheric polar vortex, it is hypothesized that cold, high-altitude polar air then may move southward and downward (Cohen et al. 2020).

These hypotheses, particular the waviness hypothesis, have been mentioned frequently in media reports on the role of climate change in extreme weather events (Blackport and Screen 2020). However, there is disagreement in the scientific community over the effect of Arctic amplification on midlatitude extreme weather (Cohen et al. 2020). Much of the recent contention centers on claims that Arctic amplification has caused extreme cold snaps. For example, a study attributing the cold snap that affected Texas in February 2021 to Arctic amplification (Cohen et al. 2021) was quickly challenged because it inferred a connection that was not supported by the authors' own analysis and because the claim that Arctic amplification will increase frequency of extreme cold events is inconsistent with past studies (Blackport et al. 2022). Moreover, the occurrence of extreme cold events has decreased over most midlatitude terrestrial areas (van Oldenbourgh et al. 2019).

An observed correlation between the downward trend in sea ice cover and an increasingly wavy circulation prompted the waviness hypothesis (Francis and Vavrus 2012). Since the hypothesis was proposed, the large majority of observation-based studies have yielded evidence consistent with a connection between Arctic amplification and extreme winter weather (Cohen et al. 2020). Nevertheless, inferences of studies based on climate modeling have not converged, with slightly fewer indicating that Arctic amplification has a strong influence on extreme winter weather than that it does not (Cohen et al. 2020). Here, we review studies published since 2020, concluding with possible implications for climate and extreme weather in Oregon.

Several recent climate modeling studies reexamined the connection between Arctic amplification and atmospheric circulation during winter in the Northern Hemisphere. For example, Arctic sea-ice loss weakened westerlies from 50–65°N but strengthened those around 30–45°N, although the overall response of atmospheric circulation to Arctic amplification was weak (Smith et al. 2022). Another two studies suggested that in the North Pacific, Arctic amplification leads to strengthening and eastward extension of the North Pacific jet (30–50°N) during winter (Ronalds et al. 2020, Rodriquez Solis et al. 2022). A stronger and more eastward jet is associated with fewer anomalously cold temperatures over the United States and Canada and an increase in the frequency of the North America dipole pattern: relatively warm temperatures in the west and northwest and relatively cool temperatures in the east and southeast (Ronalds et al. 2020).

The results of the above studies were consistent with the hypothesized link between Arctic amplification and a weakening of the westerlies, at least north of ~45°N. However, Blackport and Screen (2020) did not find that reducing the difference between equatorial and polar temperature in a climate model induced more waviness, although mid- to high-latitude westerlies weakened. Furthermore, Blackport and Screen (2020) reported that the observed apparent trend toward wavier circulation has reversed in recent years even as Arctic amplification has continued. Dai and Deng (2021) found that although modeled Arctic amplification decreased the equator-to-pole temperature gradient, it also decreased the variability of the gradient, which in turn decreased the variability in the flow of heat energy. Consequently, variability in winter temperature decreased, with fewer events that were extremely cold or hot relative to the mean temperature. Similarly, Blackport et al. (2021)

discovered that winter temperature variability in the mid to high latitudes has already decreased and that the decrease is attributable to human activity.

Additionally, Arctic amplification may affect midlatitude winter precipitation extremes. Climate models indicated that the effect of sea ice loss on the North Pacific jet brings atmospheric rivers closer to the west coast of North America, although the storm track shifts northeast, increasing precipitation in Canada and the northwestern corner of the United States and decreasing precipitation in the southwestern United States (Ma et al. 2021). On the basis of observations, Liu et al. (2021) concluded that Arctic amplification has increased the amplitude of planetary waves and that Arctic amplification will lead to future increases in extreme precipitation over the Northern Hemisphere, although they did not find a significant effect on precipitation over the northwestern United States.

Although much of the focus has been on winter, climate modeling indicates that Arctic amplification contributed to an increase in the frequency of summer heat waves over North American midlatitudes (Song et al. 2021, Wu and Li 2022). Wang et al. (2022) even attributed the persistent high-pressure ridge that led to the heat wave over British Columbia and the northwestern United States in summer 2021 to ice loss in the Chukchi Sea. The processes that link Arctic amplification to development of a high-pressure ridge over the western United States may also drive the increasing frequency of fire weather during autumn in the lower to midlatitudes of northern Mexico, the United States, and Canada (Zou et al. 2021).

On the whole, the likely effect of Arctic amplification on Oregon's future climate and weather appears to be small. South of ~60°N, the effect of Arctic amplification on the climate is minor. The observed correlation between Arctic amplification and midlatitude extreme weather may not be causal, but reflect that both are affected by greenhouse gas-induced warming and short-term climate variability (Dai and Song 2020). Nevertheless, Arctic amplification, in isolation from other factors driving regional climate change, may decrease the number of winter cold snaps (Dai and Deng 2021, Song et al. 2021) and increase the number of summer heat waves in Oregon (Song et al. 2021, Wang et al. 2022, Wu and Li 2022). Arctic amplification will also promote hot and dry autumn weather that is conducive to wildfires, maybe more so in eastern than in western Oregon (Zou et al. 2021). Arctic amplification's impact on extreme precipitation may be negligible given that Oregon is near the transition zone between increasing atmospheric river frequency to the north and decreasing frequency to south (Ma et al. 2021).

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Projected Changes in Wind Speeds

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Wind patterns in the northwestern United States affect natural disturbances, public health, and multiple sectors. For example, variability in winds affects generation of wind power and, via downed power lines, the reliability of electricity transmission. Changes in winds affect the safety of transportation by air, land, and sea and the spread of wildfires and pollutants, including wildfire smoke and allergens (Figure 1). In Oregon, mean near-surface wind speeds are expected to decrease slightly in the future in response to global climate change (Pryor et al. 2012, Jeong and Sushama 2019, Chen 2020, Mass et al. 2022). However, this decrease in the mean wind speed may not translate to a decrease in strong and extreme winds. Although projections are highly uncertain, climate models tend to agree that the magnitude of extreme wind speed will increase in western Oregon (Pryor et al. 2012, Jeong and Sushama 2019). An extreme wind refers to an annual maximum wind speed with a given probability of being exceeded, such as 5 percent probability of exceedance (a 20-year mean return period) or 2 percent probability of exceedance (a 50-year mean return period). Such increases are not projected in eastern Oregon.

Figure 1. Wind-driven wildfires in Oregon during September 2020 as captured by the Aqua satellite. Source: NASA Worldview.

Oregon's location accounts for some of the uncertainty in the response of strong winds to human-caused emissions of greenhouse gases. In Oregon, the most severe windstorms occur from October through April and are associated with extratropical cyclones (cyclones that occur from 30–60° latitude) (Read 2003, 2007; Mass and Dotson 2010). Although future changes in wind speeds in extratropical cyclones are expected to be small, the projected poleward shift in the storm tracks of these cyclones could lead to substantial changes in extreme wind speeds in some regions (Seneviratne et al. 2021). Whether the speed of strong winds in Oregon changes depends

on the current and future mean and variability of the storm tracks' locations. One study indicated that by 2081–2099 relative to 1981–1999, assuming a high emissions scenario (RCP 8.5), explosive extratropical cyclones—those that generate severe winds—will shift northward by an average of 2.2° over the North Pacific (Seiler and Zwiers 2016). Therefore, explosive extratropical cyclones will become more frequent north of 45°N and less frequent and weaker south of 45°N. Oregon lies between about 42°N and 46°N. Accordingly, although Seiler and Zwiers (2016) did not examine the landfall location of these severe cyclones, the value of 45°N implies high uncertainty in whether the frequency of severe landfalling extratropical cyclones in Oregon will change.

The intensity of strong offshore (easterly) winds typically is less than that of winter wind storms. Nevertheless, offshore winds play a major role in summer heat waves in Oregon, including the record-breaking June 2021 heat wave (Chang et al. 2022), because they displace cooler marine air west of the Cascade Range (Brewer and Mass 2016). Projections from global climate models, assuming RCP 8.5, suggest a decrease in the frequency of strong offshore winds over western Oregon and Washington in July and August, with a ~50 percent reduction from 1970–1999 to 2071–2100 in the number of days with an easterly 850-hPa wind above 5 m sec^{-1} (Brewer and Mass 2016).

In late summer and autumn and prior to the onset of the autumn rains, particularly strong and dry easterly winds, known colloquially as east winds, promote the rapid spread of wildfire. East winds were key drivers of the largest wildfires on record in western Oregon, including the 2020 Labor Days fires (Abatzoglou et al. 2021, Mass et al. 2021, Reilly et al. 2022). Recent research incorporating regional climate models that accounted for the effects of the Cascade Range shed light on the potential human influence on east winds. Model results indicated that from the preindustrial to the current era, the frequency of autumn (September through November) east winds along the Cascade Range in Oregon decreased by ~2 percent (Hawkins et al. 2022). The latter research defined east winds as those with a 700-hPa horizontal speed $u \geq 13$ m sec^{-1}, a 700-hPa vertical speed greater than $\omega \geq 0.6$ Pa sec^{-1} (positive ω in pressure per time coordinates is downward), and near-surface relative humidity ≤ 30%. By the year 2099 relative to 1970, assuming RCP 8.5, the frequency of 10-m easterly winds with a daily maximum exceeding 3.4 m sec^{-1}, which is one standard deviation above the mean, decreased modestly west of the Cascade Range (Mass et al. 2022). For example, in Alpine, Washington, the annual number of days with such winds decreased from 15 to 11 (Mass et al. 2022).

Despite recent advances, understanding of how anthropogenic emissions may affect local winds in Oregon remains limited. Due to their coarse spatial resolution, global climate models and all but the highest-resolution regional climate models cannot adequately simulate mountain slope and valley winds, coastal winds, sea breezes, and winds associated with mesoscale convective systems (Doblas-Reyes et al. 2021). Large numbers of simulations from multiple high-resolution (1 to 10 km [0.6 to 6 mi]) regional climate models ultimately will be required to estimate, with high confidence, changes in these types of winds across Oregon.

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Understanding the Most Current Climate Projections

Meghan Dalton and Dominique Bachelet

Introduction

The Coupled Model Intercomparison Project (CMIP), an initiative of the World Climate Research Programme that aims to increase understanding of past, present, and future natural and human-caused changes in climate, is in its sixth phase (CMIP6). CMIP6 is the climate modeling foundation for the sixth assessment report of the Intergovernmental Panel on Climate Change (IPCC; 2021). The fifth phase of CMIP (CMIP5) was the climate modeling foundation for the IPCC's fifth assessment report (2013). Climate modeling institutions worldwide build different global climate models to simulate the future climate given a common set of scenarios of concentrations of greenhouse gases, aerosols, and other external influences on the global climate (climate forcings). Evaluation of climate projections from multiple models in that coordinated set of simulations or experiments improves understanding of the likelihood of various aspects of climate change.

Participating in CMIP6 are 132 models from 49 modeling institutions (pcmdi.llnl.gov/CMIP6/ArchiveStatistics/esgf_data_holdings). By comparison, CMIP5 included 61 models from 28 modeling institutions (pcmdi.llnl.gov/mips/cmip5/availability.html). The global climate science community strives to maintain continuity across phases of CMIP. All global climate models included in CMIP5 and CMIP6 ran historical simulations and standardized DECK (Diagnostic, Evaluation and Characterization of Klima—climate in Ancient Greek) experiments, which evaluated the models' variability, climate sensitivity, and performance (Taylor et al. 2012, Eyring et al. 2016). The institutions participating in CMIP adopted common standards for data, documentation, and software (Eyring et al. 2016).

Here, we describe key differences between CMIP6 and CMIP5 in terms of experimental design, greenhouse gas scenarios, climate models, projections of future climate, and climate sensitivity (the extent to which global temperature is affected by a given change in concentrations of greenhouse gases). We also offer guidance on use of CMIP6 climate projections in climate impacts assessments and describe downscaled CMIP6 data that currently are available.

Experimental Design

CMIP6 has three foci: how the Earth system responds to forcings; systematic model biases; and future climate change considering internal variability, predictability, and uncertainty in scenarios. CMIP6 concentrates on clouds, circulation, and climate sensitivity; melting ice; climate extremes; changes in water availability; regional sea level change; biogeochemistry; and near-term prediction. These science priorities are addressed through 21 model intercomparison projects (MIPs) that isolate a particular facet of the Earth system (for example, aerosol chemistry, cloud feedbacks, or ice sheets) to better understand and quantify its uncertainty and contribution to climate change. Many of the MIPs were continued from CMIP5 (Eyring et al. 2016).

Of the 21 MIPs, ScenarioMIP is the primary MIP that will be used in climate impacts assessments. ScenarioMIP is dedicated to multi-model projections of future climate that are based on alternative scenarios of future emissions and land-use changes. This coordinated project selected a set of scenarios to be used by all participating modeling institutions to produce climate projections that are the foundation for investigation of climate impacts, vulnerability, adaptation, and mitigation by the

research community (O'Neill et al. 2016). Twenty-eight modeling institutions contributed results to ScenarioMIP as part of CMIP6, whereas 19 modeling institutions participated in CMIP5's analogous experiments (Chen et al. 2021). Differences in climate projections between CMIP6 and CMIP5 are due to differences in model structure and type, such as general circulation models or Earth system models (see below), emissions scenarios, and initial conditions and years of the future scenarios (2015 for CMIP6, 2006 for CMIP5) (O'Neill et al. 2016).

Greenhouse Gas Scenarios

The scenarios used in ScenarioMIP are related to those that drove the CMIP5 models, which were based on four representative concentration pathways (RCPs). RCPs are concentrations of greenhouse gases, aerosols, and other factors that determine radiative forcings by 2100. Radiative forcing is the total amount of energy retained in the atmosphere after absorption of incoming solar radiation, which is affected by the reflectivity of Earth's surface, and emission of outgoing long-wave radiation, which is affected by the concentrations of heat-trapping or greenhouse gases. The four RCPs, 2.6, 4.5, 6.0, and 8.5, represent radiative forcings of 2.6, 4.5, 6.0, and 8.5 watts per square meter (W m^{-2}) by 2100, respectively. The most commonly used RCPs, 4.5 and 8.5, are often described as representing moderate reductions and business-as-usual increases in greenhouse gas emissions, respectively. The RCPs do not specify a particular set of social and economic assumptions that would result in the radiative forcing by 2100. Multiple sets of social and economic assumptions could result in the same radiative forcing.

In CMIP6, each of the four radiative forcing levels of the RCPs, plus four additional radiative forcing levels (1.9, 3.4, 3.4 overshoot [OS], and 7.0), was paired with one of five sets of assumptions about future population, technological, and economic growth (Table 1). These assumptions are referenced as Shared Socioeconomic Pathways (SSPs) (O'Neill et al. 2016). SSP1 assumes few challenges to mitigation and adaptation. SSP2 assumes continuation of historical social and economic trends, with moderate challenges to mitigation and adaptation, whereas SSP3 assumes conflicts among regions and substantial challenges to mitigation and adaptation. SSP4 assumes inequality within and among countries and minor challenges to mitigation, but substantial challenges to adaptation, and SSP5 assumes dependence on fossil fuels with substantial challenges to mitigation, but minor challenges to adaptation (O'Neill et al. 2016). Each SSP results in a trajectory of greenhouse gas emissions independent of climate policy. The radiative forcing levels represent climate policy outcomes. Some forcing levels are not feasible for a given SSP. For example, only SSP5 can achieve 8.5 W m^{-2} radiative forcing by 2100, and only SSP1 and SSP2 can limit radiative forcing to 1.9 W m^{-2} by 2100.

2100 forcing level (W m^{-2})	SSP1	SSP2	SSP3	SSP4	SSP5
8.5	n/a	n/a	n/a	n/a	SSP5-8.5
7.0	n/a		SSP3-7.0	n/a	
6.0				SSP4-6.0	
4.5		SSP2-4.5			
3.4				SSP4-3.4	SSP5-3.4-OS
2.6	SSP1-2.6		n/a		
1.9	SSP1-1.9		n/a	n/a	n/a

Table 1. The combinations of shared socioeconomic pathways (SSPs) and radiative forcing levels by the year 2100 chosen for CMIP6 projections of future climate. n/a, combination of SSP and radiative forcing level is not feasible. Forcing levels 8.5, 6.0, 4.5, and 2.6 correspond to the four RCPs. Adapted from Chen et al. 2021.

Eight SSP-forcing level combinations were selected for CMIP6 projections of future climate (Table 1). Four scenarios (SSP1-2.6, 2-4.5, 3-7.0, and 5-8.5; the number after the dash corresponds to the forcing level) were the basis for projections of future climate in ScenarioMIP. These four scenarios span a wide range of uncertainty in future forcings and are similar to the RCPs that drove CMIP5. Four additional scenarios (SSP1-1.9, 4-3.4, 5-3.4-OS, and 4-6.0) were considered lower priorities (O'Neill et al. 2016) and will be simulated by institutions contributing to ScenarioMIP only after they complete simulations of the higher-priority scenarios. Of the 56 models participating in ScenarioMIP, 39 have contributed data for the four high-priority scenarios. The four scenarios similar to the RCPs from CMIP5, plus SSP1-1.9, are the core set of scenarios in the IPCC's sixth assessment report (Chen et al. 2021).

The SSPs paired with radiative forcing levels produce trajectories of greenhouse gas emissions that result in different degrees of warming by 2100 (Figure 1). SSP1-1.9 assumes that the Paris Agreement goal of limiting warming to 1.5°C (2.7°F) by 2100 relative to the 1850–1900 mean global temperature is met, with net-zero carbon dioxide emissions by the middle of the twenty-first century. SSP1-2.6 limits warming to 2.0°C (3.6°F) by 2100, with net-zero carbon dioxide emissions by the second half of the century. It is slightly warmer than RCP 2.6. In SSP2-4.5, as in RCP 4.5, carbon dioxide emissions plateau and then gradually decline by mid-century. SSP3-7.0 assumes that carbon dioxide emissions double by 2100, and SSP5-8.5 that carbon dioxide emissions double by 2050. SSP5-8.5 has higher carbon dioxide emissions but lower emissions of other greenhouse gases than RCP 8.5, and is marginally warmer (O'Neill et al. 2016, Chen et al. 2021) (Figure 1).

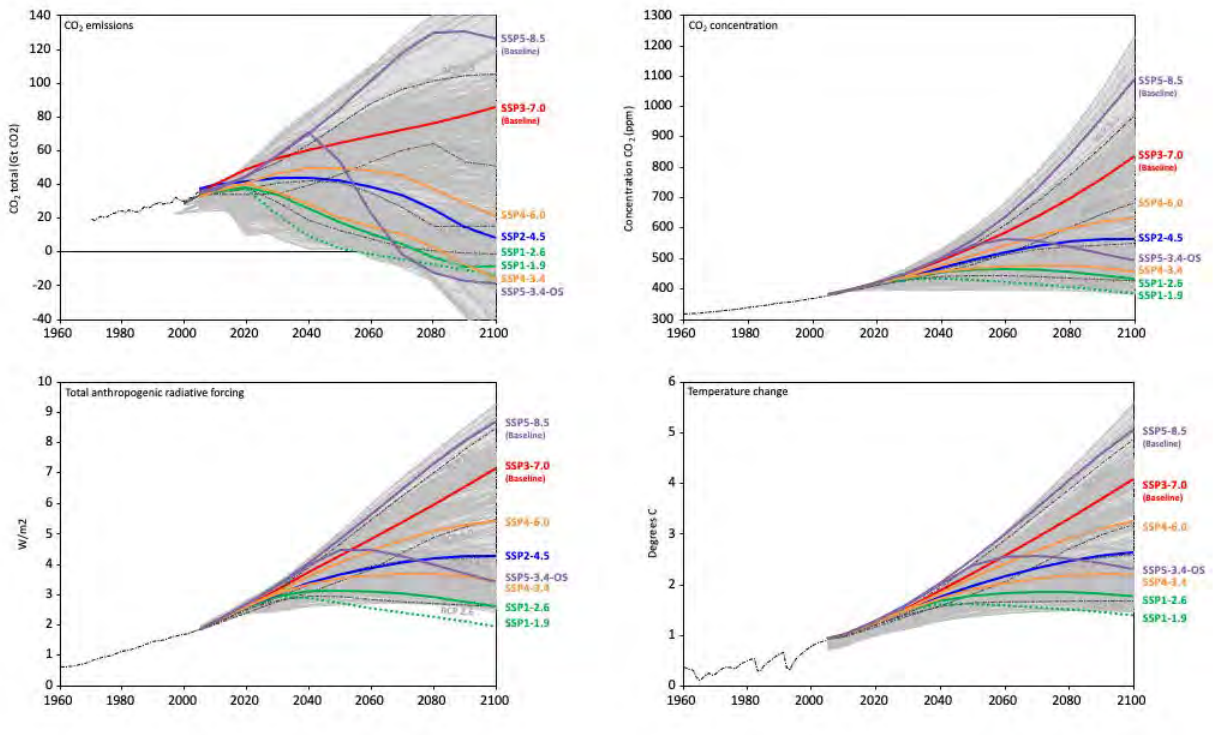

Figure 1. Carbon dioxide emissions (top left) and concentrations (top right), human-caused radiative forcing (bottom left), and global mean temperature (bottom right) for the twenty-first century scenarios in ScenarioMIP (Riahi et al. 2017). Gray areas represent the range of scenarios included in the IPCC's fifth assessment report (Clarke et al. 2014). Source: O'Neill et al. 2016.

Climate Model Advances in CMIP6

Relative to the CMIP5 models, the CMIP6 climate models include many improvements to atmospheric and oceanic circulation and to stratospheric processes (Chen et al. 2021). For example, most CMIP6 models have higher horizontal resolution in the atmosphere, ranging from 50 to 260 km (31–162 mi). Among the exceptions is CanESM5, which maintained the same relatively coarse horizontal resolution as its predecessor (approximately 250 km [155 mi]) to facilitate the production of large ensembles (Swart et al. 2019). CMIP6 models also have a greater number of vertical levels in the atmosphere (14–102), with the top of the atmosphere at 29–88 km (18–55 mi) above Earth's surface (Gutiérrez and Tréguier 2021).

Climate models generally refer to both general circulation models (GCMs) and Earth system models (ESMs). GCMs simulate the dynamics of interactions between the atmosphere and the land and ocean, whereas ESMs also simulate more-detailed chemical and biological processes that interact with the physical climate (Heavens et al. 2013). CMIP6 climate models include improved representation of cloud and aerosol microphysics, ocean eddies, sea ice, and ice sheets (Chen et al. 2021). Not only are there more ESMs in CMIP6 than in CMIP5, but CMIP6 models better represent atmospheric chemistry, carbon and nitrogen cycles, dynamic vegetation and wildfires, and ocean biogeochemistry (Chen et al. 2021, Gutiérrez and Tréguier 2021). Several of the ESMs included in CMIP5 were capable of representing temporal variation in vegetation and simulating vegetation responses to novel climate conditions. However, because the teams that developed these models did not have sufficient time to test the models, vegetation was treated as static rather than dynamic. Similarly, most of the ESMs included in CMIP5 did not include a wildfire submodel. The majority of those included in CMIP6, by contrast, simulated wildfires, allowing land cover to change abruptly and affect land surface reflectivity, point-source emissions, and, in turn, atmospheric chemistry. It is ideal to represent the nitrogen cycle in ESMs to account for the response of vegetation to increasing levels of atmospheric carbon dioxide, which reduces the extent to which nutrient limitation constrains plant growth. Most of the ESMs in CMIP6, in contrast with those in CMIP5, include the nitrogen cycle. However, the level of sophistication in their treatment of the cycle varies greatly, and agreement between models needs to be improved (Davies-Barnardet al. 2022).

Simulation of observed mean temperature trends and variability in global climate models has become more accurate (IPCC 2021). CMIP6 models also simulate past temperature and precipitation extremes more accurately than CMIP5 models (Chen et al. 2020, Fan et al. 2020). The area of the Northern Hemisphere covered by snow generally was simulated fairly well in CMIP5, but CMIP6 models performed better (Mudryk et al. 2020, Zhu et al. 2021). Simulation of Northern Hemisphere storm tracks improved in CMIP6, although the spatial patterns of future storms are similar to those in CMIP5 (Harvey et al. 2020). Moreover, CMIP6 models can reasonably simulate a range of observed atmospheric circulation patterns over the Pacific Northwest, and the temperature and precipitation anomalies associated with those circulation patterns (Taylor et al. 2022).

Climate Sensitivity

One measure of climate sensitivity, the equilibrium climate sensitivity (ECS), is an estimate of the temperature response to carbon dioxide concentrations that have doubled, and remained so, after stabilization of temperature over hundreds or thousands of years. On the basis of observations, paleoclimate data, and other evidence, the ECS of Earth was assessed to be within 2.5–4.0°C (4.5–7.2°F) (66 percent likelihood) or 2.0–5.0°C (3.6–9.0°F) (90 percent likelihood) (Forster et al. 2021).

The scientific community typically evaluates climate model outputs on the basis of how close they are to this assessed range of ECS. Some climate models are more sensitive than others: they produce greater warming given the same concentration of greenhouse gases.

The range of ECS is 1.8–5.6°C (3.2–10.0°F) among CMIP6 models and 2.1–4.7°C (3.8–8.5°F) among CMIP5 models (Meehl et al. 2020, Zelinka et al. 2020). The average ECS value of the CMIP6 model ensemble is higher than both the assessed average value and the CMIP5 model results (Forster et al. 2021). ECS values in all CMIP5 models were less than 5°C (9°F), whereas about one-fifth of the CMIP6 models had an ECS above 5°C (9°F) (Hausfather et al. 2022). Cloud feedbacks and cloud-aerosol interactions most likely are the primary contributors to the higher sensitivities (Meehl et al. 2020, Zelinka et al. 2020). Although there is a 5 percent likelihood that Earth's ECS could be above 5°C, the CMIP6 climate models with ECS >5°C overestimate the observed warming and are considered less valid and reliable than those with ECS ≤5°C. Consequently, use of the average and range of the CMIP6 model ensemble would not be appropriate for analyzing projections of future climate (Hausfather et al. 2022). Before averaging temperature projections from the CMIP6 models, the IPCC weighted the projections on the basis of how well each model simulated historical observations. This approach prevented CMIP6 models with ECS >5°C from skewing the ensemble average (Hausfather et al. 2022). When using ouputs of individual CMIP6 climate models or interpreting published results that were based on CMIP6 climate models, the models' climate sensitivity and their skill in simulating past climate is central to evaluation of reliability (Tokarska et al. 2020, Hausfather et al. 2022).

Projections of Future Climate and Effects of Climate Change

Comparisons of future climate as projected by CMIP6 and CMIP5 are facilitated by ScenarioMIP's inclusion of three scenarios designed to provide continuity between the CMIPs: SSP1-2.6, SSP2-4.5, and SSP5-8.5. These comparisons are useful despite different initial years and assumptions about the composition of greenhouse gas emissions (Tebaldi et al. 2021).

The ensemble of CMIP6 models projects greater and somewhat faster warming than CMIP5 models (Forster et al. 2021). For example, in the CMIP6 ensemble, average global surface air temperature is projected to increase by 4.4°C (7.9°F) by 2081–2100 relative to 1986–2005 under SSP5-8.5, compared to the CMIP5 ensemble average increase of 3.7°C (6.7°F) under RCP 8.5 (Tebaldi et al. 2021). In addition, CMIP6 models project that certain global warming levels (e.g., 1.5°C [2.7°F], 2°C [3.6°F]) will be reached three to nine years earlier than projected by CMIP5 models (Tebaldi et al. 2021). To illustrate, 2°C of warming above the 1850–1900 average temperature is projected to occur in 2038 under SSP5-8.5 and 2041 under RCP 8.5 (Tebaldi et al. 2021). The greater warming of CMIP6 models has been attributed to the inclusion of some models with unrealistically high ECSs that overestimated observed warming (Forster et al. 2021, Tebaldi et al. 2021). Constraining future warming projections by the observed warming trend effectively eliminates many of the unreliable models (Tokarska et al. 2020) and brings CMIP6 temperature projections closer to those of CMIP5 (Tebaldi et al. 2021). For example, when the observed warming trend is used to constrain future warming projections for both CMIP5 and CMIP6 models, the ensemble average increase in temperature by 2081–2100 is 3.5°C (6.2°F) and 3.6°C (6.5°F), respectively (Tebaldi et al. 2021).

In both CMIP6 and CMIP5 models, high latitudes warm more than low latitudes, particularly in the Northern Hemisphere, and continents warm more than oceans (Tebaldi et al. 2021). Projected changes in global precipitation, including spatial patterns, are also similar in CMIP6 and CMIP5 (Lee

et al. 2021, Tebaldi et al. 2021). In both sets of results, the largest increases in precipitation occur in the equatorial Pacific and at the poles, and drying trends are most pronounced in the Mediterranean, Central America, Amazonia, southern Africa, and western Australia (Tebaldi et al. 2021).

In the western United States, the spatial pattern of changes in temperature and precipitation projected by CMIP5 and CMIP6 models is similar (Almarzroui et al. 2021). Although CMIP6 projects higher average temperatures than CMIP5, the range of temperature and precipitation projections over the United States and Canada is smaller in CMIP6 (Martel et al. 2022). Of the 21 CMIP6 models used, seven had ECS >4°C (one with ECS >5°C) and two had ECS <2°C (Zelinka et al. 2020, Martel et al. 2022). However, CMIP6 projects greater increases in temperature and precipitation extremes than CMIP5 (Chen et al. 2020). Of the 11 CMIP6 models used, three had ECS >4°C (one with ECS >5°C) and one had ECS <2°C (Chen et al. 2020, Zelinka et al. 2020). CMIP6 models also project declines in wind power density (a measure of the wind energy available in a given location) in much of the United States and Canada, whereas CMIP5 models project little to no change (Martinez and Iglesias 2022). Of the 18 CMIP6 models used, six had ECS >4°C (one with ECS >5°C) and two had ECS <2°C (Zelinka et al. 2020, Martinez and Iglesias 2022).

In CMIP6 models, the area covered by snow during spring (April–June) is projected to decline throughout the twenty-first century under SSP1-2.6, 2-4.5, 4-6.0, and 5-8.5, as it was under all RCPs in CMIP5 models. Declines in snow cover stabilized by the end of the century only under SSP1-2.6 (Mudryk et al. 2020, Zhu et al. 2021). Under SSP5-8.5, spring snow cover in the Northern Hemisphere from 2081–2100 is projected to be 40 percent lower than from 1995–2014 (Zhu et al. 2021). However, given that seven of the 20 CMIP6 models that resulted in the latter projection had ECS >4°C, and three of those had ECS >5°C (Zelinka et al. 2020, Zhu et al. 2021), projected declines in snow cover may be exaggerated. By contrast, CMIP5 projections under RCP 8.5 projected spring snow cover from 2080–2099 that was 25 percent lower than that from 1986–2005 (Brutel-Vuilmet et al. 2013). Projected annual mean streamflow over the Northwest is marginally greater in CMIP6 models than CMIP5 models (Martel et al. 2022).

A suite of nine crop models projected a larger decrease in median global crop yields by the end of the twenty-first century when using CMIP6 model outputs than CMIP5 model outputs (-19 to 1 percent in CMIP6 versus -13 to 5 percent in CMIP5) (Muller et al. 2021). This may result from a warmer growing season in the CMIP6 model ensemble, which in turn reflects the inclusion of several CMIP6 models with ECS >5°C (Zelinka et al. 2020, Muller et al. 2021). In general, projected global crop yield increased until mid-century and then declined. Muller et al. (2021) did not account for temperature-driven changes in growing season length.

CMIP6 models overestimate global mean leaf area index to a greater extent than CMIP5 models (Song et al. 2021). The leaf area index, the ratio of the one-sided leaf area per unit ground area, is associated with primary productivity, carbon balance, and water and nutrient budgets. Overestimation of the index leads to overestimating primary production, transpiration, and evaporation from the canopy (Song et al. 2021). Furthermore, in temperate regions, CMIP6 models overestimate tree height, which may lead to overestimating aboveground carbon storage and underestimating wind speed (Song et al. 2021). However, in both CMIP5 and CMIP6 models, leaf area index is projected to increase in virtually all biomes worldwide under scenarios of 1.5°C and 2°C warming above pre-industrial levels (Peng et al. 2022).

Use of CMIP6 Projections in Climate Impacts Assessments

Best practices for analyzing and reporting projections of future climate from CMIP5 and earlier generations of climate models were to calculate the average and range across at least ten climate models (Mote et al. 2011). This approach assumed that each model was an independent and equally valid representation of the Earth system. Neither of these assumptions are met within the CMIP6 ensemble. The climate models within the CMIP5 ensemble are not independent, either, often because a given team produced more than one model, such as an early GCM and a subsequent ESM (Knutti et al. 2013, Eyring et al. 2019). Consequently, different models may share code or even submodels that represent major processes (Table 2), violating the assumption of independence (Knutti et al. 2013). Model independence can be evaluated by testing whether model errors are correlated. The effective number of independent models is much less than the total number of models in the ensemble (Eyring et al. 2019). Because several fundamental biogeochemical processes are represented by the same algorithm in most models, selecting climate models from different institutions is a useful but imperfect surrogate for selecting independent models.

The ensemble of climate models from CMIP5 appear to be equally valid representations of Earth's system given their good agreement with observations (Knutti et al. 2013) and range of ECSs (Hausfather et al. 2022). Selecting a subset of models that best simulate past climate of a particular region (e.g., Rupp et al. 2013) also can increase the probability that those models are equally valid for a given application. As explained above, in contrast to the CMIP5 models, not all CMIP6 models can be considered equally valid (Eyring et al. 2019, Torkarska et al. 2020, Hausfather et al. 2022).

The IPCC's correction method of weighting modeled temperature increases is useful in some contexts, but may be impractical when evaluating climate projections at a regional or local level (Eyring et al. 2019). Instead, two alternative approaches have been recommended. First, projections can be presented in terms of temperature increase instead of time. For example, one can consider how other aspects of Oregon's climate are projected to respond to 2°C of global warming regardless of the year in which 2°C warming is reached. This approach is consistent with the Paris Agreement's target levels of global warming. However, time-based estimates are often necessary for impacts assessments (Hausfather et al. 2022). Second, one can select a subset of CMIP6 models with ECSs within the IPCC's likely assessed range (Hausfather et al. 2022). It remains best practice to analyze and present an average and range of projections from at least ten global climate models with realistic ECSs that simulate the historical climate well (Mote et al. 2011, Hausfather et al. 2022).

Availability of CMIP6 Downscaled Projections and Applications to Impact Assessments

Local and regional climate impacts assessments often rely on downscaled climate projections. There are two types of downscaling, statistical and dynamical. Statistical downscaling uses statistical relations between historical, fine-resolution observations of weather (e.g., daily) or climate (e.g., monthly) and coarse-resolution global climate model outputs to increase the spatial resolution of climate projections. Statistical methods attempt to correct global climate model biases under the assumption that historical biases also will be applicable in the future (the stationarity assumption). Dynamical downscaling increases the resolution of climate projections by applying numerical, three-dimensional representations of atmospheric hydrodynamics and thermodynamics. These representations are similar to those used in global climate models, but have finer resolution and are not run over the entire globe. The regional climate models used in dynamical downscaling, however, use global climate model results at their geographic boundaries, and therefore include all of the

Table 2. Coupled general circulation models (GCMs) and Earth system models (ESMs) that participated in ScenarioMIP, adapted from Table AII.5 in Gutiérrez and Tréguier 2021. Models are grouped by the land surface model and processes they included. Aerosols are prescribed or emissions-driven. Land carbon, active land carbon cycle; N cycle, active nitrogen cycle; prog veg, prognostic biogeography of vegetation; permafrost, carbon included in a permafrost pool; fires, dynamic fires. Equilibrium climate sensitivity (ECS) values in Celsius (°C) from Zelinka et al. 2020, updated at github.com/mzelinka/cmip56_forcing_feedback_ecs/blob/master/CMIP6_ECS_ERF_fbks.txt.

GCM or ESM	References	ECS (°C)	Atmosphere model	Aerosol model	Atmospheric chemistry model	Ocean model	Cryosphere model	Land surface model	Land processes	Ocean interactive biochemistry model
TaiESM1.0	W.-L. Lee et al. 2020	4.36	TaIAM1	SNAP, emissions-driven	none	POP2	CICE4.0	CLM4.0	land carbon, N cycle, fires	none
FIO-ESM-2-0	Bao et al. 2020	Not evaluated	CAM5	MACv2-SP, prescribed	none	POP-W with MASNUM surface wave model	CICE4.0	CLM4.0	land carbon, N cycle	BEC
CMCC-CM2-SR5, CMCC-ESM2	Cherchi et al. 2019	3.55, 3.58	CAM5.3	MAM3, emissions-driven	specified oxidants based on MOZART simulations	NEMO3.6	CICE4.0	CLM4.5	land carbon, N cycle, permafrost, fires	CM2-SR5: none; ESM2: BFM5.2
FGOALS-f3-L	He et al. 2020	2.98	FAMIL 2.2	prescribed	none	LICOM3.0	CICE4.0	CLM4.0 / CAS-LSM	none	none
FGOALS-g3	Li et al. 2020	2.87	GAMIL3	prescribed	none	LICOM3.0	CICE4.0	CLM4.0 / CAS-LSM	none	none
NorESM2-LM, NorESM2-MM	Seland et al. 2020	2.56, 2.49	CAM6-Nor2	OsloAero6, emissions-driven	OsloAero6: prescribed oxidants, interactive sulphur chemistry, SOA precursor chemistry	BLOM1.0	CICE5.1	CLM5	land carbon, N cycle, permafrost, fires	HAMOCC5.1
CESM2, CESM2-FV2, CESM2-WACCM	Danabasoglu et al. 2020	5.15, 5.16, 4.68	CAM6	MAM4, emissions-driven	CESM2: prescribed oxidants; others: interactive	POP2	CICE5.1, CISM2.1	CLM5	land carbon, N cycle, permafrost, fires	MARBL
AWI-CM-1-1-MR	Sidorenko et al. 2015, Semmler et al. 2020	3.16	ECHAM6.3.04p1	MACv2 SP, prescribed	none	FESOM 1.4	FESOM 1.4	JSBACH3.20	none	none

MPI-ESM-1-2-HAM	Neubauer et al. 2019	2.95	ECHAM6.3	HAM2.3, emissions-driven	specified oxidants, sulphur chemistry	MPIOM 1.63	MPIOM 1.63	JSBACH3.20	land carbon, N cycle, prog veg, fires	HAMOCC6
MPI-ESM1-2-LR, MPI-ESM1-2-HR	Müller et al. 2018, Mauritsen et al. 2019	MPI-ESM1-2-LR: 3.03, MPI-ESM1-2-HR: 2.98	ECHAM6.3	MACv2-SP, prescribed	none	MPIOM 1.63	MPIOM 1.63	JSBACH3.20	LR: land carbon, N cycle, prog veg, fires; HR: none	HAMOCC6
NESM3	Cao et al. 2018	4.76	ECHAM v6.3	prescribed	none	NEMO v3.4	CICE 4.1	JSBACH v3.1	land carbon, prog veg	none
KIOST-ESM	Pak et al. 2021	Not evaluated	GFDL-AM2.0	GFDL-AM2.0, emissions-driven	none	GFDL-MOM5.0	GFDL-SIS	GFDL-LM3.0	land carbon, N cycle, prog veg	TOPAZ2
GFDL-CM4	Held et al. 2019	3.89	GFDL-AM4.0.1	GFDL-AM4.0.1, emissions-driven	GFDL-AM4.0.1: specified oxidants, fast chemistry, aerosol only	GFDL-OM4p25 (GFDL-MOM6)	GFDL-SIM4p25	GFDL-LM4.0.1	land carbon, prog veg, fires	GFDL-BLINGv2
GFDL-ESM4	Dunne et al. 2020	2.65	GFDL-AM4.1	GFDL-AM4.1, emissions-driven	GFDL-ATMCHEM4.1, interactive	GFDL-OM4p5 (GFDL-MOM6)	GFDL-SIM4p5	GFDL-LM4.1	land carbon, prog veg, fires	GFDL-COBALTv2
HADGEM3-GC31-LL, HADGEM3-GC31-MM	Kuhlbrodt et al. 2018, Williams et al. 2018, Sellar et al. 2019	5.55, 5.44	MetUM-HadGEM3-GA7.1	UK-GLOMAP, emissions-driven	none	NEMO-HadGEM3-GO6.0	CICE-HadGEM3-GSI8	JULES-HadGEM3-GL7.1	none	none
UK-ESM1.0-LL, UK-ESM1.1-LL	Sellar et al. 2019, Mulcahy et al. in review	ESM1.0: 5.36; ESM1.1: 5.27	MetUM-HadGEM3-GA7.1	UK-GLOMAP, emissions-driven	UKCA-StratTrop	NEMO-HadGEM3-GO6.0	CICE-HadGEM3-GSI8	JULES-HadGEM3-GL7.1, TRIFFID, RothC	land carbon, N cycle, prog veg	MEDUSA2
KACE-1-0-G	J. Lee et al. 2020	4.75	MetUM-HadGEM3-GA7.1	UKCA-GLOMAP-mode, emissions-driven	specified oxidants for aerosols	MOM4p1	CICE-HadGEM3-GSI8	JULES-HadGEM3-GL7.1	none	none
IPSL-CM6A-LR	Boucher et al. 2020	4.7	LMDZ NPv6	prescribed	specified oxidants for aerosols	NEMO3.6	NEMO-LIM3	ORCHIDEE (v2.0, water / carbon / energy mode)	none	PISCES

IPSL-CM5A2-INCA		3.82	LMDZ APv5	INCA, emissions driven	INCA, interactive	NEMO3.6	NEMO-LIM3	ORCHIDEE (IPSLCM5A2.1, water / carbon / energy mode)	land carbon	PISCES
CNRM-CM6-1, CNRM-CM6-1-HR	Voldoire et al. 2019, Saint-Martin et al. 2021	4.9, 4.33	Arpege 6.3	TACTIC_v2, prescribed	OZL_V2, linear ozone	NEMO3.6	Gelato 6.1	ISBA-CTRIP	none	none
CNRM-ESM2-1	Seferian et al. 2019	4.79	Arpege 6.3	TACTIC_v2, emissions-driven	REPROBUS-C-V2	NEMO3.6	Gelato 6.1	ISBA-CTRIP	land carbon, fires	Pisces 2.s
ACCESS-ESM1-5	Ziehn et al. 2020	3.88	HadGAM2 r1.1	CLASSIC (v1.0), emissions-driven	specified oxidants for aerosols	ACCESS-OM2 GFDL-MOM5	CICE4.1	CABLE2.4	land carbon, N cycle	Wombat1.0
ACCESS-CM2	Bi et al. 2020	4.66	HadGEM3-GA7.1	UKCA-GLOMAP-mode, emissions-driven	specified oxidants for aerosols	ACCESS-OM2 GFDL-MOM5	CICE5.1.2	CABLE2.5	none	none
EC-Earth3, EC-Earth3-LR; options: AerChem, Veg	Döscher et al. 2021	EC-Earth3: 4.26; EC-Earth3-AerChem: 3.87; EC-Earth3-Veg: 4.33; EC-Earth3-Veg-LR: 4.23	IFS cy36r4	EC-Earth3: MACv2-SP, prescribed; AerChem: TM5, emissions-driven	EC-Earth3: none; AerChem: interactive	NEMO3.6	LIM3	EC-Earth3: H-TESSEL; Veg: H-TESSEL, LPJ-GUESS	EC-Earth3: none; Veg: N cycle, prog veg, fires	none
EC-Earth3-CC	Döscher et al. 2021	4.23	IFS cy36r4	MACv2-SP, prescribed	none	NEMO3.6	LIM3	H-TESSEL, LPJ-GUESS	land carbon, N cycle, prog veg, fires	PISCES v2
CAMS-CSM1-0	Rong et al. 2018	2.29	ECHAM5_CAMS	MACv2-SP, prescribed	none	MOM4	SIS1	CoLM	none	none
CAS-ESM 2	Zhang et al. 2020	3.51 (Schlund et al. 2020)	IAP AGCM 5.0	MAM3, MOZART	IAP-AACM	LICOM 2.0	CICE4.0	CoLM	Land carbon, prog veg, fires	none

BCC-CSM2-MR	Wu et al. 2019	3.02	AGCM3	MACv2-SP, prescribed	none	MOM4	SIS1	BCC_AVIM2	none	none
CanESM5, CanESM5-CanOE	Swart et al. 2019	CanESM5: 5.64	CanAM5	emissions-driven	specified oxidants, interactive sulphur	NEMO3.4.1	LIM2	physics, CLASS3.6 biogeochemistry, CTEM1.2	land carbon	CanESM5: CMOC; CanESM5-CanOE: CanOE
IITM-ESM	Swapna et al. 2018	2.37	IITM-GFS	MAC-v2, prescribed	none	MOM4p1	SISv1.0	NOAH LSMv2.7.1	none	TOPAZv2.0
E3SM 1.0, E3SM-1-1, E3SM-1-1-ECA	Golaz et al. 2019	E3SM-1-0: 5.31	E3M v1.0	MAM4, emissions-driven	specified oxidants for aerosols; linear interactive stratospheric ozone (LINOZ v2)	MPAS-Ocean v6.0	MPAS-Seaice v6.0	ELM v1.0, based on CLM4.5	E3SM 1.0: none; E3SM1.1: land carbon, N cycle, fires	none
INM-CM4-8, INM-CM5-0	Volodin et al. 2017, 2018	1.83; 1.92	CM4: INM-AM4-8; CM5: INM-AM5.0	INM-AER1, emissions-driven	none	INM-OM5	INM-ICE1	INM-LND1	land carbon	none
MIROC-ES2L, MIROC6	Tatebe et al. 2019, Kawamiya et al. 2020	MIROC-ES2L: 2.66; MIROC6: 2.6	CCSR AGCM	SPRINTARS, emissions-driven	MIROC-ES2L and MIROC6: prescribed oxidants	COCO4.9	COCO4.9	MIROC6: MATSIRO6.0; MIROC-ES2L: MATSIRO6.0 with visit-e v1.0	MIROC6: none; MIROC-ES2L: land carbon, N cycle	OECO v2.0
MRI-ESM-2.0	Mizuta et al. 2012, Yukimoto et al. 2019	3.13	MRI-AGCM3.5	MASINGAR mk-2r4c, emissions-driven	MRI-CCM2.1, interactive	MRI.COM4.4	MRI.COM4.4	HAL 1.0 and MRI-LCCM2	land carbon, prog veg, fires	MRI.COM4.4
GISS-E2-1-G, GISS-E2-1-H, GISS-E2.1-G-CC, GISS-E2-2-G	Kelley et al. 2020, Rind et al. 2020	GISS-E2-1-G: 2.71; GISS-E2-1-H: 3.12; GISS-E2-2-G: 2.43	GISS-E2-1: GISS-E2.1; GISS-E2-2-G: GISS-E2-2	Varies with physics. Versions p1, p3: OMA. Version p5: MATRIX.	Varies with physics. Version p1: none. Version p3, p5: GPUCCINI, interactive.	GISS-E2-1-G, GISS-E2-2-G: GISS ocean; GISS-E2-1-H: HYCOM	GISS-SI	GISS-LSM	none	GISS-E2-1-G-CC: NOBM; others: none
CIESM	Lin et al. 2020	5.63	CIESM-AM	MACv2-SP, prescribed	none	CIESM-OM	CICE4	CIESM-LM	none	none
MCM-UA-1-0	Delworth et al. 2002	3.65 (Schlund et al. 2020)	Manabe R30L14	none	none	MOM1.0	thermo-dynamic simplified sea ice	Manabe bucket scheme	none	none

global models' biases. The projections derived from dynamical downscaling may be more accurate than those from statistically downscaling because they directly incorporate fine-resolution data rather than statistically approximating fine-resolution data from coarse-resolution data. However, such improvement in accuracy depends on the availability of fine-resolution data within the full extent of the model, which is rare.

Dynamically downscaled data still may have substantial biases. Several sets of statistically or dynamically downscaled CMIP6 projections are available or in preparation (Table 3). Many of these products were generated with methods that were applied to CMIP5 models, and still are widely used in assessments of the impacts of climate change (Kim et al. 2022). Each product was created with a different method, spatial and temporal resolution, and observational data. The reference data used to correct the future projections were a main cause of differences among downscaled climate projections for the northwestern United States (Jiang et al. 2018). However, the bias correction method and the downscaling algorithm used in each method are the most obvious causes of divergence among downscaled projections. The choice of GCM realization (a model run with a given set of initial conditions or parameters) strongly affects divergence among projections, with or without downscaling, at the extent of the conterminous United States (Kim et al. 2022).

The scientific community is evaluating CMIP6 projections of a range of climate variables, and the resulting effects on biogeochemical and hydrological cycles, at global to local extents. The realism of emissions pathways and their radiative forcing remains uncertain because these depend on social and economic decisions. Simulated responses of planetary processes to forcing is driven in part by the coarse-resolution concentrations of anthropogenic aerosols that are fed into ESMs (Persad et al. 2022). Uncertainty in values of these concentrations to 2050 and beyond, which may exceed the increases in values since 1850 (Wilcox et al. in review), causes differences in radiative forcings, from -0.3 to -1.5 W m^{-2}, among models results. Consequently, most of the literature on climate impacts relevant to Oregon and the Northwest is still based on CMIP5 (e.g., Dalton and Fleishman 2021); little is based on CMIP6 or has compared outcomes that were based on the two sets of models. This will change in the coming years as CMIP6 projections become better understood and more accessible, and as their biases are corrected. Some downscaled CMIP6 projections are already available, and additional downscaled projections are in production. Climate impacts assessments that incorporated projections of future climate from CMIP5 are still valid and useful. It may be worth considering whether to update the assessments, or compare inferences based on CMIP5 and CMIP6, in a few years as new climate data emerge and model weaknesses are addressed.

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Table 3. Sources and attributes of downscaled CMIP6 climate projections.

Product	Method	Spatial resolution and domain	References	Status
Statistical				
NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6)	Statistical: bias-correction spatial disaggregation (BCSD)	25 km; global	Thrasher et al. 2022 Technical documentation: www.nccs.nasa.gov/sites/default/files/NEX-GDDP-CMIP6-Tech_Note.pdf Data: ds.nccs.nasa.gov/thredds2/catalog/AMES/NEX/GDDP-CMIP6/catalog.html	Available
LOCA2	Statistical: localized constructed analogs (LOCA)	6 km; conterminous United States	Overview: loca.ucsd.edu	Available
Global Downscaled Projections for Climate Impacts Research	Statistical: quantile delta mapping and quantile-preserving localized-analog downscaling	25 km; global	Overview: planetarycomputer.microsoft.com/dataset/group/cil-gdpcir Data access: /github.com/ClimateImpactLab/downscaleCMIP6	Available
CarbonPlan	Statistical: four different methods	25 km; global	Chegwidden et al. 2022 carbonplan.org/research/cmip6-downscaling-explainer	Available
WorldClim	Statistical: bias correction	Various; global	www.worldclim.org/data/cmip6/cmip6climate.html	Available
ClimateNA	Statistical: Delta change	1 km; North America	adaptwest.databasin.org/pages/adaptwest-climatena	Available
MACAv3	Statistical: multivariate adaptive constructed analogs (MACA)	4 km; conterminous United States	Overview: www.climatologylab.org/maca.html	In progress
Dynamical				
CMIP6 downscaling with WRF	Dynamical: weather research and forecasting (WRF) regional model	9 km; western United States	dept.atmos.ucla.edu/alexhall/downscaling-cmip6	Available
North American CORDEX	Dynamical	25–50 km; North America	Overview: na-cordex.org/index.html	In progress

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Extreme Temperatures

Larry O'Neill, Nicholas Siler, Paul Loikith, and Alexis Arends

Periods of unusually hot or cold weather, or extreme temperature, can have substantial and detrimental impacts on individuals, communities, infrastructure, agriculture, and other sectors. More high-temperature records than low-temperature records were broken during the last two decades at long-term monitoring stations within Oregon (Table 1). This trend is consistent with the observed effects of climate change (Meehl et al. 2009). Temperatures in Pendleton are an exception to the trend; since the 1980s, Pendleton has broken more low-temperature records than high-temperature records. Here, we summarize observed variability and trends in extreme warm and cold temperatures in Oregon and discuss projected changes in heat and cold waves in the coming decades.

Decade	Astoria	Portland	Salem	Eugene	The Dalles	Pendleton	Ontario	Medford
1951–1960	0.36	0.56	1.29	0.75	4.89	1.08	1.02	1.30
1961–1970	0.45	0.87	0.97	1.48	0.43	1.26	1.36	0.85
1971–1980	0.33	1.31	0.77	0.74	0.29	2.06	0.72	0.85
1981–1990	0.58	2.08	0.83	0.76	1.80	0.63	0.70	3.71
1991–2000	2.08	5.64	6.80	1.10	1.04	0.57	1.23	4.00
2001–2010	4.00	4.54	8.50	1.00	0.76	0.83	5.25	8.00
2011–2020	2.53	3.29	11.0	2.94	1.38	0.58	1.48	9.20

Table 1. Ratio of the number of new daily record high to record low temperatures per decade at selected long-term climate monitoring stations in Oregon. A ratio greater than 1 indicates that more record highs than record lows were set. A ratio of 2, for instance, indicates that two new record highs occurred for every one new record low. National Oceanic and Atmospheric Administration / National Centers for Environmental Information Global Historical Climatology Network daily data (NOAA/NCEI GHCNd, Menne et al. 2012) via the Iowa Environmental Mesonet portal (mesonet.agron.iastate.edu).

Extreme Heat

Heat is the leading cause of weather-related deaths in the United States, killing approximately 1500 people per year from 2008 through 2017 (Khatana et al. 2022). Although dangerously warm temperatures are less common in Oregon than in many other parts of the country, Oregonians are less likely than residents of most other states to have air conditioners in their homes, leaving them more vulnerable to high heat. To illustrate, in June 2021, record-breaking heat caused an estimated 116 deaths across the state, mostly inside homes without air conditioning.

Dangerous heat is almost always associated with a weather event called a heat wave (Peterson et al. 2013). There is no single definition of a heat wave, but heat waves usually are defined with respect to both the relative magnitude of temperature anomalies (e.g., temperatures above the 99th percentile for a given location and season) and the duration of those anomalies (e.g., at least three consecutive days). By this definition, a prolonged period with temperatures exceeding 100°F (38°C) would not be considered a heat wave if it occurred in Phoenix, Arizona, in July, but would be considered a heat wave if it occurred in Portland in July or in Phoenix in March. Heat waves can occur during any season, although the term heat wave is generally reserved for prolonged stretches of extreme heat that pose a substantial health and safety risk. Here, we focus on summer (June–September), when temperatures in Oregon are most likely to be dangerously high.

Previous studies of heat-wave trends distinguished between extremely warm daytime high temperatures and overnight low temperatures (Bumbaco et al. 2013). Although extremely warm

daytime highs often generate the most press coverage and public interest, extremely warm overnight lows often are a greater threat to human health, especially where access to air conditioning is limited (Gershunov et al. 2011). In 2021, in response to the increasing vulnerability of marginalized populations to the warming climate, the Oregon legislature directed funding to the Oregon Health Authority to distribute air conditioning units to eligible people at risk for heat-related illness.

Observed Trends in Extreme Daytime Heat

Extreme warm temperatures often are defined on the basis of absolute thresholds. A common definition of an extremely warm day in the Pacific Northwest is a day on which the maximum temperature is 90°F (32°C) or above. By this definition, the number of extremely warm days increased significantly across Oregon since 1951 (linear regression; >95% probability that the result was not obtained by chance alone). The number of extremely warm days increased significantly in Portland, Pendleton, and Medford since 1940 (Figure 1). Portland, for instance, averaged 7.4 days ≥90°F per year during the 1950s and 17.3 in the 2010s. From 2011–2020, the number of days ≥90°F at many long-term climate monitoring stations in Oregon was significantly greater than the average from 1951–2020 (Table 2). Moreover, 2021 and 2022 were among the hottest years on record in the state as measured by days above 90°F (Table 2). In Portland, 24 days in 2021 and 29 days in 2022 were above 90°F, well above the 1951–2020 average of 12.5 days per year (Table 2). The number of extremely warm days in these years ranked fourth and second, respectively, in Portland's historical record, ahead of the 31 days recorded during 2018.

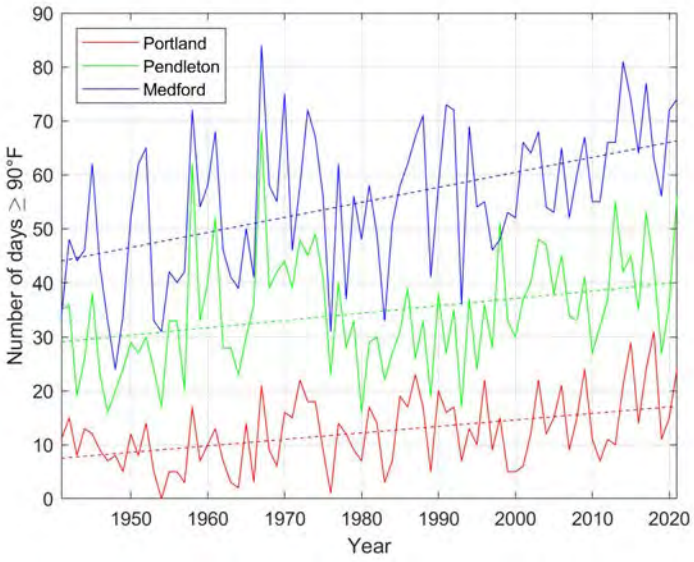

Figure 1. Number of days per year on which the observed daily high temperature was 90°F (32°C) or above. Dashed lines are statistically significant linear regressions. Data source: NOAA/NCEI GHCNd.

Years	Astoria	Portland	Salem	Eugene	The Dalles	Pendleton	Ontario	Medford
1951–1960	0.6	7.4	14.8	13.6	29.5	31.9	50.0	53.5
1961–1970	0.3	9.4	17.4	16.5	37.3	39.0	53.7	55.7
1971–1980	0.5	12.5	16.0	16.0	42.0	36.2	49.3	53.3
1981–1990	0.3	14.2	16.5	15.5	39.6	29.4	51.4	54.8
1991–2000	0.3	11.9	15.6	14.8	43.2	31.8	49.3	55.8
2001–2010	1.1	14.7	17.8	17.4	39.9	39.0	56.8	60.4
2011–2020	0.8	17.3	21.5	21.7	44.1	40.5	54.1	67.4
1951–2020 average	0.6	12.5	17.1	16.5	39.4	35.4	51.7	55.8
2021–2022	1.0	27	37	38	65	56	66	77

Table 2. Average number of days per year on which the observed daily high temperature at long-term monitoring stations in Oregon was 90°F (32°C) or above. Data source: NOAA/NCEI GHCNd.

Observed Trends in Extreme Nighttime Heat

The number of extremely warm nights is also increasing across Oregon. A common absolute threshold for nighttime extreme heat is a day on which the minimum temperature is 65°F (18°C) or above. In western Oregon, such warm nights were rare before 1990 (Table 3, Figure 2), but the number of warm nights has increased significantly in Portland, Medford, The Dalles, and Ontario in the past two decades. In Pendleton, by contrast, extremely warm nights were more common before about 2000 than they are now, and the annual number of extremely warm nights has not changed significantly since 1940 (Table 3, Figure 2). Extremely warm nights are rare in Salem and Eugene, even since 2011 (Figure 3). Similar to the trends in the number of extremely warm days, several long-term climate monitoring stations in Oregon recorded significantly more extremely warm nights from 2011–2020 than from 1951–2020 (Table 3). The exceptions were Astoria, Eugene, and Salem. The number of extremely warm nights in 2021–2022 was far above the historical number (Table 3).

Years	Astoria	Portland	Salem	Eugene	The Dalles	Pendleton	Ontario	Medford
1951–1960	0.0	0.2	0.0	0.0	6.8	9.5	6.6	1.0
1961–1970	0.0	0.1	0.0	0.0	13.4	9.6	7.1	1.7
1971–1980	0.0	1.6	0.1	0.0	14.3	10.7	7.5	1.4
1981–1990	0.0	1.4	0.0	0.1	14.9	7.2	5.7	1.8
1991–2000	0.0	2.7	0.2	0.1	14.8	5.9	3.9	3.9
2001–2010	0.0	2.3	0.8	0.2	15.8	6.4	10.2	6.6
2011–2020	0.0	5.2	1.2	0.0	20.9	6.0	8.9	11.4
1951–2020 average	0.0	1.9	0.3	0.1	14.4	7.9	7.1	4.0
2021–2022	0.0	17	6	3	43	19	33	26

Table 3. Average number of days per year on which the observed daily minimum temperature at long-term monitoring stations in Oregon was 65°F (18°C) or above. Data from NOAA/NCEI GHCNd.

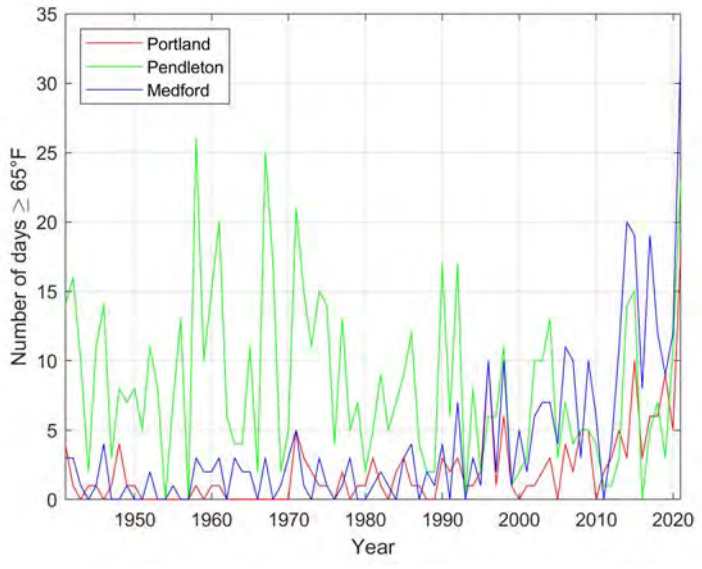

Figure 2. Number of days per year on which the observed daily low temperature was 65°F (18°C) or above. Linear trends during this period were not statistically significant. Data source: NOAA/NCEI GHCNd.

Days Below Freezing

At many locations across Oregon, including Portland and Medford, the annual number of days on which the minimum temperature is below freezing (32°F or 0°C) has decreased significantly since 1940 (Figure 4). However, trends in the observed number of cold days are less consistent than trends in the number of warm days. For example, the number of sub-freezing days in Astoria, Eugene, and Pendleton has not changed significantly (Table 4). Nevertheless, at all stations except Pendleton, fewer days per year were below freezing in 2021 and 2022 than the annual average from 1951–2020 (Table 4).

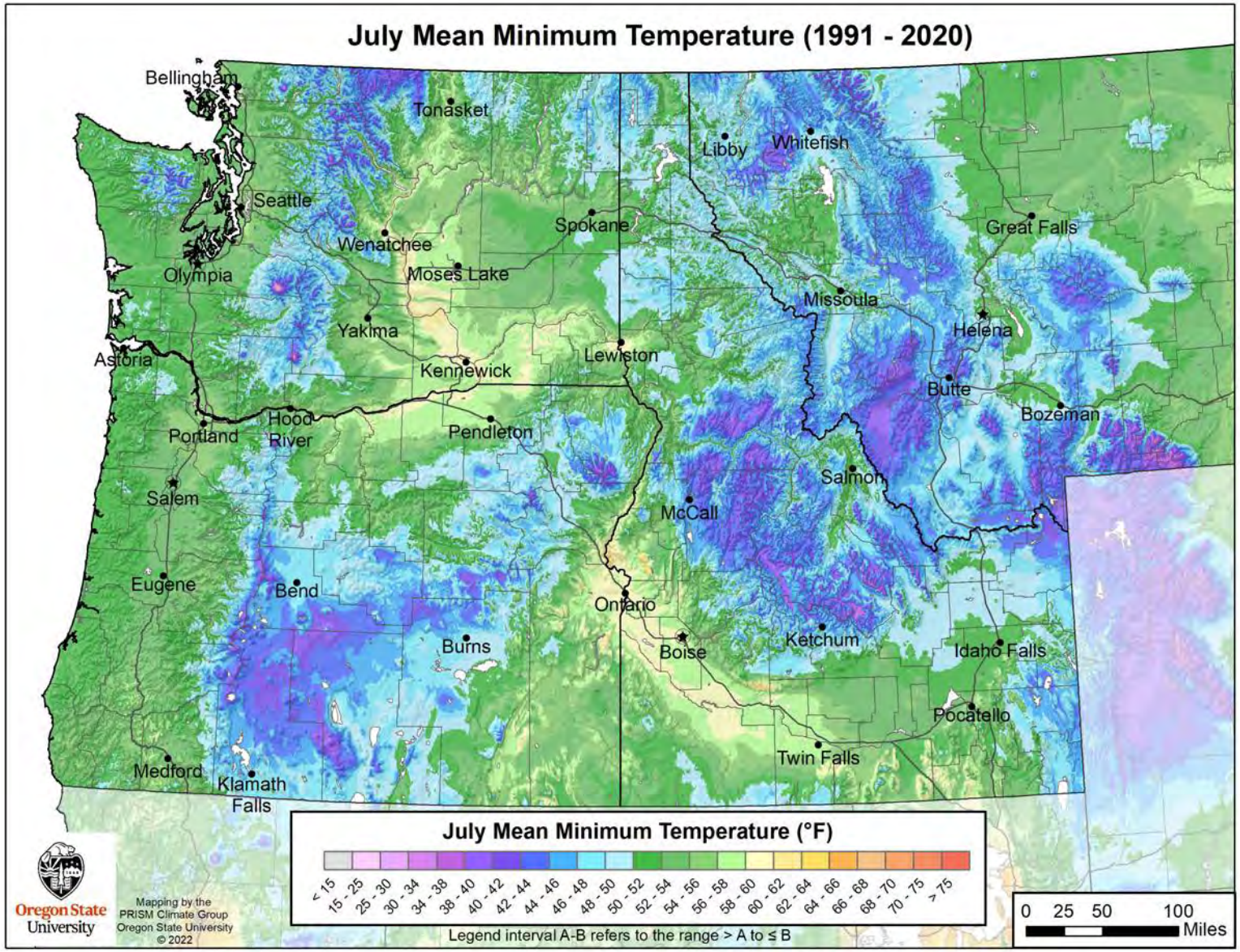

Figure 3. Average minimum July temperatures across the Northwest, 1990–2020.

Extreme Heat, Public Health, and Workplace Safety

During May 2022, the Oregon Occupational Safety and Health Administration (OSHA) adopted new regulations on workplace heat exposure (OOSH 2022). These regulations are based on thresholds of the heat index. The heat index, also known as the apparent temperature, is what the temperature feels like to the human body when relative humidity is combined with air temperature. As air becomes more humid, the human body is less able to cool through the evaporation of perspiration. Therefore, the incidence of heat illness is not necessarily directly correlated with air temperature. When relative humidity is low, the heat index is roughly the same as, or slightly cooler than, the air temperature. As relative humidity increases, the heat index becomes higher than the air temperature, and the difference between the heat index and the air temperature increases. For example, when the air temperature is 90°F (32°C), the heat index will be 88°F (31°C) if the relative humidity is 30 percent, but 100°F (38°C) if the relative humidity is 60 percent. To combat heat illness, the Oregon OSHA guidelines stipulate that when the heat index is 90°F or above, employers must provide each employee with a break of at least 10 minutes every two hours, and at least one quart of drinking water per hour.

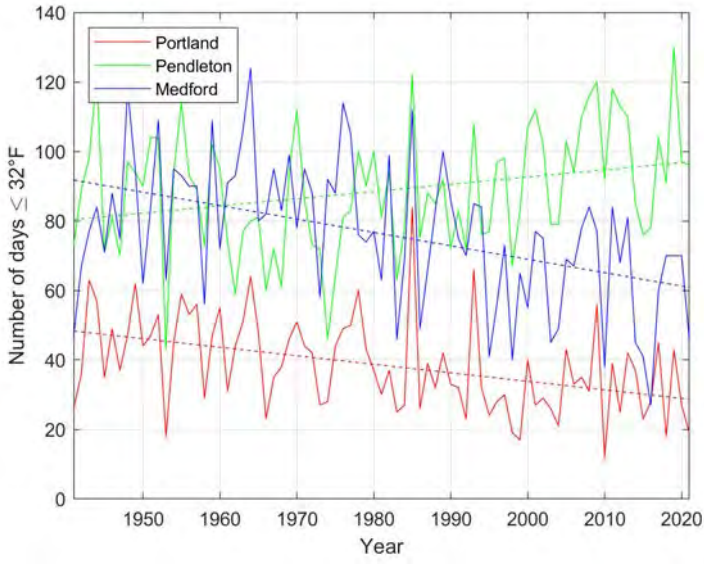

Figure 4. Number of days per year on which the observed daily low temperature was 32°F (0°C) or below. Dashed lines are linear regressions. Data source: NOAA/NCEI GHCNd.

Years	Astoria	Portland	Salem	Eugene	The Dalles	Pendleton	Ontario	Medford
1951–1960	27.5	46.2	63.6	57.9	87.1	91.1	142.5	86.1
1961–1970	39.8	43.1	67.0	42.9	77.8	77.0	141.2	93.1
1971–1980	35.5	42.4	67.7	57.0	76.5	79.5	137.5	86.7
1981–1990	36.7	37.5	63.4	57.2	72.1	85.0	145.5	77.3
1991–2000	28.6	31.1	48.6	48.5	66.5	86.8	132.0	64.4
2001–2010	27.9	31.3	53.0	53.1	74.6	100.7	119.3	65.9
2011–2020	30.7	32.7	46.9	54.0	73.9	100.2	111.3	61.6
1951–2020 average	32.4	37.8	58.6	52.9	75.5	88.6	132.7	76.4
2021–2022	31.5	19.0	38.5	39.0	82.0	87.0	120.0	52.0

Table 4. Average number of days per year on which the observed daily minimum temperature at long-term monitoring stations in Oregon was 32°F (0°C) or below. Data from NOAA/NCEI GHCNd.

Historically, heat waves across Oregon rarely were humid (Rastogi et al. 2020). Because high heat and low relative humidity tend to co-occur in Oregon, the heat index is generally a few degrees lower than the actual air temperature. As a result, approximating the heat index with only air temperature would significantly overestimate the number of high heat-index days in Oregon.

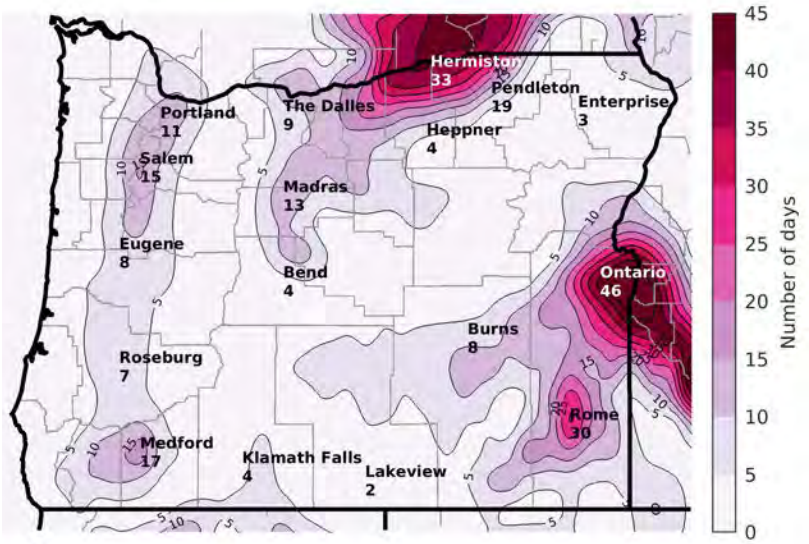

Figure 5. Average annual number of days from 1991–2020 on which the heat index was 90°F (32°C) or above. Heat indexes derived from ERA5 atmospheric reanalysis data.

The occurrence of high heat-index days varies considerably across Oregon (Figure 5). In western Oregon from 1991–2020, the greatest number of days per year with a heat index above 90°F occurred in the Willamette Valley and Rogue Valley, ranging from an average of 17 days in Medford to 7 days in Roseburg. In much of Oregon east of the Cascades, the heat index exceeded 90°F on fewer than 10 days per year. However, the heat index exceeded 90°F in Ontario and Rome (Malheur County) on an average of 46 and 30 days per year, respectively. In northeastern Oregon, the heat index exceeded 90°F in Hermiston and Pendleton on an average of 33 and 19 days per year, respectively.

The summer of 2021 was the warmest in Oregon's recorded history. Heat indexes exceeded 90°F on many more days (Figure 6) than the most recent 30-year average (Figure 5). Summer heat conditions similar to those in 2021 are projected to become more common by the middle to end of this century.

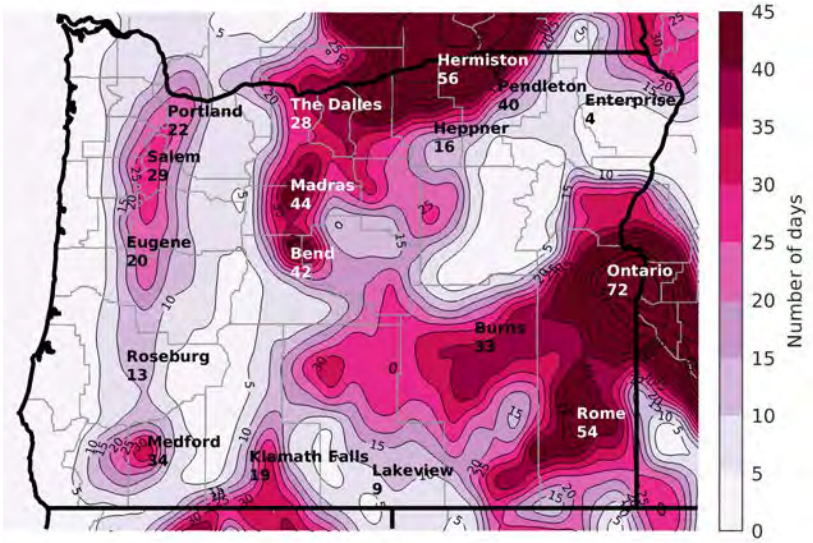

Figure 6. The number of days during 2021 on which the heat index was 90°F (32°C) or above. Heat indexes derived from ERA5 atmospheric reanalysis data.

The annual duration of most Oregonians' exposure to high heat, such as a heat index of 80°F (27°C) or greater (Table 5) or 90°F or greater (Table 6), has increased significantly during the past 40 years. From 1981–2010, the mean annual number of exposure hours at the Willamette Valley stations of Portland, Salem, and Eugene was similar: 320 hours at 80°F or above and 32 hours at 90°F or above. The number of exposure hours at Medford and Pendleton was substantially greater than in the Willamette Valley, whereas the number at Burns was only somewhat greater. Since 2011, the average number of hours of exposure to heat indexes above either 80°F or 90°F has increased throughout Oregon relative to 1981–2010. In Portland, the average number of exposure hours in 2021 and 2022 was more than three times greater than from 2011–2020.

Influence of Climate Change on Extreme Temperatures

Extreme Heat

Daily and annual temperature are highly variable. At a given location on a particular day of the year, the likelihood of a temperature above or below a given value can be estimated with a probability distribution derived from historical temperature observations. Extreme heat and cold can be characterized by their frequency. Moderately extreme events might be expected to recur every 10 years (10 percent probability of occurrence in a given year), whereas more extreme events might be expected to recur every 100 or even 1000 years (1 or 0.1 percent probability of occurrence in a given year, respectively). Models indicate that, as climate changes, the probability of warmer temperatures increases, while the distribution of relatively high and low temperatures remains similar (Figure 7).

Years	Portland	Salem	Eugene	Medford	Pendleton	Burns
1981–1990	301.8	323.5	300.8	701.0	503.8	331.5
1991–2000	315.2	331.0	318.0	715.4	541.2	359.1
2001–2010	324.2	331.4	338.0	758.4	598.0	423.8
2011–2020	331.6	361.5	401.0	842.2	609.1	459.0
2021–2022	537.0	545.5	523.5	954.0	782.5	651.5

Table 5. Average number of hours per year with a heat index 80°F (27°C) or above. Data source: Iowa Environmental Mesonet (mesonet.agron.iastate.edu).

Years	Portland	Salem	Eugene	Medford	Pendleton	Burns
1981–1990	33.4	37.6	27.3	138.9	53.3	19.1
1991–2000	30.8	31.0	30.5	132.1	74.4	20.3
2001–2010	31.3	32.1	30.1	137.3	87.2	21.9
2011–2020	34.6	40.7	41.7	155.8	85.4	24.0
2021–2022	105.0	106.5	97.5	261.5	200.5	117.0

Table 6. Average number of hours per year with a heat index 90°F (32°C) or above. Data source: Iowa Environmental Mesonet (mesonet.agron.iastate.edu).

Climate change will continue to affect extreme heat events in two ways. First, the intensity of extreme heat events will increase further. Consider a scenario in which the mean temperature at a given location increases by 3°F. If the shape of the temperature distribution does not change (Figure 7), then an extreme heat event will be 3°F warmer than in the absence of climate change (e.g., 100°F historically and 103°F in the future). For example, the average daily maximum temperature in Portland is projected to increase by about 3.7°F from 2020 through 2050 (Figure 8). Second, humans'

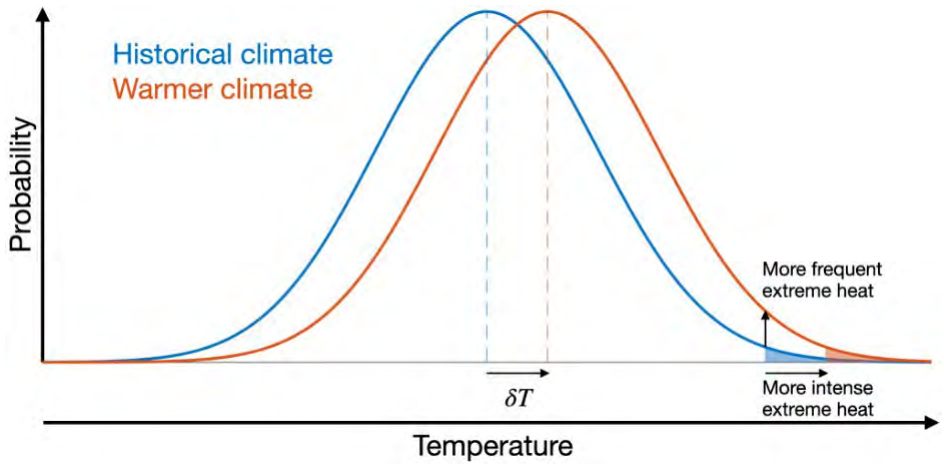

Figure 7. Schematic probability distributions of temperature during a particular season at a given location historically and in the future, warmer climate. Shaded regions at the right tails represent the warmest 0.5 percent of days.

perception of extreme heat will change as the frequency of events currently considered to be extreme increases. For example, temperatures that historically occurred on 0.5 percent of days are projected to become more than twice as common (Figure 7). In Portland during the twentieth century, 100°F temperatures occurred about once every 10 years. By 2025, they are likely to occur about once every 2 years (Figure 8).

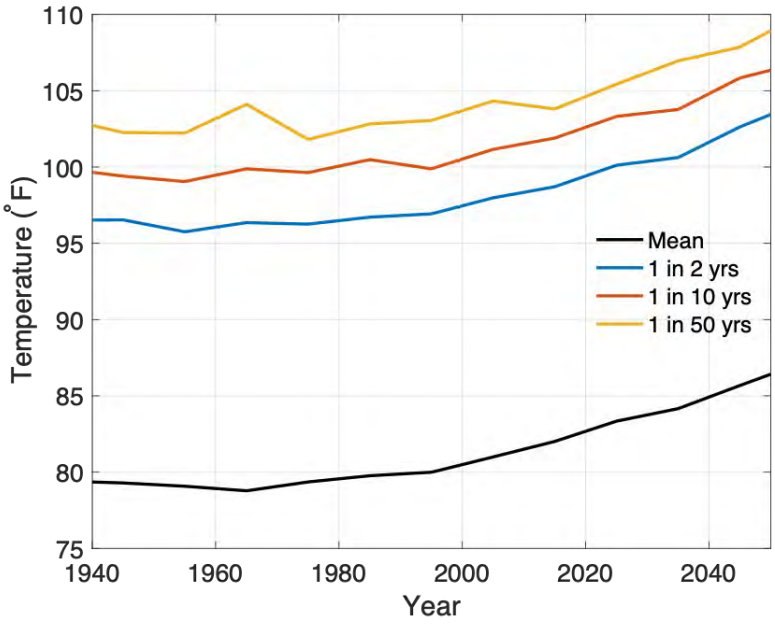

Figure 8. Daily maximum temperature during July and August in Portland, Oregon, as simulated by the CESM1 Large Ensemble (a 35-member set of global climate models) from 1940–2050, assuming a relatively high emissions scenario (RCP 8.5). Black line, mean high temperature; colored lines, temperatures that occur once every 2 (blue), 10 (red), and 50 years (yellow). Values are based on simulated temperatures over 10 years. A bias correction was applied to yield a mean 1990–2020 high temperature that matched observations (81°F).

Although climate models broadly agree that changes in the shape of the temperature distribution will be small relative to changes in mean temperature, some mechanisms might cause a more substantial change in the shape of the temperature distribution. For example, if a decrease in the equator-to-pole temperature gradient, caused in part by the melting of Arctic sea ice, alters the shape and position of the midlatitude jet stream, the temperature distribution could be altered (see *Arctic Amplification*, this volume). Soil-moisture feedbacks also amplify heat waves in some instances (e.g., Zeppetello et al. 2022), such as the European heat wave of 2003 (Miralles et al. 2014). Dry soils can amplify extreme heat events through relative lack of evaporative cooling of the surface. Soil-moisture feedbacks also may have played a role in the June 2021 heat dome (Bartusek et al. 2022), which followed the driest spring in Oregon's recorded history (see *Drought*, this volume). How Arctic amplification and soil moisture feedbacks affect historical and future extreme temperatures is an active area of research.

Extreme Cold

Extreme cold in Oregon is generally associated with cold air outbreaks, in which the jet stream migrates south over the Intermountain West and Arctic air moves into Oregon from the north and east. Because the Arctic is warming more quickly than other regions, the air associated with cold air outbreaks is warming at a greater rate than the global mean temperature, causing a decrease in both the intensity and frequency of extreme cold events (e.g., Screen 2014, Schneider et al. 2015, Holmes et al. 2016, Gross et al. 2020). However, the frequency distribution of Oregon's winter temperatures has a long cold tail that reflects the rare occurrence of extremely cold temperatures (Catalano et al. 2020). This long tail may result in a slow decrease in the frequency of extreme cold (Loikith and Neelin 2019); the rate at which the frequency of extreme heat increases will exceed that at which the frequency of extreme cold decreases. Therefore, although Oregon's coldest temperatures are warming and will continue to warm, rare, extreme cold will still be possible in the coming decades.

Extreme High Heat Index

Climate change is projected to alter both temperature and relative humidity, and thus the heat index. Climate models project little change in relative humidity in Oregon, with a decrease of only a few percent in eastern Oregon during summer by the end of the century. Warming over extensive areas is the primary driver of projected future changes in extreme heat index values in the Pacific Northwest (Schoof et al. 2019).

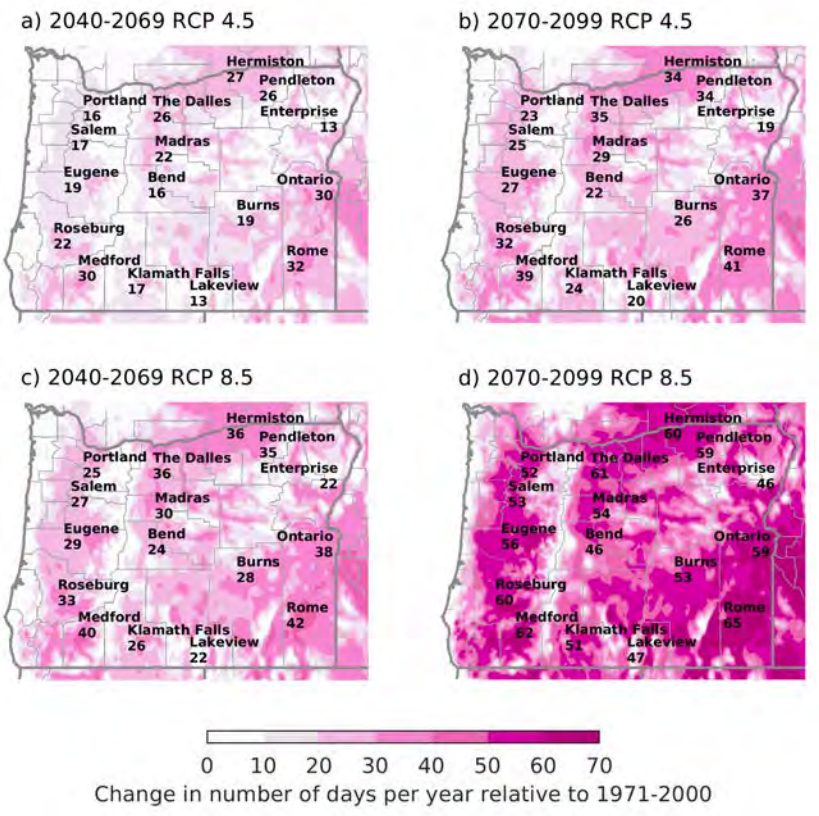

Figure 9. Increase in the projected number of days per year with a heat index of 90°F or above relative to 1971–2000. Values are means of 18 downscaled models from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) (Dahl et al. 2019). Data source: www.climatetoolbox.org.

We consider projected trends in the heat index and temperature separately for two reasons. First, the heat index describes human health impacts better than air temperature and is now the primary metric Oregon uses for regulating heat in work environments. Second, because the heat index has a nonlinear relation to relative humidity, the projected trends in the heat index are not necessarily constrained to follow those in air temperature.

The number of days on which the heat index exceeds 90°F is projected to increase throughout Oregon except at high elevations and on the west side of the Coast Range (Figure 9). Across the majority of Oregon by the mid-twenty-first century, the mean annual number of days with a heat index above 90°F is projected to increase by 15–30 days assuming RCP 4.5 and 25–40 days assuming RCP 8.5 (Figures 8a, c). In the Willamette Valley, the annual number of days with an extreme heat index will be double or triple that from 1991–2020 (Figure 5). The greatest increases in the number of extreme heat index days by the late twenty-first century, 20–40 days assuming RCP 4.5 and 45–65 days assuming RCP 8.5, will occur near Hermiston, Rome, and Ontario. The number of days with an extreme heat index in these areas is already among the highest in Oregon. In some parts of eastern Oregon given the RCP 8.5 scenario, the heat index is projected to exceed 90°F on most summer days. In large part, these exceedances reflect projected increases in warming in eastern Oregon, which are greater than those in western Oregon, throughout the twenty-first century. Projections suggest that if the concentration of greenhouse gases does not decrease, the frequency and magnitude of days with an extreme heat index will increase substantially throughout most of Oregon by the middle and late twenty-first century.

Pacific Northwest Heat Wave of June 2021

During the last week of June, 2021, an exceptional heat wave with no precedent in the modern observational record occurred across Oregon and the Pacific Northwest (Bercos-Hickey et al. 2022, Neal et al. 2022, Thompson et al. 2022, Vescio and Bair 2022, Philip et al. in press). The all-time high temperature records at multiple weather stations were broken by several degrees. Portland's previous all-time record of 107°F (42°C) broke on 26 June (108°F [42°C]), 27 June (112°F [44°C]), and 28 June (116°F [47°C]). Salem's all-time record of 108°F broke on 28 June at 117°F. Previous official all-time record high temperatures of 119°F (48°C) at the Pelton Dam and Moody Farms weather stations were tied (Vescio and Bair 2022). Nights also were extremely warm during this event, although records for warm nights were broken by smaller margins at most major weather stations (for example, 75°F [24°C] at Portland, breaking the previous record of 74°F [23°C]).

This heat wave, which became known as the heat dome, was driven by a remarkable amplification of meteorological features historically associated with heat waves in the region (Bumbaco et al. 2013). The primary driver was a record-breaking ridge of mid-tropospheric high pressure (the heat dome) that peaked just offshore of central British Columbia on 26 and 27 June (Neal et al. 2022). The ridge set all-time records for 500 hPa geopotential height and temperature at the Quillayute upper-air station (Vescio and Bair 2022). Sinking air under this ridge of high pressure warmed thermodynamically and prevented clouds from forming, maximizing solar heating. Additionally, winds were blowing offshore (westward) across the state, preventing any cooling by the Pacific Ocean while increasing the warming in the Willamette Valley as air descended on the west side of the Cascade Range. There is some evidence that widespread dry soils in the western United States may have amplified the already extreme heat wave (Bartusek et al. 2022), consistent with conclusions of other studies indicating that antecedent abnormally dry soils can amplify heat waves through reduction of surface cooling by evapotranspiration (e.g., Zeppetello et al. 2022).

The simplest and most straightforward way to interpret the effect of anthropogenic climate change on the severity of the June 2021 event is to assume that it elevated temperatures by an amount equivalent to the mean increase in temperature since anthropogenic climate change began. A recent study estimated that this heat wave was about two degrees Fahrenheit warmer than it would have been without human influence on the climate (Bercos-Hickey et al. 2022), consistent with the increase in mean temperature. An event of this magnitude is likely to occur once in 1000 to 100,000 years (McKinnon and Simpson 2022, Thompson et al. 2022). A heat dome would have occurred without climate change, but maximum temperatures would not have been as high (McKinnon and Simpson 2022). Thompson et al. (2022) estimated that a heat wave of similar magnitude will recur about once in six years by the end of the twenty-first century if concentrations of greenhouse gases do not decrease. There is no evidence that the highly unusual combination of weather features that drove the heat dome were made more likely by climate change, and climate models do not project an increase in the frequency of high-pressure ridges over the Pacific Northwest (Loikith et al. 2022). However, the relations between extreme atmospheric circulation patterns and climate change are not yet fully understood.

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Drought

Larry O'Neill and Nick Siler

Over the last three years, one of the most severe droughts in Oregon's recorded history strained the water supply to communities, agriculture, and ecosystems. Water availability is central to the state's economy, contributing significantly to the resilience of agricultural and livestock production, public health, urban environments, energy supply, fisheries, and industry. For example, drought and other climate stressors are affecting Pacific salmon populations that are central to the cultural identities and economies of Indigenous communities (see *Tribal Resilience to Climate Change*, this volume).

Over the last 20 years, the incidence, extent, and severity of drought has increased throughout the western United States, including the Pacific Northwest (e.g., Dalton et al. 2017, Williams et al. 2020, 2022). The likelihood of continued increases in drought severity and duration in the twenty-first century raises questions about how best to prepare for and mitigate the impacts of drought, and to better understand historical and projected future variability of drought. Here, we summarize recent drought variability in Oregon and recent research on drought and water supply relevant to Oregon.

Defining Drought

There are many conceptual and quantitative definitions of drought (Wilhite and Glantz 1985, Rasmussen et al. 1993). The simplest definition of drought is insufficient water to meet demand (Redmond 2002). Drought is generally characterized by a deficit in the supply of water (Swann 2018). However, the precise definition of drought depends on the location and context.

Meteorological drought traditionally has been defined by lack of precipitation, but is better defined as evaporative demand that exceeds precipitation over a prolonged period. Hydrological drought occurs when extended periods of meteorological drought affect surface or subsurface water supply, and is most consequential for society when water supply does not meet human demand. Meteorological and hydrological drought are driven by physical factors and do not describe impacts on humans or ecosystems. Several other types of drought are defined on the basis of their effects on particular components of human and natural systems. For example, agricultural drought occurs when lack of surface or subsurface water supply adversely affects agricultural production. Nevertheless, the effects of meteorological and hydrological drought depend in part on the duration of drought. The Pacific Northwest is prone to seasonal drought due to gaps in wet season precipitation. Flash droughts occasionally occur throughout Oregon (Otkin et al. 2018, Pendergrass et al. 2020). Flash droughts are characterized by rapid-onset periods of elevated surface temperatures, low relative humidities, precipitation deficits, and a rapid decline in soil moisture. These conditions often occur in Oregon during summer heat waves, and the impacts of flash drought can emerge in as little as a week (Mo and Lettenmaier 2015, Rupp et al. 2017).

As the climate warms and the hydrologic cycle changes, the western United States is becoming more arid, and the process and effects of aridification are intensifying (Sherwood and Fu 2014, Cook et al. 2016, Overpeck and Udall 2020, Williams et al. 2022). As distinct from drought, aridification refers to gradual, long-term drying of the climate system. Most of the southwestern United States, extending north to southern and eastern Oregon, is experiencing a megadrought that is estimated to be one of the most severe since at least 800 CE (Williams et al. 2020, 2022). Megadrought generally refers to droughts that persist for longer than a decade, although wet years can occur during a megadrought. Additionally, virtually all of Oregon is in a multiple-year drought, defined as drought

that persists for more than one water year. Impacts on human and natural systems can become more severe in each consecutive year of drought as groundwater, soils, and surface-water bodies continually dry without normal recharge.

Oregon and much of the western United States depend on mountain snowpack. Snow acts as a large, natural reservoir of water that accumulates during winter and is released slowly during spring and summer. The concept of snow drought is particularly relevant in snowmelt-dominated watersheds. Snow droughts are typically defined as a deficit in snow water equivalent (SWE; the amount of water contained in the snowpack) on 1 April (Harpold et al. 2017, Hatchett and McEvoy 2018). Years with poor snowpack often presage hydrological drought conditions during the ensuing spring and summer in snowmelt-dominated watersheds (Sproles et al. 2017) as impacts from lack of water at high elevations cascade through the watershed. In recent years, two types of snow drought occurred in Oregon. Warm snow droughts, such as the drought that occurred in 2015 (Cooper et al. 2016, Mote et al. 2018), are primarily the result of above-average winter temperatures. Dry snow droughts, such as the 2020–2022 drought in the central and south Cascade Range in Oregon, are mainly the result of below-average winter precipitation. Snow droughts may be both warm and dry. For example, during the 2022 water year (defined as October 2021–September 2022), below-average high-elevation precipitation in Oregon coincided with well-above-average temperatures at elevations above 3000 ft (914 m). On 28 March 2022, the average SWE value for all of Oregon's SNOTEL stations was 37 percent below the median.

Historical Trends in Drought Severity and Extent

In 17 of the last 23 water years, Oregon's precipitation was below average (Figure 1). In terms of precipitation, water years 2001 and 2020 ranked as the third and fifth driest water years in Oregon

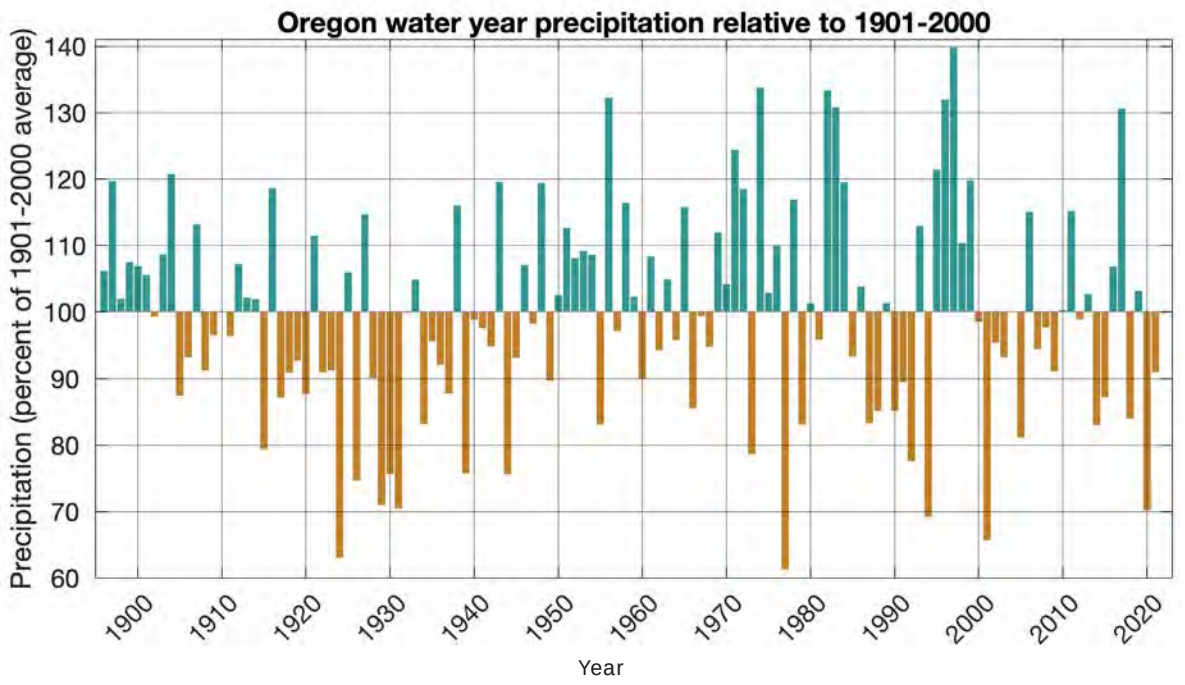

Figure 1. Time series of total water year precipitation averaged across Oregon. Data from the PRISM Climate Group and accessed via the West Wide Drought Tracker, wrcc.dri.edu/wwdt/time, with the following selections: Oregon, Precipitation, 1895–2022, September, 12-month; accessed 5 December 2022.

since 1895. The average temperature in Oregon also was warmer than normal in 18 of the last 23 water years (Figure 2), which contributed to increases in evapotranspiration and drought frequency.

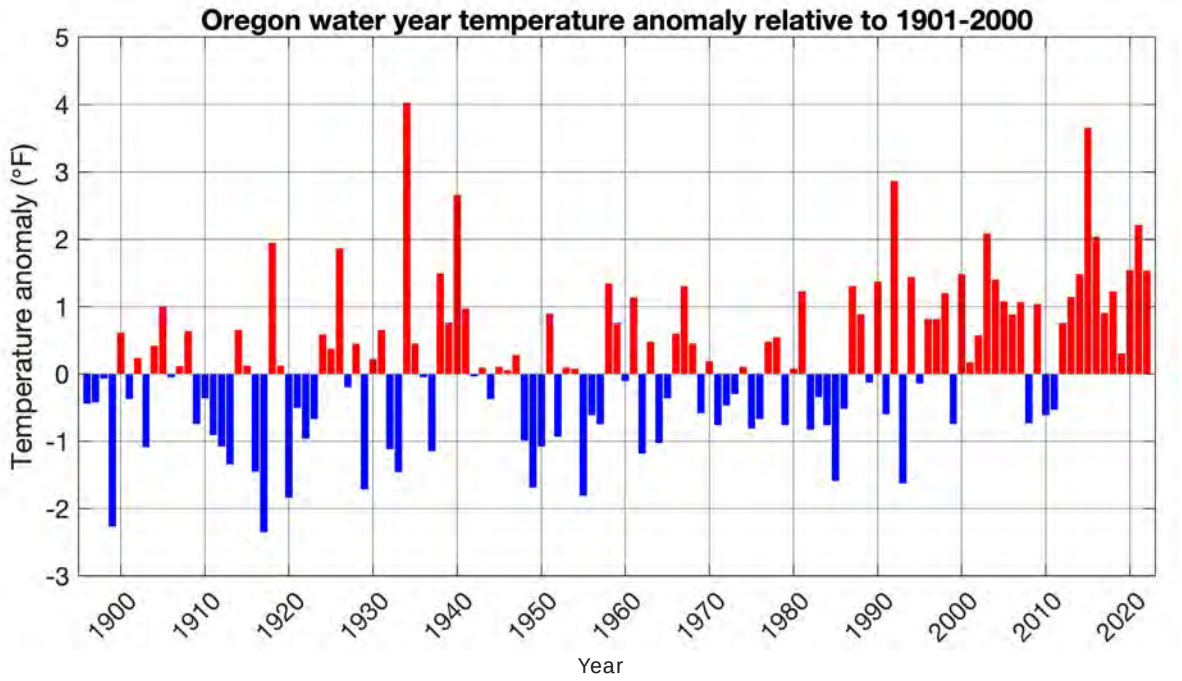

Figure 2. Time series of water year average temperature in Oregon. Data from the PRISM Climate Group accessed via the West Wide Drought Tracker, wrcc.dri.edu/wwdt/time, with the following selections: Oregon, Temperature, 1895–2022, September, 12-month; accessed 5 December 2022.

The dimensionless Standardized Precipitation-Evapotranspiration Index (SPEI) is a primary quantitative metric for assessing the existence and severity of meteorological and hydrological drought, especially in the western United States (Vicente-Serrano et al. 2010). The SPEI compares the net water balance between precipitation and potential evapotranspiration (evapotranspiration from a large area with uniform vegetation and unlimited soil water) between a recent period of time and a historical period (Vicente-Serrano et al. 2010). The SPEI allows for evaluation of drought severity in different locations and time periods, identification of different drought types (Ahmadalipour et al. 2017), and consideration of the role of temperature-driven evapotranspiration in drought. The 12-month SPEI is a reliable predictor of annual streamflow in the Pacific Northwest (Abatzoglou et al. 2014a, Peña-Gallardo et al. 2019) and water levels in lakes and reservoirs (McEvoy et al. 2012). Accordingly, the SPEI at extents between 3 and 24 months is a key indicator of drought severity and extent in the U.S. Drought Monitor for Oregon. The U.S. Drought Monitor provides a consistent overview of drought conditions nationwide. It combines multiple indicators of dryness, including precipitation, snowpack, streamflow, soil moisture, groundwater, and evapotranspiration, at multiple temporal extents, into a single drought severity classification (Svoboda et al. 2002).

During water year 2020, the 12-month SPEI in Oregon was at its lowest value since 1896 (Figure 3). By this measure, the drought was the most severe in Oregon's recorded history, exceeding 1924, 1931, 1977, and 1994 (Xiao et al. 2016). The 2020 drought was driven by a combination of low precipitation and high evapotranspiration, which in turn reflected well above normal temperatures (Bumbaco et al. 2021).

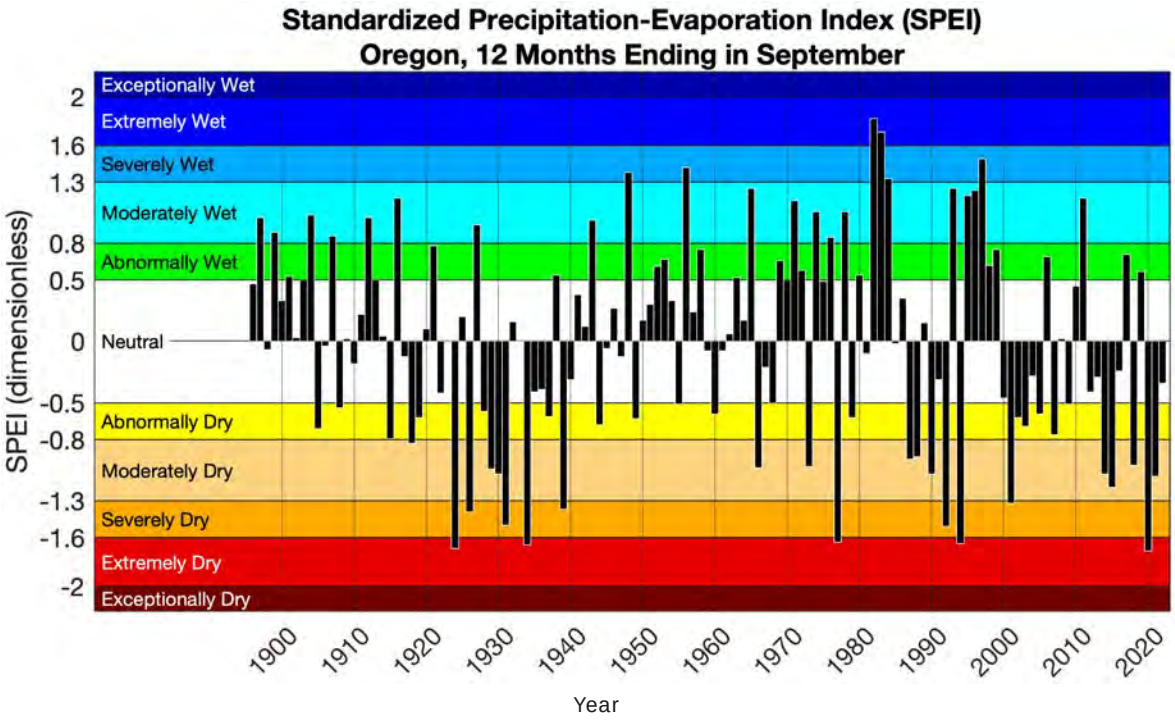

Figure 3. Time series of the Standardized Precipitation-Evapotranspiration Index (SPEI) for each water year since 1896 for the state of Oregon. Data from the PRISM Climate Group accessed via the West Wide Drought Tracker, wrcc.dri.edu/wwdt/time, with the following selections: Oregon, SPEI, 1895–2022, September, 12-month; accessed 5 December 2022.

Yearly estimates of soil moisture from tree rings suggested that the years 2000–2021 were the driest in the southwestern United States since at least 800 CE (Williams et al. 2022). In Oregon, this 22-year period was among the five driest such periods since 800 CE. These years were characterized by low snowpack, decreased summer streamflow, low precipitation during all seasons, and steadily rising evaporative demand due to climate change-induced aridification.

Persistent and severe droughts have occurred in Oregon since 2000. These droughts were caused by different conditions, such as low winter precipitation and snowpack (2001), low summer precipitation and high winter temperature (2003), and low snowpack and low winter precipitation (2005) (Bumbaco and Mote 2010). Low precipitation contributed to each drought, but temperature and snowpack also affected drought severity and impacts, including the propagation of meteorological drought to hydrological and agricultural drought (Bumbaco and Mote 2010). Multiple studies have related cooler sea surface temperatures in the eastern Pacific Ocean, which typically are associated with La Niña, and the 1998–2004 drought and other historical droughts in the western United States (Hoerling and Kumar 2003, Cook et al. 2007, Seager 2007, Wise 2016). An estimated 19 percent of the soil moisture deficits in the West from 2000–2021 are attributable to anthropogenic climate change (Williams et al. 2022).

Anticipated Impacts of Climate Change on Drought

Most global climate models project that annual mean precipitation will increase in Oregon by five to ten percent by 2100 (e.g., Almazroui et al. 2021). Precipitation is projected to increase during winter but decrease during summer (Abatzoglou et al. 2014b, Rupp et al. 2017), which implies an increase in the number of consecutive days without rain during the dry season. Some studies suggested that

precipitation events and dry periods will become more intense in the coming decades (Pendergrass et al. 2017, Rupp et al. 2022). However, changes in total annual precipitation will continue to be driven primarily by annual variation rather than long-term trends (Rupp et al. 2017).

Evaporation is generally expected to increase in Oregon as temperatures increase (Abatzoglou and Rupp 2017). Warm air holds more moisture than cool air, so projected increases in total evaporation are driven by projected increases in vapor pressure deficit. Even if the net water balance (precipitation minus evaporation) increases on average, the likelihood of drought, particularly during summer, increases as precipitation becomes more intense and seasonal. Under the moderate (RCP 4.5) and high (RCP 8.5) emissions scenarios, the severity and duration of droughts, as characterized by the three-month SPEI, were projected to increase across most of Oregon (Gu et al. 2020). Seasonal droughts were projected to be 11–33 percent longer and at least 40 percent more severe by the end of the century (Gu et al. 2020).

Across Oregon, snow water equivalent declines of approximately 25 percent are projected by 2050 relative to 1950–2000 (Siirila-Woodburn et al. 2021). These losses are similar to declines that already occurred in the late twentieth and early twenty-first century. As climate change reduces mountain snowpack in the western United States (Livneh and Badger 2020, Siirila-Woodburn et al. 2021), snow droughts will increase the likelihood of hydrological or agricultural drought during the following spring and summer (Koster et al. 2010, Wood et al. 2016, Harpold et al. 2017), and seasonal drought will become less predictable (Marshall et al. 2019, Livneh and Badger 2020).

It is still unknown whether conditions similar to the 2015 or 2022 snow droughts may become common in Oregon by the mid-twenty-first century (Cooper et al. 2016, Dalton et al. 2017). An analysis of historical climate data suggested that for every 1°C of warming, peak SWE decreases by up to 30 percent (Cooper et al. 2016). Effects of anthropogenic climate change on spring snowpack trends since 1980 may have been mitigated by natural variability produced by changes in atmospheric circulation over large areas that were driven by sea surface temperatures in the North Pacific Ocean (Siler et al. 2019). Declines in western United States snowpack may accelerate once the cycle of natural variability shifts (Siler et al. 2019). Projections assuming RCP 8.5 suggest that winter snowpack in the Pacific Northwest will decrease by more than 60 percent by 2050 (Fyfe et al. 2017, Shrestha et al. 2021). The average number of water years that are encompassed by a snow drought of two or more years also is projected to increase from 7 percent (1970–1999) to 42 percent by 2050–2070 (Marshall et al. 2019).

The social and economic effects of snow drought may be considerable in basins that rely more heavily on irrigated water derived from snowmelt runoff. For example, snowmelt runoff accounts for about 25 percent of total surface water allocated to irrigation in the Columbia River basin (Qin et al. 2020). The Willamette River basin is also vulnerable to projected decreases in Cascade Range snowpack and snowmelt runoff, with increased incidence of short-term agricultural drought during summer (Jung and Chang 2012). Short-term drought during the growing season may have major effects on agricultural productivity if water for irrigation becomes limited and soil moisture is not recharged. Watersheds in the Pacific Northwest that receive both rain and snow, and in which snowmelt runoff makes a substantial contribution to spring and summer streamflow, are the most sensitive to projected winter warming (Vano et al. 2015). The frequency of hydrological drought is projected to increase in such watersheds.

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Changes in the Water Cycle and the Contributions of Community Science

Contemporary discussion of the hazards that changes in the water cycle pose to Oregon often focus on drought and changes in the proportion of precipitation falling as rain rather than snow. As Fountain explains in this section, the amount of water stored in Oregon's glaciers and perennial snowfields also is changing as glaciers disappear and retreat in the state's major mountain ranges.

Weather and climate mapping systems long have relied on data from networks of observation stations, such as those operated by the National Oceanic and Atmospheric Administration's National Weather Service and the U.S. Department of Agriculture's Natural Resources Conservation Service. Increasingly, however, professional meteorologists and climate scientists are capitalizing on the expertise and generosity of members of the public, or community scientists, who measure precipitation in areas without formal observation stations. For example, as described in this section by Daly and Newman, the PRISM climate mapping system is now regularly incorporating information from thousands of community observers. These data contribute to development of 30-year climate normals, updates to Plant Hardiness Zone maps, and numerous other resources that support diverse economic, recreational, and scientific sectors. The most comprehensive community science network contributing to PRISM—with more than 25,000 active volunteers across the United States and Canada—is the Community Collaborative Rain, Hail, and Snow network (CoCoRaHS).

Two additional community science programs highlighted in this section, Community Snow Observations (CSO) and Mountain Rain or Snow, exemplify how community scientists have dramatically expanded the geographic scope of precipitation sampling and enhanced the reliability of hydrologic models. For example, Hill and the CSO team illustrate how community data have improved models of snow depth. Similarly, Collins and collaborators at Mountain Rain or Snow demonstrate the advances in understanding when precipitation falls as rain, snow, or mixed, and the probability of snowfall as a function of air temperature, that have been facilitated by community observations. Moreover, community participation increases the accessibility of science and scientific literacy. We hope that this section will pique some readers' interest in becoming new members of one or more community observation programs.

Glacier Change in Oregon

Andrew Fountain

Glaciers advance during cold climatic periods and retreat during warm periods. Thus, glaciers provide tangible evidence of climate change. Changes in winter snowfall and air temperature (summer and winter) are the most important factors affecting changes in the extent of glaciers (Cuffey and Paterson 2010, Fountain et al. 2022).

Glaciers are relevant to natural and human systems because they act as frozen reservoirs that release water when it is needed most—during the hot, dry late summer when seasonal snow has all but disappeared (Fountain and Tangborn 1985, Moore et al. 2009, Carey et al. 2017). Glacial melt protects high alpine ecosystems from the effects of drought, and maintains a flow of cool water. Shrinking glaciers change the hydrology and ecology of downstream systems, and reduces benefits to cold-adapted aquatic species, including insects (e.g., species of *Dimesa*) and bull trout (*Salvelinus confluentus*) (Milner et al. 2017, Lencioni 2018). Glacial melt also supports agriculture. For example, apple and pear orchards on the north slopes of Mount Hood are watered by the Middle Fork of the Hood River, which drains the Coe and Eliot glaciers. Modeling suggests that September flow along the Middle Fork will decrease by almost 70 percent by 2100 due to the loss of glacier area (Nolin et al. 2010, Frans et al. 2018).

Glaciers and perennial snowfields are common in the Cascade Range and the Wallowa Mountains (Figure 1). Glaciers are defined as perennial snow and ice that moves, whereas a perennial snowfield does not move. The first complete inventory of glaciers and perennial snowfields in Oregon was completed by the U.S. Geological Survey (USGS) with aerial photography (Fountain et al. 2007, 2017) as part of an effort to map the topography and geographic features of the contiguous United States in detail (Usery et al. 2009). Aerial images of Mount Jefferson, the rest of the Cascade Range, and the Wallowa Mountains were captured in 1949, 1956–1957, and 1981, respectively. The resulting maps identified 301 glaciers and perennial snowfields that collectively covered 41.6 km^2 (16 mi^2). The features initially were not classified by the USGS, but were classified later on the basis of their topography, yielding 48 glaciers (31.7 km^2 [12.2 mi^2]) and 253 snowfields (9.9 km^2 [3.8 mi^2]) (Fountain et al. 2017).

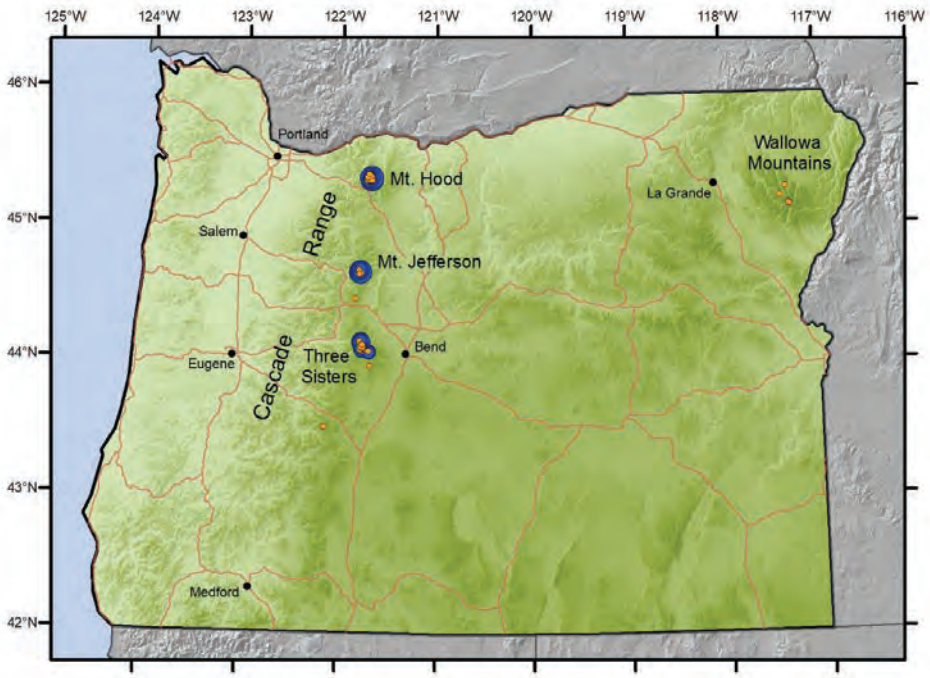

Figure 1. Locations of contemporary glaciers (blue dots) and perennial snowfields (yellow dots) in Oregon.

We compiled an updated inventory of glaciers and perennial snowfields across the western continental United States from high-resolution (~1 m) color aerial imagery acquired over the period 2014–2018. Not all imagery was used because of local variation in seasonal snow-cover; instead, we used the single best image from this period. The inventory identified all glaciers and perennial snowfields that were larger than 0.01 km^2, the international standard for such inventories (Paul et al. 2010). Glaciers were identified by the presence of ice and crevasses; perennial snowfields do not have crevasses. We examined the past 20 years of aerial and satellite imagery in Google Earth to ensure that the absence of crevasses was not due to temporary snow cover. The updated inventory includes 39 glaciers (11.8 km^2 [4.6 mi^2]) and 69 snowfields (2.3 km^2 [0.9 mi^2]).

Since the initial mapping of glaciers by the USGS, 20 glaciers have disappeared, meaning they were smaller than our minimum threshold of 0.01 km^2, showed no movement, or no snow or ice was present. In the Cascade Range, those glaciers included Thayer on North Sister; Irving, Skinner, Carver, and Clark on South Sister; Palmer on Mount Hood; and Lathrop on Mount Thielsen. Benson Glacier, the last glacier in the Wallowa Mountains, also was lost. Lathrop Glacier is a particular case in that it always has been smaller than the minimum area threshold, but we include it here for completeness. The differences between the inventories, in terms of both number and area of glaciers and perennial snowfields, are probably somewhat inflated because the USGS imagery was taken during a single summer and the resulting maps may have overestimated the area of some glaciers and snowfields due to remnant seasonal snow.

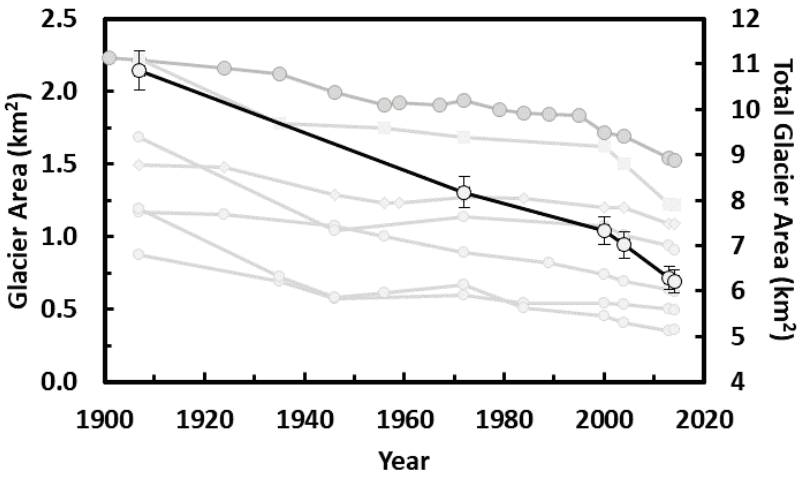

Figure 2. Total area of glaciers on Mount Hood (black line) and the area of the seven major glaciers on the mountain. The photographic record of Eliot Glacier (highest line) since 1990 is the most extensive. The six points on the total-area line indicate the years for which the area of all seven glaciers can be estimated from photographs.

An analysis of glaciers on Mount Hood and the Three Sisters paints a more accurate picture of glacier change in Oregon. Mount Hood (3426 m [11,240 ft]), a volcano east of Portland, hosts seven major glaciers and has the most extensive glacier cover in the state. We used historic photographs and more recent aerial imagery to compile a history of change in glacier area on Mount Hood (Jackson and Fountain 2007). The glaciers have retreated since 1907. Most stabilized or advanced slightly in the 1960s and 1970s. Then retreat continued, and accelerated in the 1990s (Figure 2). In 1907, the combined area was 10.85 ± 0.43 km^2 (4.19 ± 0.17 mi^2), and the sizes of individual glaciers varied from 2.22 km^2 (0.86 mi^2) (Eliot and Newton Clark glaciers) to 0.87 km^2 (0.34 mi^2) (Reid Glacier). By 2014, the total area shrank to 6.21 ± 0.26 km^2 (2.40 ± 0.10 mi^2), with individual sizes from 1.52 km^2 (0.57 mi^2) (Eliot Glacier) to 0.36 km^2 (0.14 mi^2) (White River). The pattern of retreat of Eliot Glacier, the largest and most extensively studied glacier on the mountain (Figure 3), is characteristic of glaciers in the Northwest.

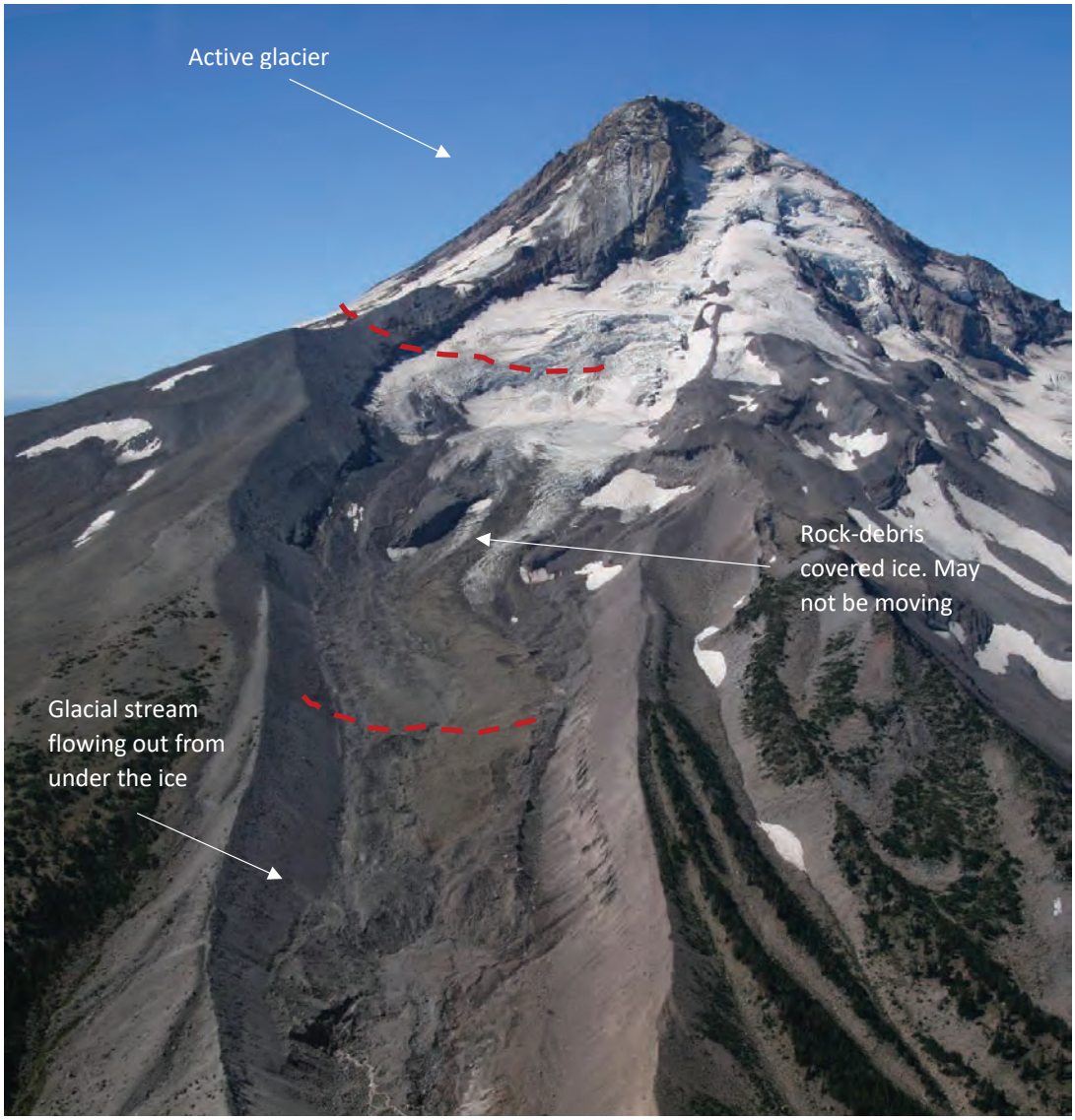

Figure 3. Eliot Glacier on Mt. Hood on 24 August 2007. Note the rock debris-covered ice lower on the glacier. This ice may not be moving and would not be considered part of the glacier. The upper dashed line is the current (2022) extent of the active ice-exposed glacier. The lower dashed line is the current extent of the buried ice. Photograph by John Scurlock.

The other most glacier-covered region in Oregon is the Three Sisters. In 1900, the total area of the 15 glaciers on the Three Sisters, estimated on the basis of geologic evidence left by the glacial moraines, was about 11.7 km^2. By 2018, the total glacier area was 3.0 km^2 (1.2 mi^2), excluding the four glaciers that had become perennial snowfields (Carver, Clark, Irving, and Skinner). Similar to the glaciers on Mount Hood, the glaciers retreated during the early half of the twentieth century, advanced in the late 1950s and 1960s, then resumed retreating, with accelerated retreat starting around 2000 (Figures 4, 5).

The overall change in the glaciers reflects the climate of the Northwest. A global cool period, the Little Ice Age, ended in the mid-late 1800s, and the warmer climate led the glaciers to recede through the early 1900s (O'Connor et al. 2001, Koch et al. 2009, Miller et al. 2012). A cool period during the 1950s and 1960s caused the glaciers to either stop receding or advance somewhat (Hubley

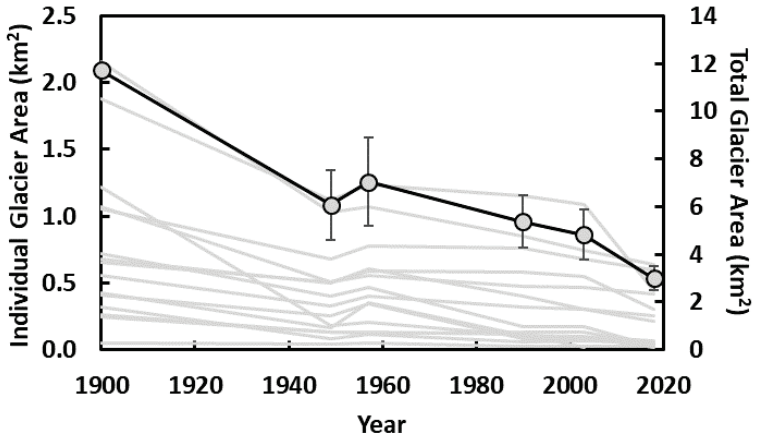

Figure 4. Change in the area of glaciers on the Three Sisters. The solid black line indicates the total glacier area and the light grey lines the area of individual glaciers.

Figure 5. Paired images of the Collier Glacier on North Sister. Top: Collier Glacier, 2020. Bottom: 2020 image with an inset of the glacier in 1934. 1934 photograph by Ruth Hopson Keen; 2020 image by Andrew Fountain.

1956, Lillquist and Walker 2006). Since then, retreat of the glaciers has continued, and accelerated in the 1990s (Hodge et al. 1998, Lillquist and Walker 2006, Jackson and Fountain 2007). Some of this retreat is due to anthropogenic climate warming (Barnett et al. 2008, Fountain et al. 2022).

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The PRISM Climate Mapping System and CoCoRaHS Community Observer Network

Christopher Daly and Noah Newman

Spatially explicit data on weather and climate, usually in the form of continuous grids of pixels, often are key inputs to decision-support systems and tools that require environmental data. These grids typically describe conditions at monthly or daily resolution, and are especially useful because their wall-to-wall estimates of weather and climate encompass areas where weather stations do not currently exist. The most widely used spatial climate data in the United States are those developed by Oregon State University's PRISM Climate Group, which is named for the PRISM (Parameter-elevation Regressions on Independent Slopes Model) climate mapping system. The PRISM Climate Group is part of the Northwest Alliance for Computational Science and Engineering (NACSE) within the university's College of Engineering.

The PRISM approach to computerized climate mapping was first developed by Christopher Daly in 1991. The PRISM algorithm was written to mimic the decisions an expert climatologist makes while mapping long-term average temperature and precipitation (Daly et al. 1994). In computer science, this kind of model is called an "expert system" (Daly et al. 2002). Since its inception, PRISM has undergone nearly constant development, and has been operationalized to produce monthly and daily time series of an expanding list of meteorological variables, including precipitation, temperature, dew point, vapor pressure deficit, and solar radiation (Daly et al. 2021, Rupp et al. 2022). PRISM simulates how weather and climate vary spatially as a function of the physiography of Earth's surface, such as elevation and coastlines, and uses novel topographic indices to identify areas that are subject to temperature inversions and rain shadows (Daly et al. 2008). Each PRISM grid covers the conterminous United States with millions of grid cells, each

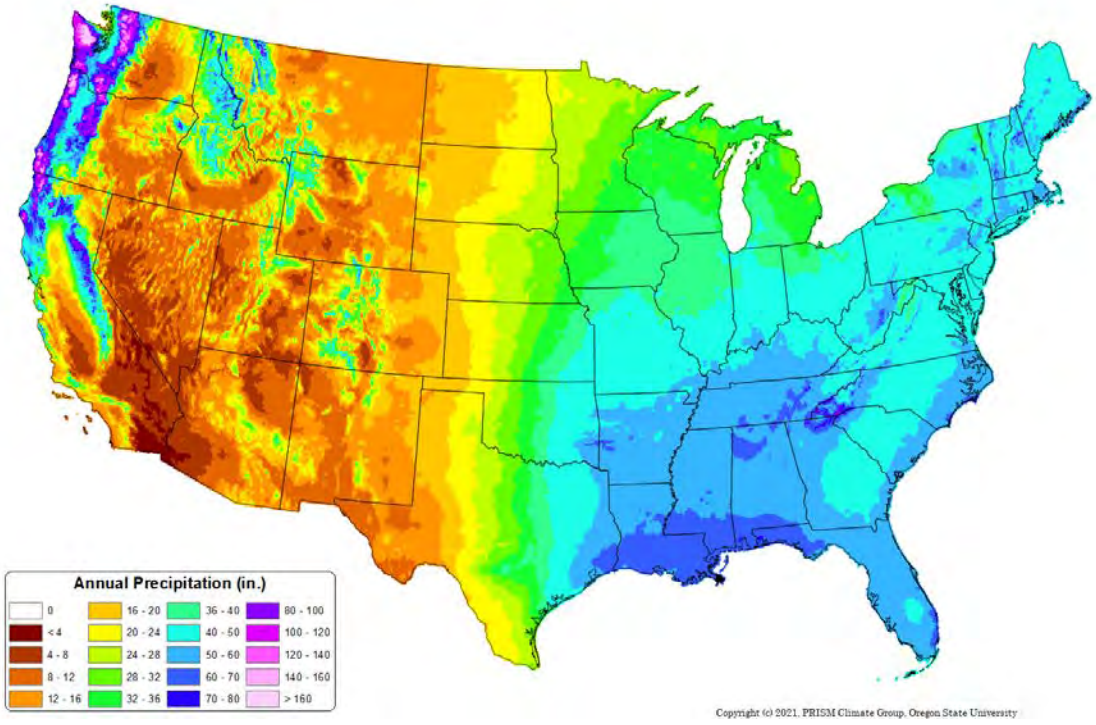

Figure 1. PRISM 1991–2020 normal annual precipitation for the conterminous United States.

approximately 800 x 800 m (1/2 x 1/2 mile), and also at 4 x 4 km (2.5 x 2.5 mile) resolution (prism.oregonstate.edu; Figures 1 and 2).

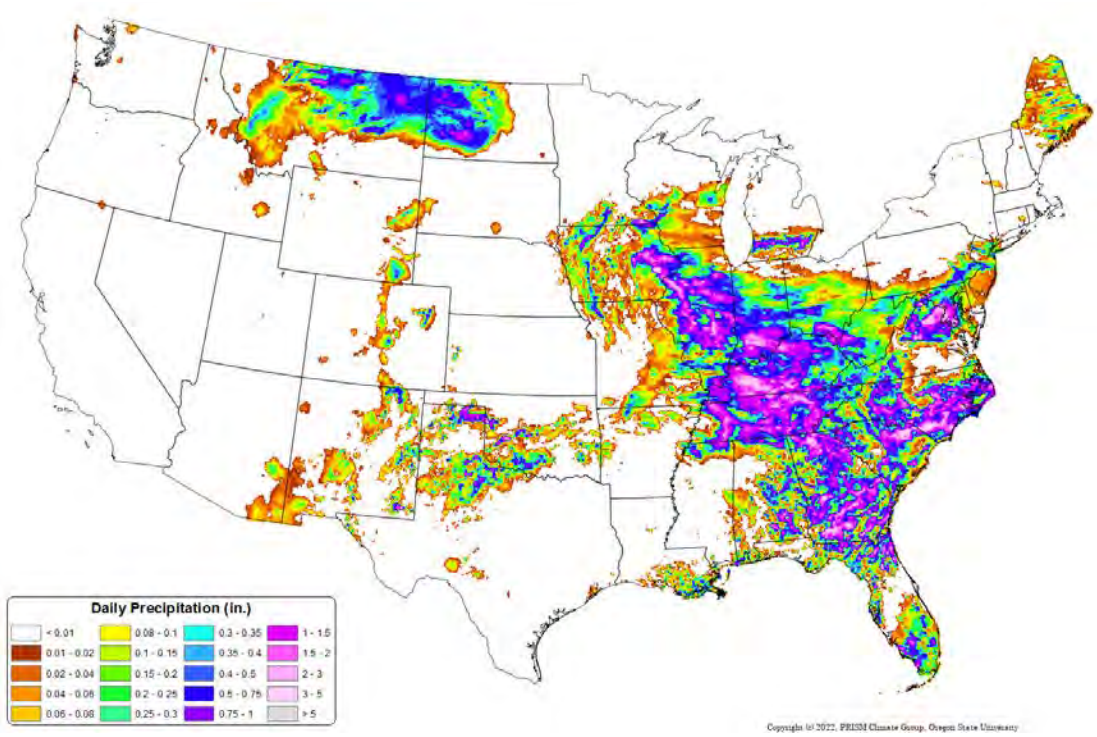

Figure 2. PRISM total daily precipitation on 9 July, 2022, for the conterminous United States.

Users download approximately one million PRISM spatial datasets each month from PRISM's public website (prism.oregonstate.edu). Nearly all U.S. government agencies use PRISM data. Furthermore, the private sector applies PRISM data to agriculture, hydrology, engineering, ecology, economics, and retail. The PRISM Climate Group developed the 2012 U.S. Department of Agriculture Plant Hardiness Zone map, which has been accessed millions of times by gardeners, farmers, horticulturists, and others (Daly et al. 2012). Moreover, the U.S. National Weather Service (NWS) and The Weather Channel have used PRISM data to guide the spatial patterns of their weather forecasts. Peer-reviewed scientific papers on PRISM have been cited in over 14,000 publications.

Contributions of the CoCoRaHS Community Network

Development of accurate, detailed, spatially explicit weather and climate data relies on a large quantity of high-quality station data. Each day, the PRISM Climate Group compiles data from more than 20,000 precipitation and 10,000 temperature stations that are members of federal, state, or regional networks. Because precipitation is sporadic and highly variable, particularly dense data are necessary to accurately quantify precipitation across large or topographically complex areas. Nearly 90 percent of the precipitation stations that contribute to the PRISM datasets are operated by community scientists, and are essential for filling gaps between automated weather stations. The largest of these community science networks is the Community Collaborative Rain, Hail and Snow network (CoCoRaHS; www.cocorahs.org), operated by the Colorado Climate Center.

CoCoRaHS's 25,000 active volunteers in all states, territories, and provinces in the United States and Canada measure and report precipitation from their selected locations, primarily residences but

increasingly schools, libraries, public parks, and workplaces. The network documents approximately 14,000 observations of precipitation or its absence each day, including more than 400 in Oregon (Figure 3). CoCoRaHS has grown from a local community project in Colorado, which began after a flash flood in 1997, to the largest source of daily, manual precipitation measurements in the United States (Reges 2016). With the goal of creating a dense network of high-quality precipitation data, CoCoRaHS volunteers have now submitted over 55 million daily reports that are used by the National Oceanic Atmospheric Administration (NOAA) and its many entities (NOAA 2021). For example, NWS incorporates CoCoRaHS data into daily operational products, and the National

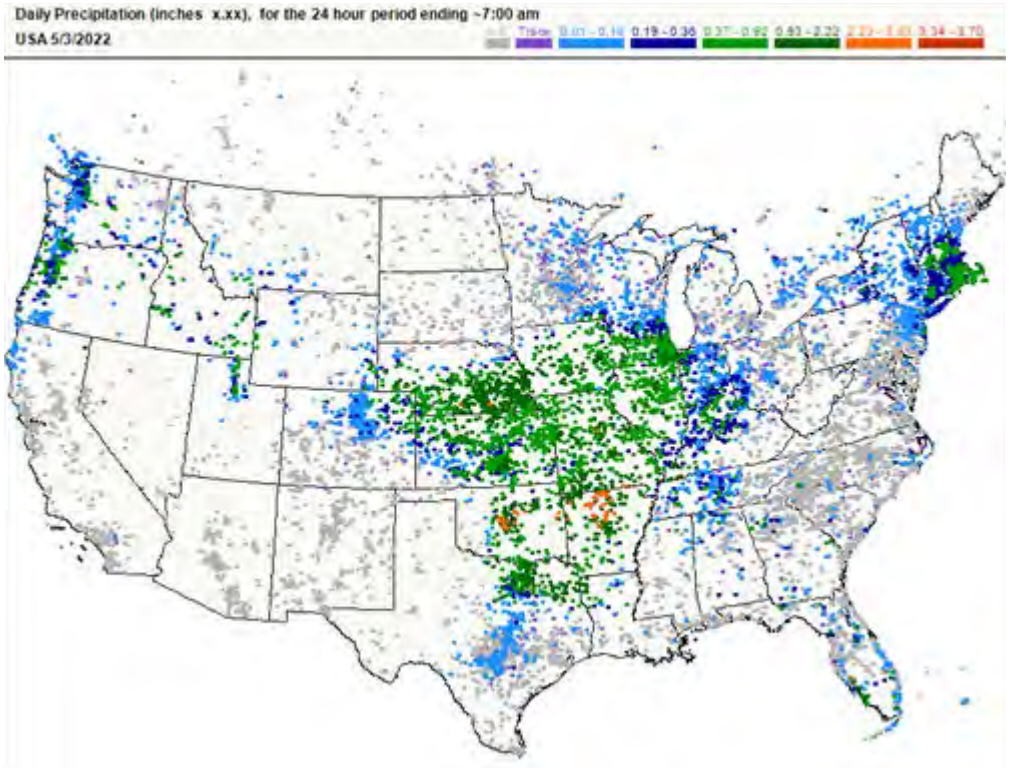

Figure 3. Data from CoCoRaHS observers documented the 24-hour precipitation totals ending at 7:00 a.m. local time on 3 May, 2022.

Centers for Environmental Information (NCEI) uses CoCoRaHS data in its climate research. CoCoRaHS also provides tools that enable volunteers to perform their own analyses, such as comparing monthly precipitation totals to 30-year PRISM averages for their locations (Figure 4).

CoCoRaHS observers measure not only rain but snowfall, snow depth, snow water equivalent (SWE; the amount of water in the snowpack), and hail size and amount. These measurements of SWE account for more than half of the ground-based observations used by NWS for its hydrologic models and predictions. Additionally, many observers submit notes with their observations, which can help to confirm an unusual rainfall or snowfall report during the quality assurance process. If a question about an observation remains, the CoCoRaHS quality control meteorologist is able to contact the observer directly to confirm the observation. This level of validation rarely is possible when data are gathered by automated weather stations rather than stations staffed by people.

CoCoRaHS requires volunteers to use a particular manual gauge that meets NWS standards and conducts extensive quality control and quality assurance processes, both automated and manual.

The CoCoRaHS leadership provides numerous engaging slideshows and videos that train observers on best practices, which helps to ensure that the measurements and reporting are consistent. Furthermore, NCEI performs their own quality assurance processes before data are disseminated to the NWS.

In 2021, NCEI completed their scheduled, decadal update of 30-year climate normals to cover the years 1991–2020. Although no CoCoRaHS station has been operating for 30 years yet, NCEI uses alternative methods to calculate normals on the basis of shorter periods of data. For the first time, data from CoCoRaHS stations were included in the updated normals; NCEI classified 4688 stations as pseudo-normal and 760 as provisional normal. To qualify for pseudo-normal status, data for every day in a given month in at least two years must be available. To qualify for provisional normal status, data for every day in a given month in at least ten years must be available. For data users, the updated normals are analogous to U.S. Census data. In the development of PRISM gridded normals for 1991–2020 (e.g., Figure 5), an activity separate from that of NCEI, 5419 CoCoRaHS stations qualified for inclusion for at least one month of the year. For a given month to be included in the PRISM normals, at least ten years or five years of complete data (for stations in the eastern and western United States, respectively) must be available. Inclusion of the CoCoRaHS data in the NCEI station normals and the PRISM gridded normals allows users to compare present-day conditions to long-term averages more thoroughly (Figure 4).

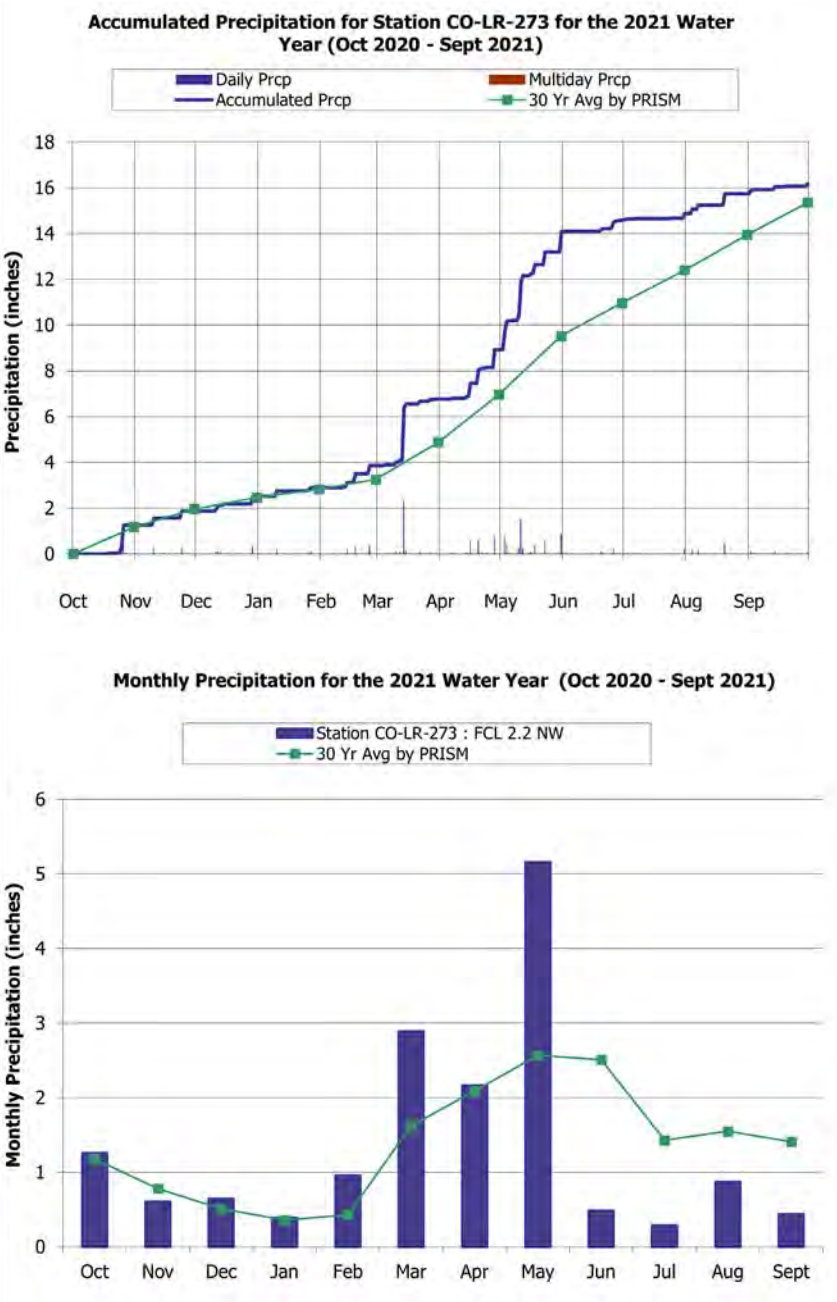

Figure 4. CoCoRaHS observers have immediate access to data analysis tools that are also available publicly, such as tools for summarizing total monthly precipitation (top) and long-term modeled average precipitation (bottom) for a given location.

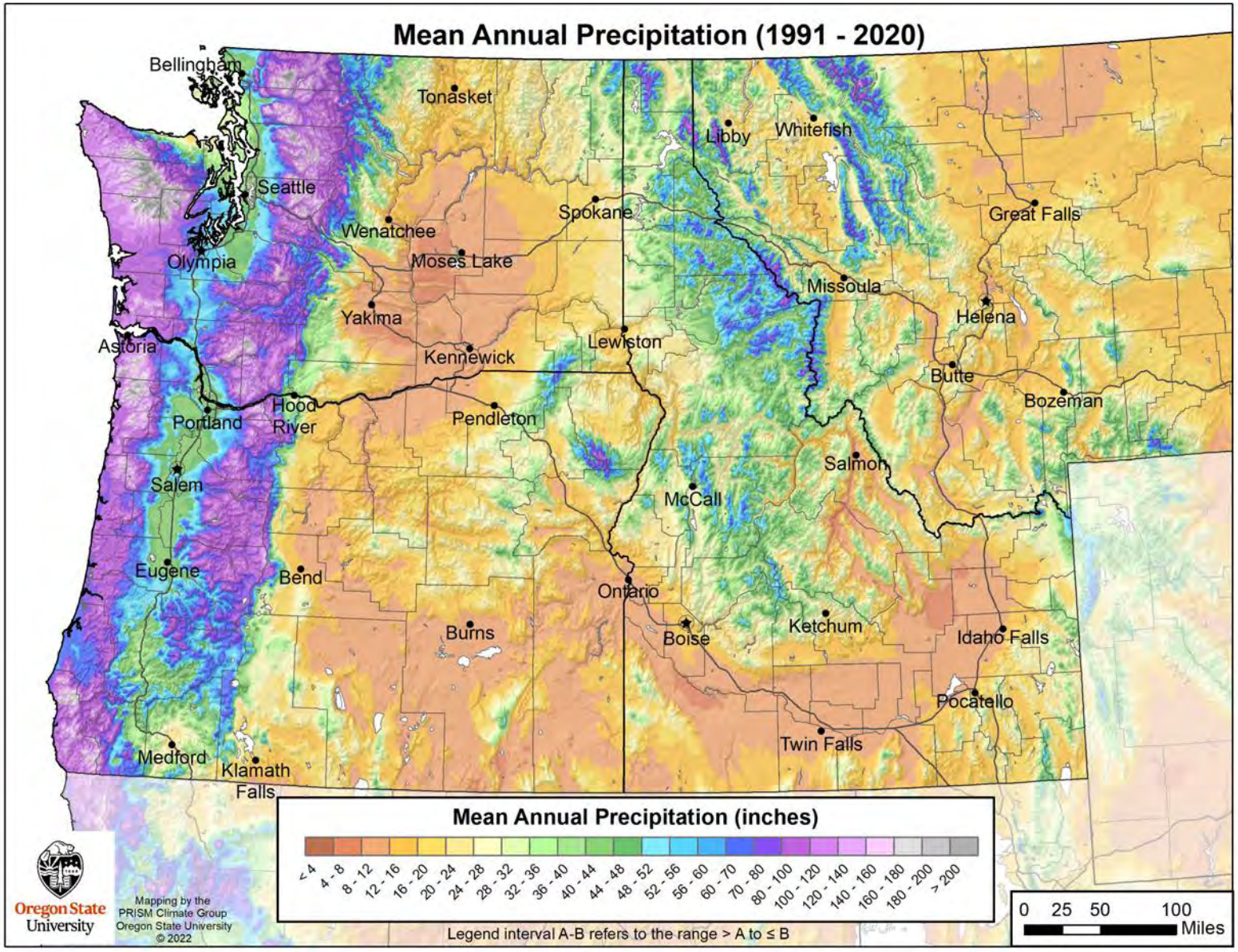

Figure 5. PRISM 1991–2020 normal annual precipitation across the Northwest.

After 24 years, the CoCoRaHS network of dedicated, volunteer observers has contributed to remarkable advances in understanding and application of meteorology and climatology. Municipal water managers use CoCoRaHS daily reports to assess supply and demand, while NWS River Forecast Centers use the daily reports as inputs to their flow prediction models. Stations with complete data over weeks, month, seasons, or years are of considerable value for agricultural applications such as the U.S. Drought Monitor, and for research on tropical storms and atmospheric rivers. The role of community science networks such as CoCoRaHS in improving the quality and detail of PRISM data cannot be overstated. Given the diverse use of PRISM data, community science weather networks have extraordinary, positive impacts throughout science and industry.

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How Community Science Benefits Everyone's Understanding of Snow and Water Resources

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Learning About Snow and Water

Storage of water in the form of seasonal snowpack is a substantial component of the hydrologic cycle. The peak snow water equivalent (SWE) of the western United States has been estimated at 150 km^3 and that of North America at nearly 1700 km^3 (Mote et al. 2018, Wrzesien et al. 2018). An understanding of the distribution and evolution of this snowpack is important for many reasons, such as water resources planning (Li et al. 2017), hazard mitigation (Morin et al. 2020), ecosystem function (Winchell et al. 2016), economic benefit (Lundquist 2018), and hydrosphere and cryosphere modeling (Dutra et al. 2012). In the Pacific Northwest, snow and water are considerable hydrologic inputs. Oregon receives about 700 mm (28 in) of precipitation per year, averaged over the state, and Washington about 1000 mm (39 in) (Wang et al. 2016). In a typical year in Oregon, about 15 percent of that precipitation falls as snow.

Precipitation, evapotranspiration, streamflow, and other components of the hydrologic cycle can be measured or estimated in the field or with remote sensing or computer model simulations. Many of the field measurements of snow in the United States come from Snow Telemetry (Schaefer and Johnson 1992) (SNOTEL), Soil Climate and Analysis (SCAN), and Snow Course Data (SCD) networks operated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), state snow-survey programs, and state departments of transportation. Some of the data from these sources have high temporal resolution (daily or sub-daily; e.g., automated snow pillow sites), whereas others have low temporal resolution (monthly; e.g., snow course). Field observations typically have low spatial resolution due to the costs associated with installation and maintenance of equipment. Because vehicular access generally is necessary for installation and maintenance, data from field observations also tend to under-sample high-elevation regions with complex terrain and few roads, especially four-season roads.

Remotely sensed data on snow can come from sources including airborne light detection and ranging (LIDAR) (Painter et al. 2016), unpiloted aerial vehicle (UAV) LIDAR (Jacobs et al. 2020), satellite LIDAR (Abdalati et al. 2010), visible-range imagery (Painter et al. 2009), and radar (Gusmeroli et al. 2014). The spatial resolution of these data can be quite high, e.g., on the order of 1 m (3 ft) for airborne LIDAR. The spatial extent of the data depends on the platform. Airborne measurements are local-to-regional, whereas satellite platforms can offer near-global coverage. A disadvantage of remotely sensed measurements is their comparatively low temporal resolution. For example, the Ice, Cloud, and Elevation Satellite (ICESat-2) mission (Neumann et al. 2019) captures an image of a given location every 91 days.

Simulation models (Essery et al. 2013) of snowpack processes can fill the spatial and temporal gaps in remotely sensed and field data. Because these models can make real-time predictions (Franz et al. 2008), they also have considerable operational value to diverse users, including avalanche forecasters and water managers. Models can be run at a wide range of spatial and temporal resolutions, and this flexibility means they can meet the needs of different stakeholders. Additionally, models exist on a spectrum of physical process representation: some models are simple and fast because they do

not directly simulate complex processes and instead use approximations, whereas other models are much more complex because they attempt to reproduce many or all of the processes occurring in the real world. In snow hydrology, energy balance models use either weather station data or modeled estimates of weather data to estimate energy fluxes and surface hydrologic processes. In these models, snow functions as an input (precipitation), a state variable (the entity being modeled), and an output (e.g., meltwater that runs off), and reliable snow information must be available for accurate model calibration and validation.

Public Participation in Snow and Water Programs

Public participation in the design and implementation of science, or *community science*, is a powerful means of increasing the scope and capacity of data collection. The number of permanent or fixed measurement stations is limited (Roy et al. 2012 , Crall et al. 2015). Members of the public, who usually are volunteers, can collect data at times and places not covered by fixed-station networks. Data from community scientists can be opportunistic in the sense that they are collected during unrelated activities that those individuals already had planned. Alternatively, data collection can be more directed in the sense that a participant designs and then follows a sampling program.

Compilation of physical environmental data from the public is far from new. For example, the Cooperative Observer Program (COOP) (Leeper et al. 2015) of the U.S. National Weather Service, which began in 1891, currently has more 11,000 contributors. The Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) (Reges et al. 2016), launched in 1998, has grown into a large national network of observers who measure rainfall, snowfall, and hail. In the narrower context of seasonal snow and ice, there have been previous efforts to document snow cover with smartphones, and studies of how high-elevation mountaineers and alpinists can inform science on the basis of their field observations (Carey et al. 2016, Dickerson-Lange et al. 2016). The Global Learning and Observations to Benefit the Environment (GLOBE) program, which was launched in 1994 and is sponsored by the National Aeronautics and Space Administration (NASA), also has a protocol for snow observations. GLOBE observations tend to be associated with school programs and other home-based observers (similar to CoCoRaHS), and are generally representative of comparatively low elevations. Additional examples include efforts to collect data on precipitation phase (rain or snow) (Elmore et al. 2014, Arienzo et al. 2021).

Community science has a distinct set of opportunities and challenges. There is evidence that community science democratizes access to science and encourages scientific literacy (Bonney et al. 2016, Garbarino and Mason 2016, Mitchell et al. 2017). Additionally, the measurements can be comparatively low cost and have the potential to increase the spatial extent of data. The data are provided by volunteers who have the resources and skills (or obtain the skills with minimal training) to collect the data at home or in the field and transmit them to the project team. However, networks of data collected by the public can be decentralized and unstructured. Although some programs, such as GLOBE and CoCoRaHS, prioritize repeated measurements at the same locations, other programs, such as mPING (Elmore et al. 2014), are opportunistic and depend on decisions about the location and time of measurement that are made by the data collectors. A project team can offer suggestions about where and when to sample, but ultimately must rely on decisions made by the participants. Another challenge is controlling data quality. Protocols can be developed, tutorials provided, and quality control methods implemented post-submission, but ultimately, measurements are contributed by a diverse body of individuals with different levels of experience.

Learning from the Success of Community Snow Observations

The Community Snow Observations (CSO; communitysnowobs.org) project (Hill et al. 2018) was launched in late 2016 with the goal of developing a global, public network of individuals who collect and submit measurements of snow depth. Although anyone can participate, the project has prioritized participation by backcountry recreationists (e.g., skiers, snowmobilers, snowshoers) and snow professionals (e.g., ski patrollers, avalanche forecasters) who regularly visit high elevations with complex terrain. The primary goal of the CSO project is to evaluate how public participation in the collection of snow information can improve models of snowpack evolution and distribution (Crumley et al. 2021). Assimilation of research-grade measurements into snowpack models can improve the accuracy of those models (Largeron et al. 2020). A parallel goal of the CSO project is to engage the public in understanding and appreciating snow and water resources.

Below, we review the structure of and participation in the CSO project, including where, when, and how frequently participants contribute data. We then compare CSO data to a wide variety of snow products available from NASA and the National Oceanic and Atmospheric Administration (NOAA) to illustrate how community science data might be used to validate national and global snow data. We demonstrate how these community measurements improve scientists' ability to model snow, and illustrate the informational and educational products that are returned to participants.

Program Components

The CSO project has six primary components: a program to recruit and retain community scientists; instrumentation for measuring snow depth in the field; mobile and desktop applications for recording and submitting measurements; web services for gathering, displaying, exploring, and downloading participant data online; a modeling environment for assimilating public measurements into snowpack estimates; and a web-based application for visualizing model results in real time.

Participant Recruitment

The CSO project recruits three general categories of participants. The first category, which encompasses the majority of CSO participants, includes winter recreationists, such as backcountry skiers, snowboarders, snowshoers, and snowmobilers. These individuals participate in CSO as part of their recreation in the backcountry. We reach these participants through frequent presentations at snow and avalanche workshops, public meetings, and backcountry festivals hosted at ski areas. We also publish regularly in mass media and outdoor-oriented periodicals (Hill 2018, Lintilhac 2018, Menzel 2020). Our social media platforms and project website allow us to reach additional recreational participants. Our second major category of project participants includes snow professionals, such as avalanche forecasters and ski patrollers, who record snow depth as part of their own work. We reach these participants partly through articles about the project that we publish in trade magazines (Hill 2019, Hill and Redpath 2020). Our third category of participants is students in outdoor education programs that run winter classes. The students in these programs, which include Winter Wildlands Alliance's SnowSchool, Teton Science School, and National Outdoor Leadership School (NOLS), have diverse snow and backcountry knowledge.

To retain participants, our project team creates and disseminates snow products, such as images and animations, that are related to the snow conditions at the locations where participants collect and submit data. We also provide educational materials about snow science, including how snow is distributed and evolves, and snow data sources.

Field Snow Measurements

Complex measurements with specialized equipment can be a barrier to community science (Kleinke et al. 2018). Equipment costs may discourage new users altogether (Ryan et al. 2018), and even with low-cost instrumentation, lengthy measurements may deter participation by recreationists. Therefore, the CSO project focuses only on snow depth (Hs) rather than on variables that are more complex and time-consuming to measure, such as snow water equivalent (SWE) or albedo. The primary tool for CSO participants is an avalanche probe (Figure 1), a vital piece of safety equipment carried by backcountry snow enthusiasts. The design of probes varies among manufacturers, but most are 3 m long and have markings every 1 cm. They are compact, easy to deploy (similar to a segmented tent pole), and relatively low cost. Participants who do not have a probe can easily use a meter stick, or a tape measure affixed to a ski pole or other rigid pole. Protocols and tutorials on the CSO website explain how to measure snow depth properly. Key elements include making multiple measurements within a few square meters of undisturbed snow to obtain a reliable average depth for that area.

Figure 1. Measuring snow depth at Hatcher Pass, Alaska.

Recording and Submitting Measurements

CSO requires geolocated and time-stamped snow depth measurements. To maximize participation, CSO offers both mobile and desktop platforms for submitting these measurements (Figure 2). Mobile applications are the best choice for most participants because only a smartphone is required. Other participants, such as avalanche forecasters, who commonly record data in a field notebook often prefer a desktop application that allows them to submit data later from their home or office. The different platforms have different interfaces, enabling participants to choose the platform with which they are most comfortable. Multiple platforms also create redundancy, so data can be submitted when one platform is offline for maintenance or upgrades.

Four platforms currently are in use by the CSO project (Figure 2): Mountain Hub, CitSci.org, SnowPilot, and RegObs. CSO partnered with Mountain Hub (app.mountainhub.com), founded in 2015 as an adventure-sharing social platform, to customize its app for collecting and reporting snow information. Mountain Hub was acquired by Mammut Inc. in 2018 and then by CSO in 2020. This acquisition gives CSO control over the brand's social assets and the flexibility to introduce future improvements and upgrades for data collection by the public. The app (iOS and Android) allows users to quickly log snow depth and other parameters while in the field. If a user is out of cell phone range, the app will store the data and upload them when cellular or wireless service is reacquired.

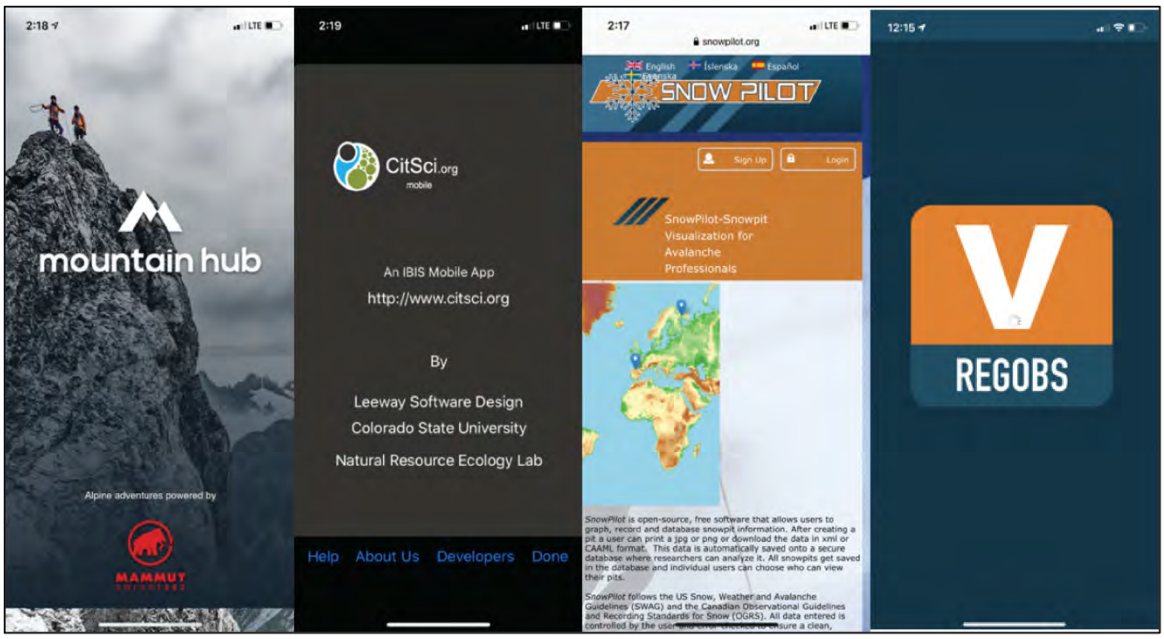

Figure 2. Platforms developed to support submission of data by Community Snow Observations participants.

CitSci.org, founded by the National Renewable Energy Laboratory (NREL) with support from the National Science Foundation, hosts approximately 1000 projects through its website and mobile application. Users can access the CSO project through the CitSci app (iOS and Android) and record data in the field. SnowPilot (www.snowpilot.org), a desktop application, is preferred by practitioners in the snow safety industry. Although much of the information that SnowPilot collects is beyond the scope of CSO, SnowPilot often is used to submit data on total snowpack depth. RegObs (www.regobs.no) is a public app developed in part by the Norwegian Water Resources and Energy Directorate. The app allows users to receive warnings and to submit observations about weather, natural hazards, and ground conditions, including snowpack depth. RegObs has global coverage and is available in many languages. [See *Addendum* below for an update on data submission platforms.]

Project Data Infrastructure

The CSO project has developed a data infrastructure for managing snow depth measurements submitted via any of the supported platforms. This infrastructure is hosted by a commercial cloud provider. CSO programs query snow depth data from the application programming interfaces, filter them on the basis of first-order data quality thresholds, and integrate them into a database. A web map application (Figure 3) allows the user to interact with, visualize, and download the data.

Snowpack Modeling

Many snow modeling efforts are intensive, watershed-level campaigns in which the watershed is heavily instrumented with sensors that provide information about weather and snowpack parameters. In contrast, the CSO project adopted an unstructured approach that is driven by where participants travel and measure snow; we welcome the "anytime, anyplace" approach to data collection by participants. The detailed model workflow (Figure 4) is described in Crumley et al. (2021). In brief, we use Micromet (Liston and Elder 2006b) and SnowModel (Liston and

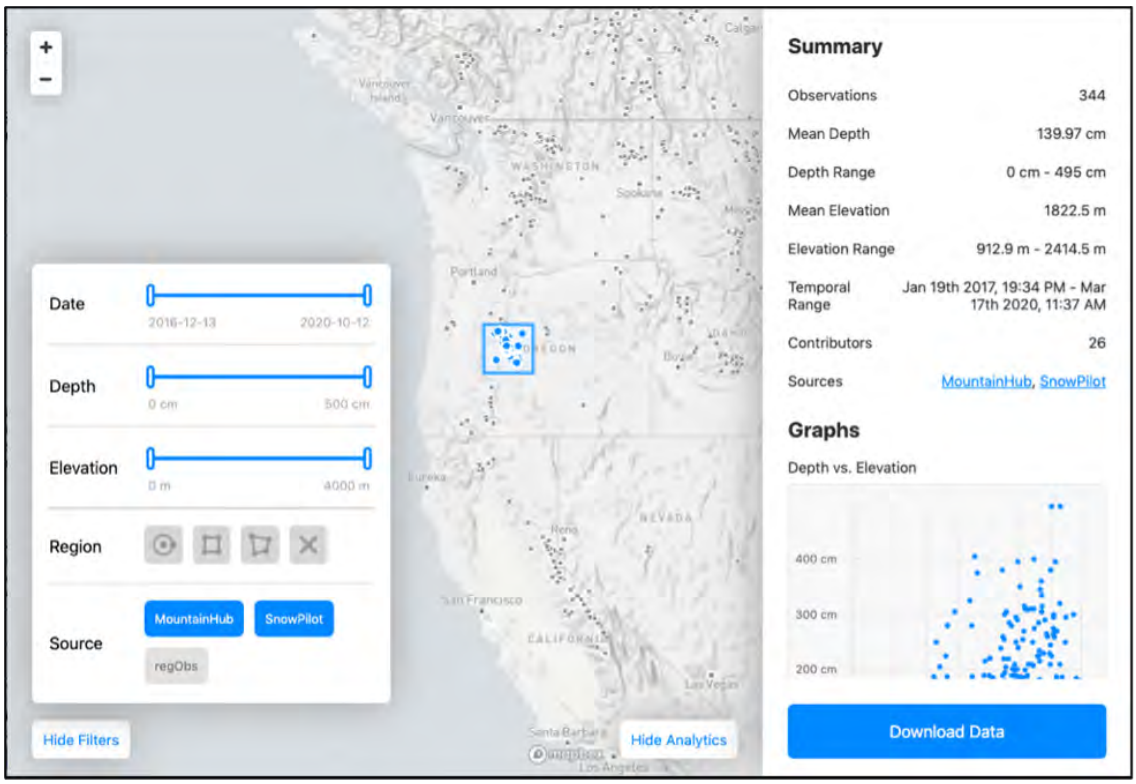

Figure 3. The Community Snow Observations web map application for visualizing, exploring, and downloading project data.

Elder 2006a), which are physically based models that interpolate weather data to a high-resolution (typically 30–100 m) model grid and evolve the snowpack, respectively. To rapidly set up new model applications, we have developed freely available scripts and digital notebooks that fully automate the acquisition of weather, terrain, and land-cover data for a prescribed area and time period; obtain weather and snowpack data for calibration; and automatically calibrate the model.

The next step in the modeling process is to use SnowAssim (Liston and Hiemstra 2008) to assimilate the data submitted by community scientists. The participants' measurements are compared to the model estimates and a set of corrections are created to adjust the model simulations on the basis of the observations. With our data-driven approach, the CSO project can implement model simulations in areas where project participation is high and where calibration data exist.

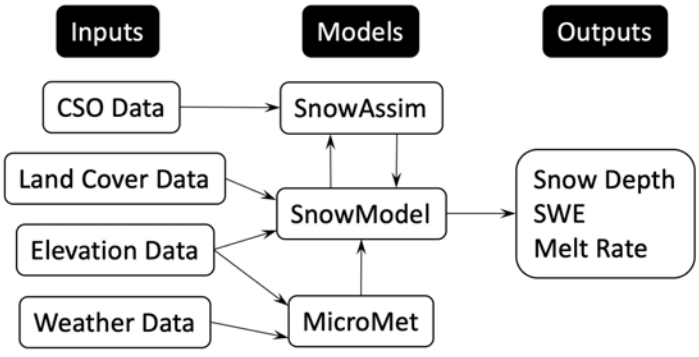

Figure 4. Workflow for snowpack modeling with assimilation of community science data.

Real-Time Web Application

In many community science projects, participants function solely as data collectors, and there is little return of information from the science team to the participants. By contrast, the CSO project aims to deliver to participants high-value information, in real time, on snow distribution and other interesting variables. This delivery initially was

accomplished in summer 2021 with the launch of MountainSnow (Figure 5) (www.mountainsnow.org). At this website, anyone can view and interact with the real-time modeling results in currently supported model domains. We regularly add new domains in areas where a high number of snow-depth submissions suggests a strong demand.

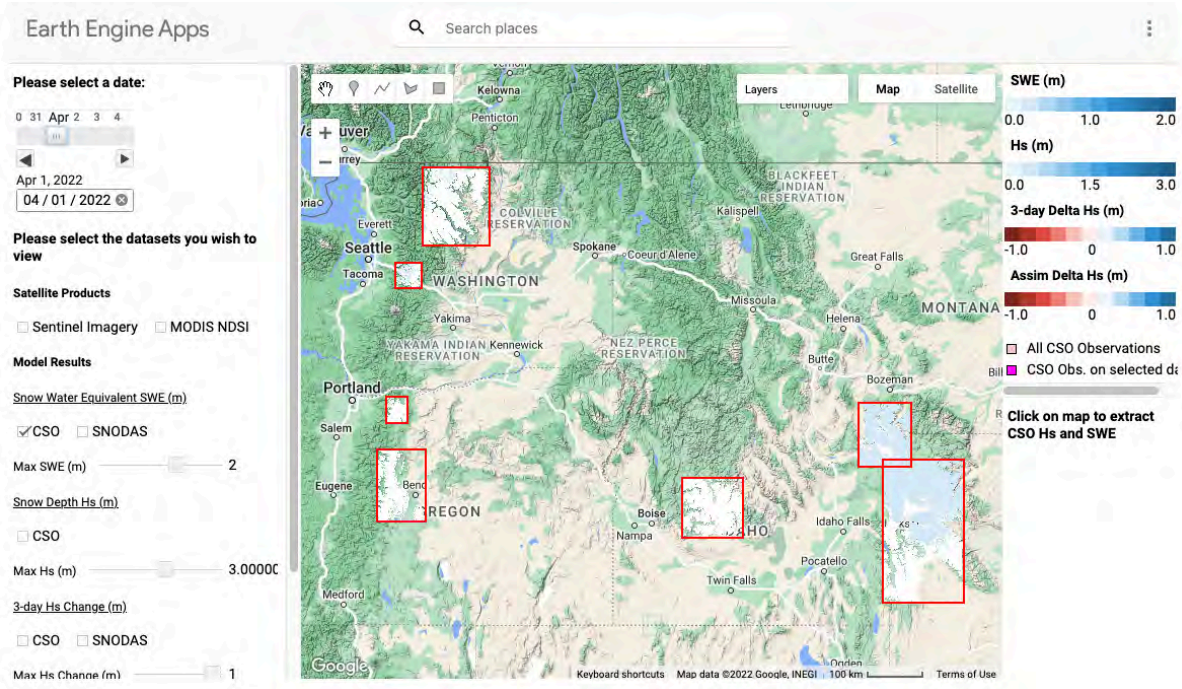

Figure 5. Sample image from the MountainSnow website.

At MountainSnow, users can view the CSO model data, satellite products related to snow cover, and other information such as the three-day change in snow depth. In addition to viewing maps of snow information, users can click on any location of interest to see the snow values there. Users also can view how participants' measurements improve the snow modeling process. We believe that this return on investment is a useful way to attract new participants and to educate, motivate, and retain current participants.

Results

Participation

From project inception through July 2022, more than 4000 unique participants submitted nearly 32,000 observations (Figure 6). Although CSO is a global program, the majority of our submissions come from the Northern Hemisphere, as reflected in the seasonality of observations. In Oregon, there have been nearly 900 measurements by 83 individual participants and in Washington, there have been over 600 measurements by 114 individual participants. The slight decrease in submissions during the 2019–2020 snow season can be attributed to the COVID-19 restrictions that curtailed access to many public lands, such as national forests and national parks, used by winter recreationists. The majority of CSO observations have been submitted by a small number of highly active participants: globally, 555 participants have submitted more than 10 measurements, 120 have submitted more than 50, and 49 have submitted more than 100. In Oregon, 16 participants have submitted more than 10 measurements, four have submitted more than 50, and three dedicated

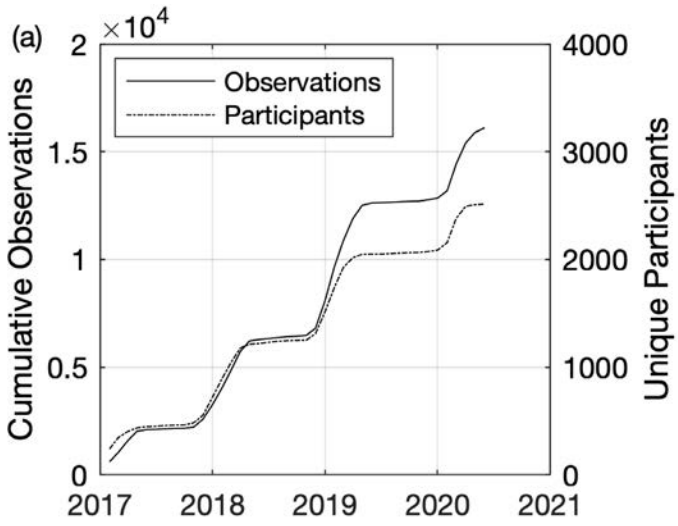

Figure 6. Cumulative number of Community Snow Observation submissions and number of unique participants since project inception.

participants have submitted more than 100 measurements.

To date, participants have submitted measurements from more than 30 countries, primarily within North America and Scandinavia (Figure 7). The geographic distribution of measurements is consistent with the fact that Mountain Hub, CitSci.org, and SnowPilot are based in the United States and RegObs was developed in Norway. Prior to the acquisition of Mountain Hub by CSO in summer 2020, CSO did not have email addresses of participants using that platform. Therefore, we have little information on the demographics (e.g., gender, age, race) of project participants. In the future, we hope to collect this information through participant surveys so that we can better understand who is choosing to participate in our program and aim to diversity the group of participants.

Inclusion of CSO Data in Snowpack Modeling

A complete demonstration of how the inclusion of community snow-depth data improves snow model estimates is available in Crumley et al. (2021). Here, we provide an example from a SNOTEL site in the Wasatch Mountains east of Salt Lake City, Utah (Figure 8). Snow water equivalent (SWE) varies throughout the water year, from 1 October (day 0) through 30 September. Day 180 corresponds to about 1 April. Data from the SNOTEL site demonstrate that snow accumulates steadily until early April, and then melts rapidly (red line). When we calibrate our model and do an "open loop" run, which does not include participant data, the model underestimates the snowpack (blue line).

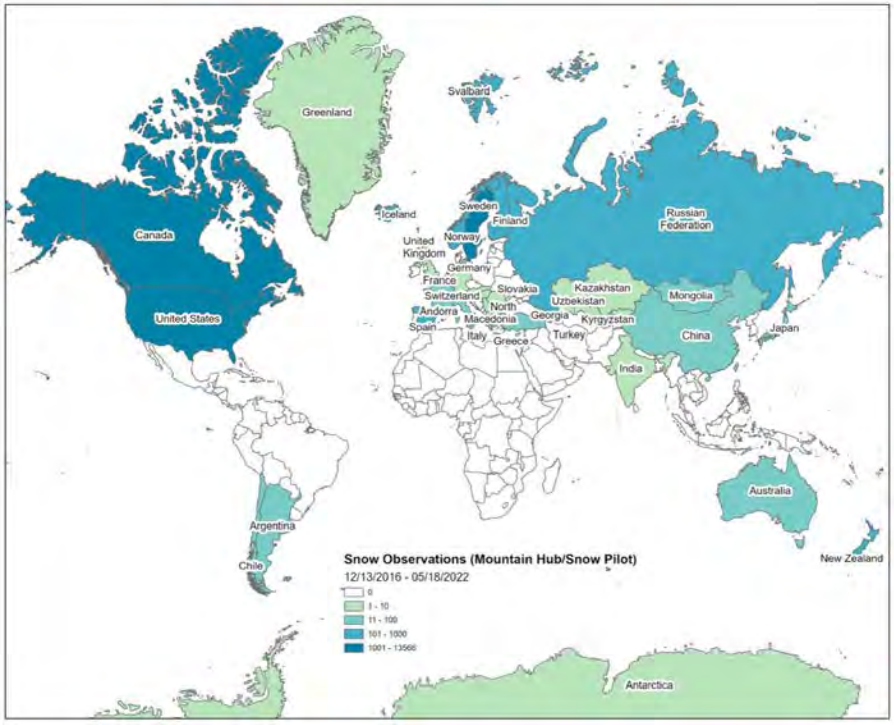

Figure 7. Geographic distribution of CSO submissions from 2016–June 2022. Shading reflects the number of submissions received from each country.

There are many reasons for the underestimate, including unresolved physical processes, biases in weather forcing data, and errors in the numerical modeling process.

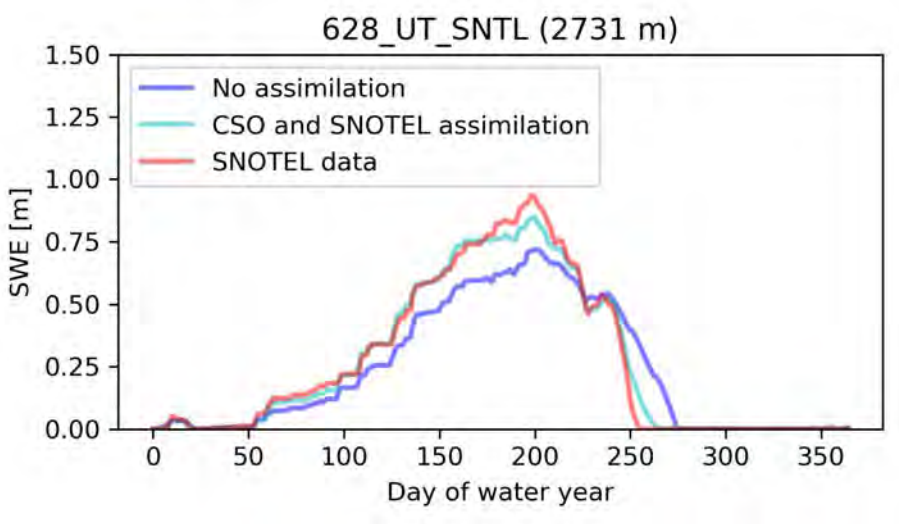

Figure 8. Example of improvements in a model of snow depth at a SNOTEL station in the Wasatch Mountains, Utah, enabled by the assimilation of participant observations.

When we include (or assimilate) both the local CSO data and the SNOTEL data (excluding data from this validation station) in the model, the model output is a close match to the data (cyan line). Assimilation of participant data improves our modeling (Figure 8). We continue to compare the contributions to improvement in model accuracy from CSO data and SNOTEL data. This is valuable because SNOTEL sites are sparse. Community participation can fill these geographic gaps in data and ensure that we obtain the best possible model results for all locations. CSO observations markedly increase the diversity of terrain for which in-situ observations are available (Figure 9).

Comparison of CSO Data with Satellite Data

A variety of snow products at varying spatial and temporal resolutions are provided by the MODIS (Moderate Resolution Imaging Spectroradiometer) (Hall et al. 1995) and VIIRS (Visible Infrared Imaging Radiometer) (Key et al. 2013) satellite missions. As one example, the MOD10A1 product (Version 6) is a 500 m, daily product with a period of record that began in February 2000. One of the variables provided by the MOD10A1 product is the Normalized Difference Snow Index (NDSI). Although there is regional variability in the NDSI value associated with a snow-covered area, an NDSI value of 40 percent is an accepted global standard (Riggs et al. 2015).

CSO data points, which are typically from high-elevation locations with complex terrain, provide a unique comparison with the MOD10A1 product. Unlike CoCoRaHS or NASA GLOBE, which frequently report both zero snow depths and positive snow depths, most CSO data reflect positive snow depths, and often considerable snow depths. Therefore, we hypothesized that the location and time of CSO submissions are reliable indicators of snow-covered areas. To evaluate this hypothesis, we extracted the NDSI values at CSO submission locations for two seasons. Of the 4000 CSO measurements, 1298 could be associated with NDSI values; the balance appeared to be made under cloudy skies that prevented satellite observations. Our results were consistent with the assumption that NDSI >40 indicates a snow-covered region (Figure 10). Only 6 percent of the CSO measurements have an NDSI less than this threshold value.

Most of the CSO points with low NDSI have non-zero snow depth. It is possible that a user was entering a no-depth measurement (which is valid, if infrequently reported) but mistyped and entered a non-zero depth. In this case, MODIS correctly reported NDSI = 0, and the erroneous CSO point

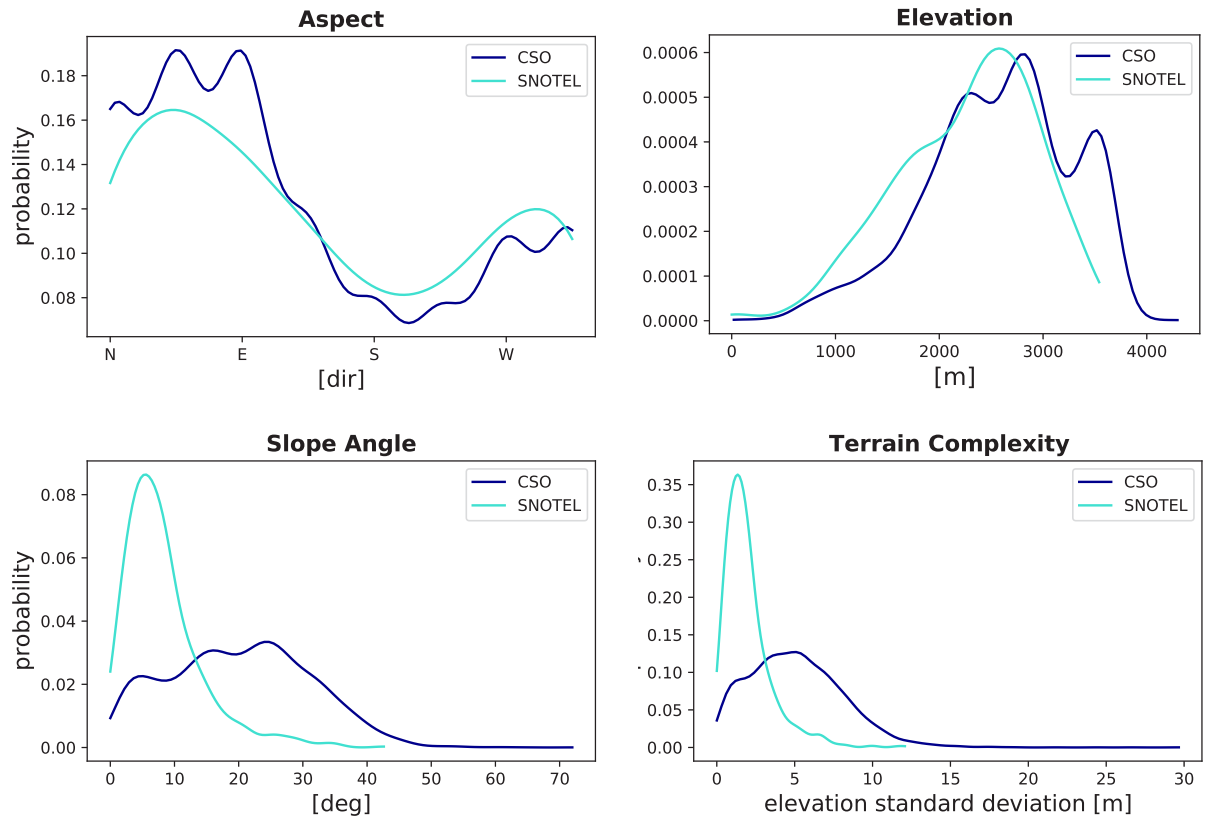

Figure 9. Probability density functions of terrain features (aspect, slope, elevation, and terrain complexity) associated with individual CSO observations submitted from 2016 through 2021 and the locations of SNOTEL stations across the western United States. We extracted elevation and calculated aspect, slope, and terrain complexity scores for CSO and SNOTEL locations from the 10-m resolution National Elevation Dataset. Slope and aspect were computed with the four connected neighbors of each pixel corresponding to the location of the CSO observation or SNOTEL site. The terrain complexity metric was calculated as the standard deviation of the 3x3 square kernel surrounding an observation or station location.

could be flagged as an outlier. A second possibility could be a geolocation error: the CSO participant correctly reported non-zero Hs, but the coordinates were incorrect and corresponded to a location with no snow depth (NDSI = 0). A third possibility is related to variability at sub-grid resolution. A MODIS grid cell with an NDSI value of 0 should indicate a snow-free land surface over the 500 m grid cell. However, several processes, including wind redistribution and differential melting of snow, can lead to patches of snow within an otherwise bare area. If a grid cell is mostly bare (say near the snow line), then a valid non-zero snow depth measurement could accompany a NDSI = 0 value.

All of the CSO data points with NDSI = 0 were in high mountain locations during snow season. Therefore, the first two explanations above are unlikely. To better understand the low NDSI values, we aim to require that future CSO measurements include photographs of the surrounding area (to gauge snow cover; these photographs currently are optional). Additionally, the CSO science team plans to pursue gridded, intensive measurements spanning entire MODIS grid cells. This will help determine the degree to which MODIS data could be used to identify outlier CSO points, or the degree to which CSO data might help to refine the MODIS results.

Are We Giving the Public What They Want?

Much of CSO's effort over the first few years was focused on a study site near Thompson Pass, Alaska. This intensive focus allowed us to work on a proof of concept and to develop all of the modules needed to fully implement a community science modeling project. Since that time, our emphasis on open science, public engagement, and collaboration between the science team and the public has led to steady growth of the project. We receive frequent comments from individuals and educational programs that the simple process of observing snow teaches them a great deal about how snow changes from place to place and time to time.

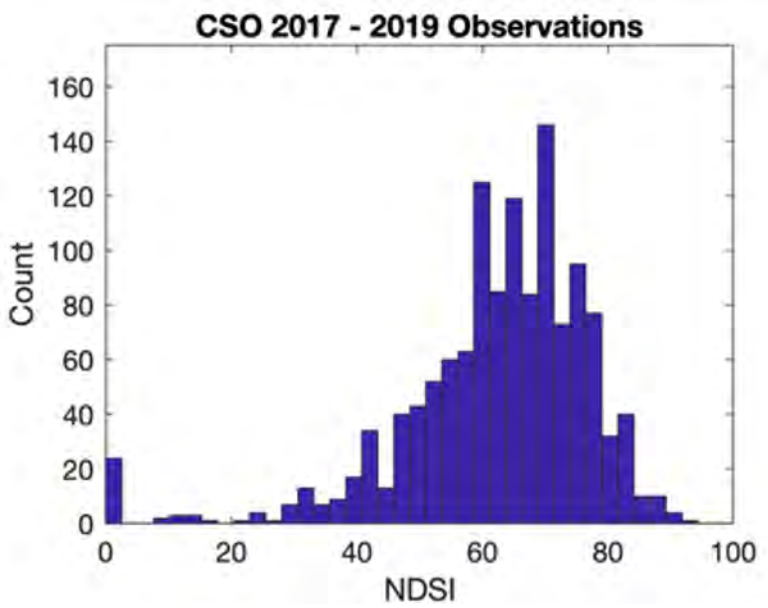

Figure 10. Normalized Difference Snow Index (NDSI) values corresponding to the locations and times of CSO observations. Data are for the 2017–2018 and 2018–2019 snow seasons.

The science team has learned a great deal from participant feedback. For example, we sometimes hear concerns about personal and location privacy. In the interest of transparency and accessible science, all data submissions appear on our project website. Some participants (or potential participants) do not want to reveal their locations as a matter of personal preference (personal privacy). Other participants do not want to attract more people to their favorite locations (location privacy). Accordingly, privacy is a real barrier to participation. When CSO began, we had little control over Mountain Hub and privacy settings. Now that CSO owns Mountain Hub, we hope to design a private mode in which submissions of snow depth will be available to project staff but will not be displayed online or otherwise be made public.

Another barrier to participation is regional differences in preferred sources of snow information. Most countries with snow environments have a national agency that is tasked with avalanche monitoring, mitigation, and education. Some countries, such as the United States, have regional agencies that are similarly tasked. Many of these agencies have their own data collection programs and protocols, although the focus (e.g., avalanche stability, snow pit profiles) usually is different from CSO's sole focus on snow depth. Some agencies are resistant to introducing a new app (Mountain Hub) that they feel will lead to a decrease in submissions to their own programs. The CSO program is working to build a culture of data sharing and cooperation that we hope will alleviate concerns about competition for data.

Among our ongoing goals are to better quantify uncertainty in data quality and reliability (Hill et al. 2019, Crumley et al. 2021) and to offer tools and training to minimize erroneous observations. These goals are consistent with NASA's recent efforts (Amos et al. 2020) to formalize data standards and data quality for observations from public participants. Sources of error in the CSO project include observers mistyping an entry on their mobile device; submission of data via the mobile

app from a physical location other than where they were collected, causing the coordinates of the measurement to be incorrect; and poor selection of measurement locations (for example, in an area of significant scour, deposition, or disturbed snow). We can mitigate the first source of error by asking (or eventually requiring) participants to include a photograph of the depth measurement on their measurement device. We can mitigate the second by reinforcing through tutorials that measurements submitted via the mobile app must be submitted at the observation site. Additionally, since taking possession of the Mountain Hub app, we have made numerous improvements to its positional accuracy. We can mitigate the third source of error by continuing to provide tutorial videos on our website that enable participants to recognize ideal measurement locations. We are also developing data filters that automatically screen for erroneous depth measurements by comparing the submissions to MODIS-derived and other snow products.

We believe that the future of community science in the context of water and snow is bright. Science is advanced by access to new and unique data, and public understanding of and appreciation for water resources is advanced through active participation and learning. The flexible CSO collaboration gives participants control over their level of participation, and therefore their experience. The project also readily can grow. Because we develop models in areas with strong participation, the future of the project is in the hands of the public. If you are intrigued, please consider exploring the many community science projects related to climate and water that are available to you.

Addendum

Between submission of this contribution and publication, the data submission platforms available to participants in the CSO project changed. The Mountain Hub app, website, and social media channels have been retired. In September 2022, the CSO team partnered with Propagation Labs (www.propagationlabs.com) to make use of their Snow Scope app (available for iOS and Android). This app (Figure 11) is an extremely fast and easy way to log snow depth measurements, and the CSO team recommends this app for all its recreational users. As with Mountain Hub (and the other platforms) previously, all data submitted via Snow Scope automatically will flow to the CSO website and database.

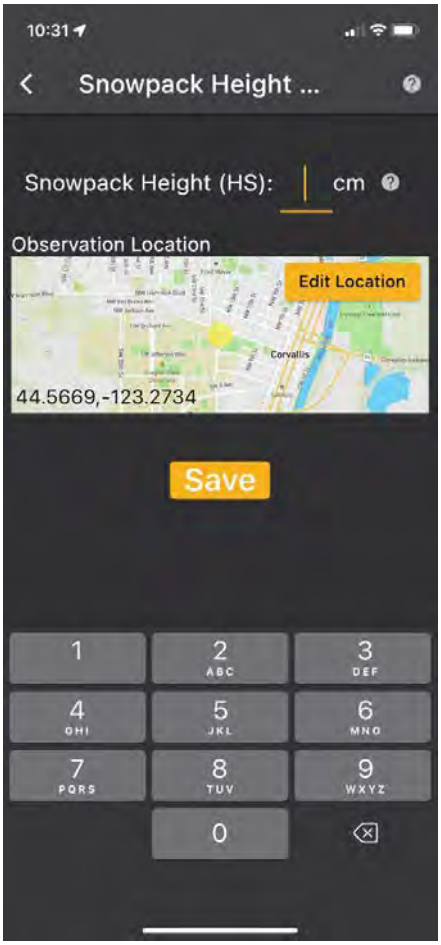

Figure 11. View of the Snow Scope app developed by Propagation Labs.

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Community Observers' Distinct Role in Advancing Meteorology and Climate Science

Meghan Collins, Keith Jennings, Monica Arienzo, Benjamin Hatchett, and Anne Nolin

In many regions, community observers have both on-the-ground access to diverse geographic areas and the ability to discern complex weather and climate patterns, or anomalies in those patterns, in a meaningful way. Answering many questions in meteorology, climatology, and climate change requires this combination of access and skills. High-resolution observation of weather over large areas, which can inform climate science, requires access to places from backyards to the backcountry, including places where deployment of weather stations and similar infrastructure is not feasible. Even more importantly, community observers can provide local and historical context for weather and climate phenomena and distinguish changes in these phenomena that technology or analyses have not yet recognized. Here, we describe how the nexus among community observers, professional scientists, and technology advances understanding of weather and climate.

Human observation of environmental phenomena has a long history. Local and traditional knowledge, collected over generations, helped people to survive and thrive worldwide and as climate changed. As the field of science has evolved, so has the spectrum between community observer and professional scientist. In the last ~150 years, Western science has become increasingly professionalized, creating a larger divide between professional scientists and non-professionals, often marginalizing the role of the latter (Miller-Rushing et al. 2012). However, a more formal role for community observers has grown in recent decades, along with formal names for their contributions to science, such as public participation in scientific research, citizen science, community-based monitoring, and community science. The term *citizen science*, first used in the mid-1990s, was intended to evoke the idea of scientific citizenship (Bonney 2021): civic involvement in science, or participation in science without the need for credentials (Shirk et al. 2012). But as many have pointed out (e.g., Cooper et al. 2021), the word *citizen* can be exclusionary and possibly reinforces a pattern of limited representation in science. *Community science* describes the role of community members in guiding research questions, analysis, and applications of science. Here, we use *community observer* because the contributors to the programs featured here track weather and climate phenomena to advance research questions driven by the scientific community. Dialogue about terminology and resulting changes to the culture and conduct of science (e.g., Pandya 2019) has led to acknowledgment of observers' role in generating knowledge, especially as technology evolves and as specialized fields of science increasingly require extensive training.

A broad range of technologies and extensive infrastructure have been central to many of the advances in weather and climate science during the last century. Weather and climate can be observed through extensive networks of instruments, such as weather stations equipped with thermometers, rain gauges, and sensors to track humidity, insolation, and atmospheric pressure. Examples include Snow Telemetry (SNOTEL) and Remote Automated Weather Stations (RAWS). These networks yield data from which models are created. Weather and climate also can be observed through remote sensing, which includes weather radar (e.g., Doppler) to locate precipitation and storm activity; aircraft; and satellites that track cloud cover, land surface and air temperatures, and wind. Some examples of these satellites include the U.S. National Weather Service's Geostationary Operational Environmental Satellite (GOES)-East and the CloudSat and Global Precipitation Measurement (GPM) systems of the National Aeronautics and Space Administration (NASA).

Remote sensing products also contribute to numerical forecasts of weather and climate, which require assimilation of extensive data. Advances in machine learning may overcome some limits to conventional climate models (Huntingford et al. 2019, Schultz et al. 2021, Rolnick et al. 2022). For example, deep learning is among the methods used to forecast weather beyond two weeks (Weyn et al. 2021) and to predict severe weather such as hailstorms (Gagne et al. 2019). Nevertheless, scientists and keen observers must work closely with evolving technological tools to answer major questions in weather and climate science.

Mountain Rain or Snow

Mountain Rain or Snow illustrates our belief that the triad of scientists, community observers, and technology is a powerful means of addressing weather and climate challenges. Human and natural systems are adapted to seasonal patterns of rain and snow (Barnett et al. 2005). The warming-induced shift from snow to rain challenges water supply planning, water availability, and ecosystems (e.g., Livneh and Badger 2020). However, despite years of research, it remains challenging to predict whether precipitation will fall as rain, snow, or mixed (Harpold et al. 2017). The freezing point of water is an unequivocal 0°C (32°F), yet contemporary hydrologic, land surface, and climate models and remote sensing products, which inform water budgets and hydrologic models, do not accurately partition precipitation into rain and snow near freezing (Jennings et al. 2018, Skofronick-Jackson et al. 2019).

To improve satellite measurements and models for detecting rain, snow, and mixed precipitation, the Mountain Rain or Snow team has been working closely with community observers to crowdsource visual observations of precipitation phase (Arienzo et al. 2021). Since 2019, we have worked with over 1400 participants to track more than 15,000 observations of rain, snow, and mixed precipitation (Figure 1).

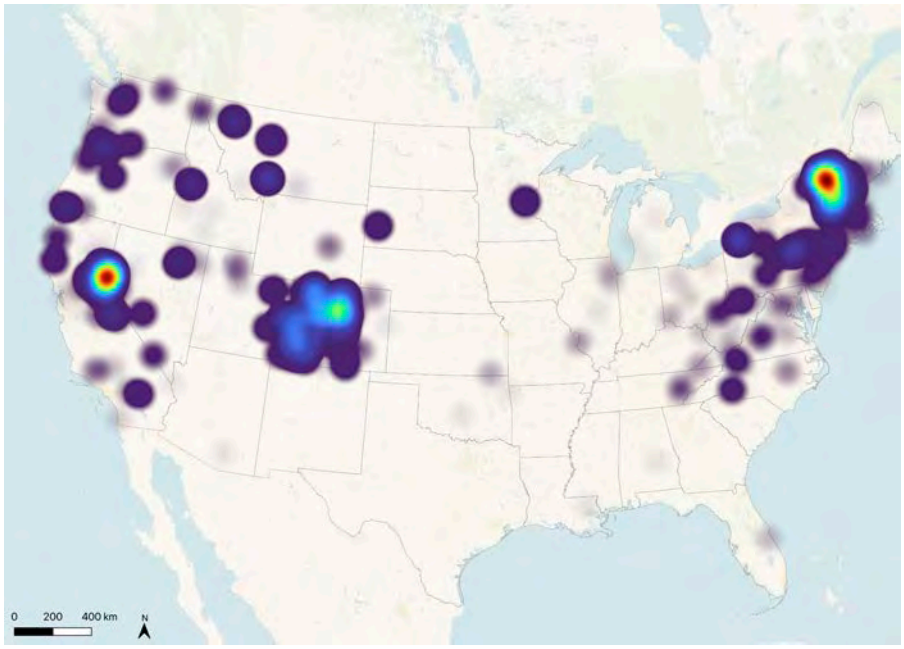

Figure 1. Distribution of Mountain Rain or Snow community observations in the continental United States during the winter of 2021–2022. Warmer colors indicate a greater number of observations. Our team analyzes observations on the basis of ecoregions.

The large number of ground-based observations compiled by Mountain Rain or Snow adds to surprisingly few other direct observations of rain and snow. In the United States, the largest network of precipitation phase reports consists of airports that contribute to the National Oceanic and Atmospheric Administration's Local Climatological Dataset. These data are useful, but typically are collected in flat, low-elevation areas, and do

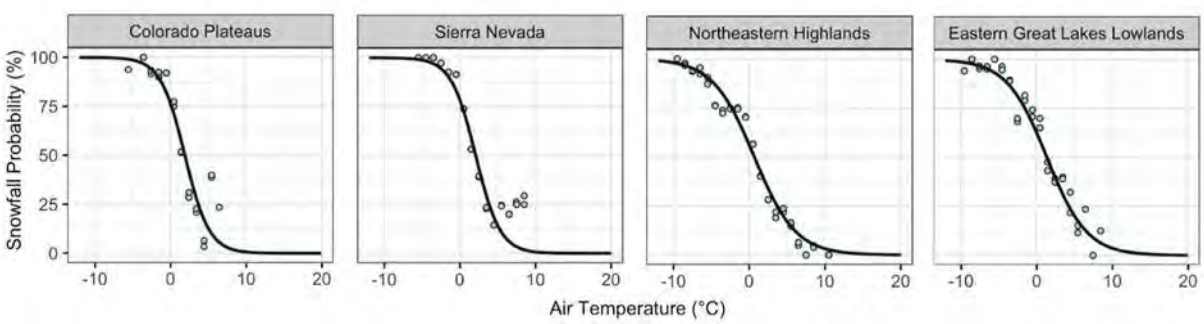

Figure 2. Probability curves produced by applying a binary logistic regression model to community observations submitted to Mountain Rain or Snow from 2021–2022. The probability of snowfall as a function of air temperature varies among U.S. Environmental Protection Agency Level III Ecoregions.

not represent higher elevation, more-complex mountain environments. As a result, they contribute little to understanding of hydrometeorological processes in the areas where the distinctions between rain versus snow matter most, and lead upland regions to rely on models and products derived from remote sensing.

Accurately tracking precipitation at the freezing point across a range of elevations and climatic zones is relevant because the hydrologic outcomes of rain and snow are fundamentally different. Rain is more ephemeral, generally infiltrating or running off soon after reaching the ground. Snow accumulates into seasonal snowpacks that act as natural, in situ reservoirs. Snow also cools the planet by reflecting incoming solar radiation. Humans, particularly in cold and temperate regions, depend on reliable seasonal cycles of snow accumulation and melt. Increasing air temperatures are driving declines in mountain snow accumulation, earlier snowmelt, and increases in the risk of floods caused by rain falling on snow. The greatest uncertainty in whether precipitation is rain or snow is near freezing.

Mountain Rain or Snow's community observations and analyses are improving NASA's GPM-derived estimates of whether precipitation is rain, snow, or mixed, and the probability of snowfall as a function of air temperature (Figure 2). Probability curves built with community observations of precipitation illustrate why a strict 0ºC threshold is not accurate for predicting whether precipitation is falling as rain or as snow.

As a result of the true heterogeneity in snowfall probability, predictions of precipitation phase from NASA GPM have varying levels of accuracy. The accuracy of NASA GPM-derived predictions of precipitation phase diverges from quality-controlled observer data from 0–8ºC (32–46˚F) (Figure 3).

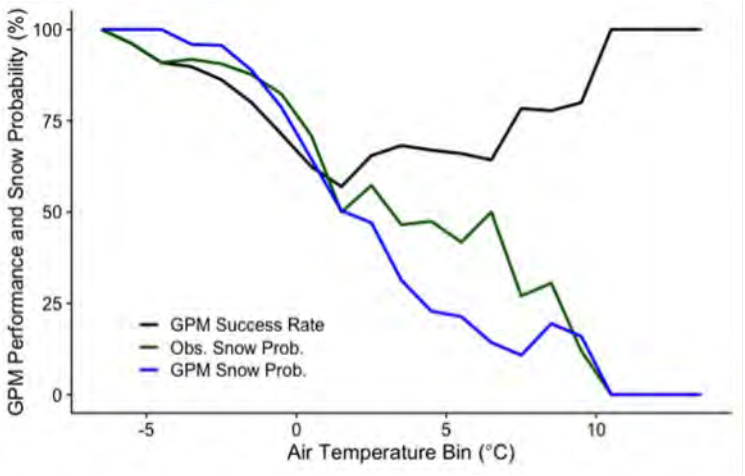

Figure 3. Divergence in the probability of snow during the winter of 2020–2021 according to quality-controlled, ground-based community observations versus Global Precipitation Measurement (GPM) satellites.

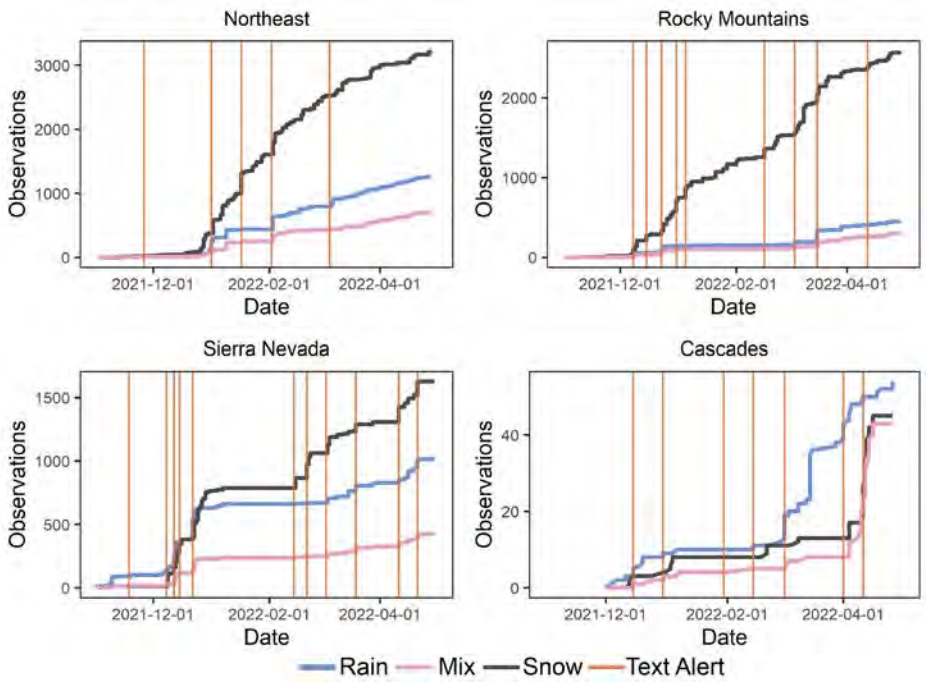

Figure 4. Text messages sent directly to Mountain Rain or Snow observers to encourage submission of observations of rain, snow, or mixed precipitation. The timing of text alerts is indicated by vertical lines.

In addition to scientific contributions, Mountain Rain or Snow seeks to advance collaboration with community observers via an ecoregion-specific, two-way text communication system. We send alerts when a local storm is approaching, and we respond to observer questions in real time to improve the user experience and the quality of the data submitted. In a recent survey of Mountain Rain or Snow observers, 82 percent of respondents (n = 415) indicated that the alerts helped them know when to submit observations of precipitation. The survey responses were consistent with the data submission trends, which indicated that text alerts increased the number of observations of the following storm (Figure 4).

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Wildfire

The wildfires that occurred across Oregon in September 2020 galvanized public attention on changes in the patterns, causes, and consequences of wildfires in the state, across the western United States, and worldwide. Rupp and Holz begin this section by exploring recent advances in understanding of wildfire trends and mechanisms. For example, evidence rapidly is accruing that extreme aridity enables large fires that expand quickly and can be remarkably difficult to contain. Social phenomena also affect the probability, locations, and timing of wildfires, especially via inadvertent human-caused ignitions. Nevertheless, as Kalashnikov explains in the second contribution to the section, a majority of wildfires east of the Cascade Range in Oregon continue to be caused by dry lightning during spring and summer.

The U.S. Department of Health and Human Services emphasizes that personal health literacy is a social risk, and organizational health literacy is a social determinant of health (health.gov/healthypeople/priority-areas/social-determinants-health/literature-summaries/health-literacy). Personal health literacy refers to individuals' ability to find, understand, and use information and services to inform their health-related decisions and actions, whereas organizational health literacy refers to the extent to which organizations equitably enable individuals to find, understand, and use such information and services. Accordingly, as a complement to the focus in *Public Health* (this volume) on the responses of human health and the healthcare system to wildfire smoke, two contributions to this *Wildfire* section examine public responses to and preparation for wildfires. Boudet and colleagues report on the results of a survey of Oregonians' behaviors related to protection of their health, property, and communities; their attitudes and beliefs about relations between wildfires and climate change; and their support for policies designed to adapt to or mitigate climate change. Coughlan and colleagues present the outcomes of a separate survey, implemented in English and Spanish, that examined Oregon residents' concerns, communication needs, and responses to wildfire smoke during the 2020 wildfire season. Both efforts contribute to the foundation for tracking future changes in health literacy and policy preferences.

The survey that Coughlan and colleagues describe was informed in part by collaboration with the Smoke Ready Communities working group. This group, convened by Oregon State University Extension Forestry and Natural Resources faculty members in January 2021, aims to identify mechanisms and media that best serve Oregonians affected by wildfire smoke and displaced by wildfire, educational information and resources, and how Oregonians access information about smoke. After its launch, the group rapidly expanded to include colleagues from other units at Oregon State University, University of Oregon's Institute for a Sustainable Environment and its Ecosystem Workforce Program, Portland State University, Oregon Department of Environmental Quality, Oregon Health Authority, Sustainable Northwest, county emergency management professionals, and other practitioners of smoke-risk mitigation. The group serves as a community of interest in which public health and environmental quality researchers and outreach educators connect to explore needs and opportunities. Participants are reviewing existing educational materials and developing new materials to fill gaps in information and education, and they are developing processes to use Oregonians' preferred media and outreach mechanisms to better address smoke-related education and communication needs.

Wildfire Trends and Drivers

David Rupp and Andrés Holz

The 2020 Labor Day Wildfires

No wildfire event has affected or threatened as many Oregonians as did the numerous wildfires that erupted across western Oregon on Labor Day (7 September) 2020. Those wildfires eventually burned nearly 4,000 km^2 (~1,500 mi^2), mostly forested, including more than 11 percent of the Oregon Cascade Range. The area burned in the western Cascade Range in 2020 equaled or surpassed that in any other year for which records are reliable (Abatzoglou et al. 2021c, Reilly et al. 2022). One of the strongest and driest easterly winds recorded since 1948, combined with vegetation that desiccated over the unusually hot and dry preceding weeks, drove the rapid growth of the fires (Abatzoglou et al. 2021c, Mass et al. 2021, Evers et al. 2022). The fire weather, as measured by a combination of heat, aridity, and wind that is consistent with expansion of wildfire, was more extreme over large areas of western Oregon than recorded since 1979 (Hawkins et al. 2022), although probably similar to fire weather during other major wildfires in western Oregon before and since European colonization (Abatzoglou et al. 2021c, Reilly et al. 2022).

Trends in Wildfires

Although the 2020 Labor Day fires were singular and defining in Oregon's history, they were among many wildfire outbreaks throughout the western United States in 2020. That year's extraordinary fire season was characterized by a large number of fires that grew extremely rapidly over a period of one to a few days, enabled by unusually high aridity (Higuera and Abatzoglou 2021, Coop et al. 2022).

The Labor Day fires also were one event in a regional trend. Total annual area burned in Oregon has increased during the last 35 years (Figure 1). Despite the considerable area burned by the Labor Day fires, the area burned in other recent years (e.g., 2012), mostly in southwestern and eastern Oregon and encompassing all land-cover types and fire regime groups, was slightly higher (Figure 2). Across the western United States, the frequency of large wildfires has increased faster than that of small wildfires in forested areas (Juang et al. 2022), and large forest fires have become near-annual in the northwestern United States (Halofsky et al. 2020). The annual area of shrubland burned, roughly half of the total area burned, has also increased, although its proportion of the total area burned has decreased (Li et al. 2021).

As aridity has increased, wildfires have spread into higher elevations that previously were cool and moist enough to deter fire expansion (Alizadeh et al. 2021). In the Cascade Range and Blue Mountains, for example, wildfires moved upslope at rates of 10 and 12 m (33 and 39 ft) per year, respectively, from 1984–2017. Reductions in snowpack depth also contributed to the upslope movement (Mote et al. 2018). Additionally, the larger fires in the western United States have generated taller plumes of smoke and injected a greater volume of fine particulate matter ($PM_{2.5}$) at high altitudes, increasing long-range transport of $PM_{2.5}$ and posing a health hazard to larger numbers of people (Wilmot et al. 2022). The population exposed to persistent extreme $PM_{2.5}$ and ozone levels in the western United States increased by 25 million person-days per year over the period 2001–2020 (Kalashnikov et al. 2022). In the northwestern United States, wildfire smoke accounted for more than 50 percent of $PM_{2.5}$ during 2017 and 2018, an increase from about 20 percent during the previous decade (Burke et al. 2021). Deposition of black carbon from large wildfires also increased the rate of snowmelt at high elevations (Uecker et al. 2020).

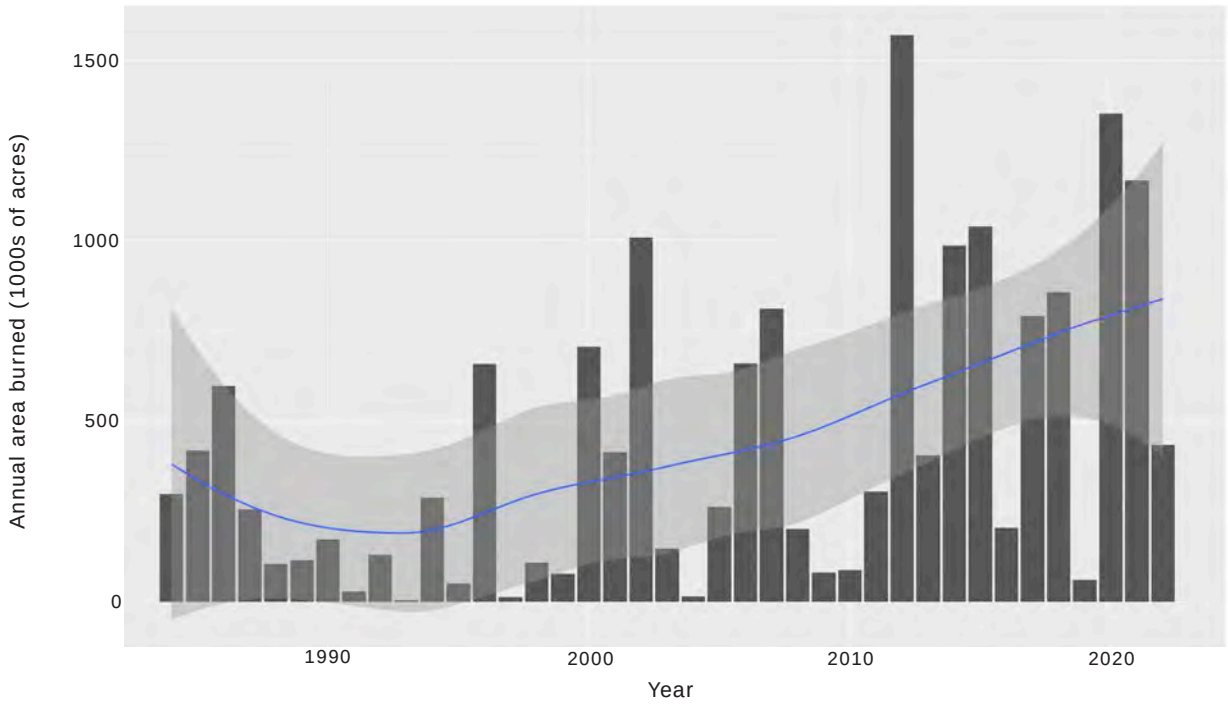

Figure 1. Annual area burned in Oregon from 1984–2022. Fires smaller than 988 acres (400 ha) were omitted. Data from Eidenshink et al. 2007 updated to October 2022 (www.mtbs.gov).

Cooler temperatures overnight typically alleviate extreme fire weather. However, an increase in nighttime temperatures (e.g., Cox et al. 2020) caused persistent nighttime fire activity across the conterminous United States, mainly concentrated inside large wildfires, from 2003 through 2022 (Freeborn et al. 2022). Nighttime fire intensity also increased globally from 2003 through 2020, driven by warmer and drier nights (Balch et al. 2022).

Regional and Global Trends in Aridity and Fire Weather

From 1979 through 2019, the duration of the fire weather season in forests of Washington, Oregon, Idaho, and California increased by 43 percent, and the annual number of days when fire danger was extreme increased by 166 percent (Jones et al. 2022). Widespread drought has led to high fire danger across much of the western United States in many recent years, further straining wildfire-suppression resources that must be shared across the region (Podschwit and Cullen 2020, Abatzoglou et al. 2021b).

These regional trends are part of the global trend of increasing fire danger over the last four decades (Ellis et al. 2022, Jain et al. 2022, Jones et al. 2022, Richardson et al. 2022). Most of the world's ecoregions became drier during this time (Ellis et al. 2022). Worldwide, fire weather became more extreme, primarily due to decreases in relative humidity (Jain et al. 2022).

Atmospheric Drivers of Wildfire

Northward displacement and weakening of the polar jet stream during summer may increase the probability of extreme wildfires (Jain and Flanagan 2021). Persistent atmospheric pressure ridges over North America that are coincident with the shift in the polar jet stream appeared to increase aridity and the probability of wildfires, particularly across more northern latitudes (Justino et al.

2022, Sharma et al. 2022). Arctic amplification may contribute to the development of these high-pressure ridges, which in turn may increase the frequency of summer heat waves and fire weather in the western United States during autumn (Zou et al. 2021; also see *Arctic Amplification*, this volume).

Contribution of Anthropogenic Emissions to Recent Fire Weather

Increases in global concentrations of greenhouse gases since the mid-1800s have increased the likelihood of extreme autumn fire weather by an estimated 40 percent over the western United States and about 50 percent over western Oregon (Hawkins et al. 2022). Autumn fire weather in western Oregon that would have occurred, on average, every 20 years during the pre-industrial era had a 13-year average return interval during the last several years. The higher likelihood of extreme fire weather was attributed to decreased vegetation moisture content during autumn and warmer temperatures during dry wind events, although emissions appear to have little effect on the frequency of easterly, downslope winds that can drive explosive fire growth (Hawkins et al. 2022). Natural variability in atmospheric circulation accounted for an estimated 32 percent of the positive trend in atmospheric vapor pressure deficit (VPD)—a variable positively correlated with wildfire area—over the western United States from 1979–2020, and anthropogenic emissions for the remaining 68 percent (Zhuang et al. 2021).

Future Wildfire

Numerous projections of future wildfire or fire weather and ignitions in the western United States have been made over the last few years, including two focusing on regions in Oregon. Projected

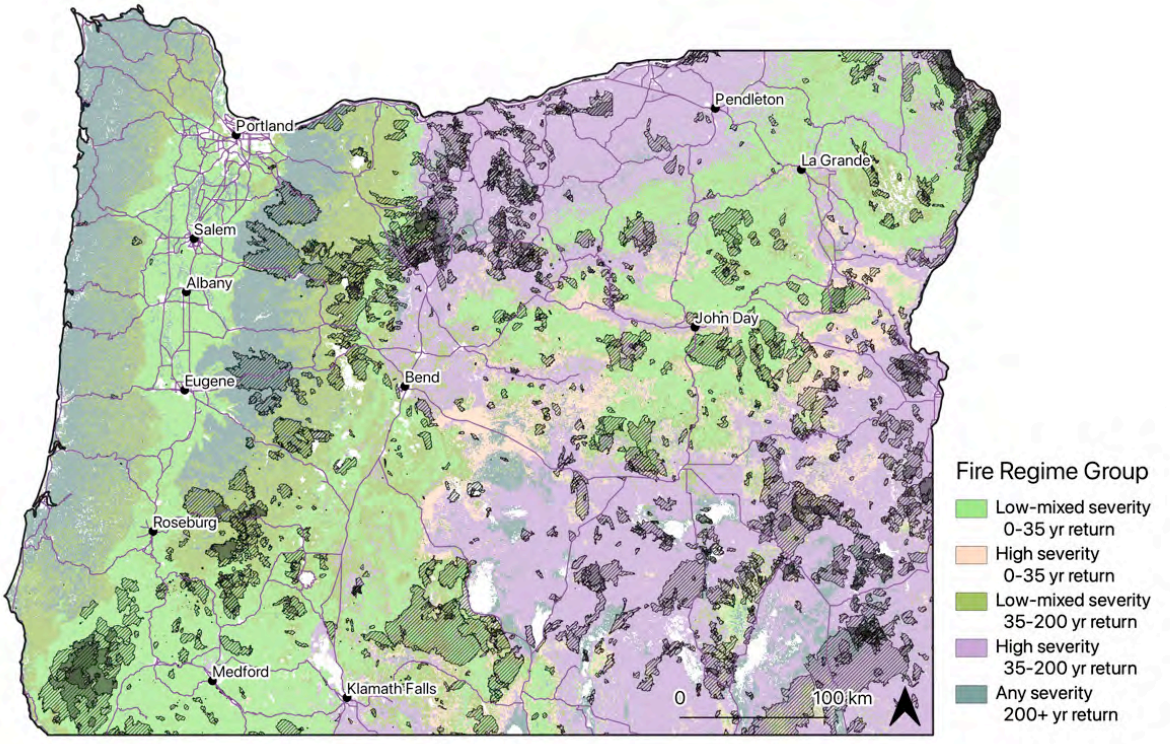

Figure 2. Total area burned in Oregon (black hatch lines) from 1984–2020 and fire regime groups. Fires smaller than 400 ha (988 acres) were omitted. Water bodies, snow peaks, and urban areas are in white. Data from Eidenshink et al. 2007 updated to 2020 (www.mtbs.gov) and LANDFIRE Remap fire regime types (landfire.gov/lf_maps.php). Figure by Cody Evers.

average annual area burned in the Clackamas Basin, an important source of water for Portland, increased by 56–540 percent from 1992–2015 to 2040–2069 under a high emissions scenario (RCP 8.5) (McEvoy et al. 2020). The projected average sizes of human-caused and lightning-caused fires on the east slope of the Cascade Range in Oregon increased by 31 percent and 22 percent, respectively, from 2006–2015 to 2031–2060, assuming a moderate emissions scenario (RCP 4.5) (Barros et al. 2021). The number of lightning-caused fires decreased by 14 percent, but the number of human-caused fires did not change (Barros et al. 2021).

In fire-prone areas of the western United States, including the mountains of Oregon, the annual number of extreme, single-day wildfire expansions was projected to increase by 100 percent if annual average temperatures increase by 2ºC (3.6˚F) above the 2002–2020 average (Coop et al. 2022). The number of wildfires in national forests in the Pacific Northwest was projected to increase by 20–140 percent from 1986–2015 to 2070–2099 under RCP 8.5 (Heidari et al. 2021). Furthermore, the area in the northwestern United States with high fire danger in summer was projected to increase by 345 percent from 1996–2004 to 2086–2094 under RCP 8.5 (Brown et al. 2021). Within Oregon, areas with the largest increases in the number of summer days with high fire danger were in the Cascade Range, Coast Range, and Klamath Mountains (Brown et al. 2021). In contrast to other projections, little change in burned area was projected over the Cascade Range and coastal mountain of Oregon and Washington (1984–2016 to 2040–2060 and 2080–2099; RCP 4.5 and 8.5) on the basis of a suite of hydrological and meteorological metrics (Brey et al. 2021). Due to increasing wildfire activity in late summer and autumn in the Pacific Northwest, $PM_{2.5}$ from wildfire smoke was projected to double under a moderate emissions scenario (SSP 2-4.5) or triple under a high emissions scenario (SSP 5-8.5) from 1997–2020 to 2080–2100 (Xie et al. 2022).

These projections of future wildfire hazard are based mainly on historical relations between a wildfire metric (e.g., size or frequency) and metrics of aridity or fire weather. However, climate change may affect the rate at which vegetation regenerates, and the plant species that become dominant, following a wildfire. For example, as the frequency of large fires increases, reduction in aboveground plant biomass (fuel loads) will eventually constrain the potential for additional large fires. Nevertheless, biomass reductions may only moderately constrain future burned area over the western United States, including dry and cold forests in Oregon east of the Cascade Range, and it is likely that biomass reduction will be lower west of the Cascade Range. The mean annual forest area burned over the next three decades may still increase by at least 50 percent compared to the previous three decades, assuming a moderate emissions trajectory (SSP 2-4.5) (Abatzoglou et al. 2021a). Uncertainties in the direction and stationarity of plant growth after fire create uncertainties in projections of wildfire-fuel feedbacks. Fuel loads may be insufficient to carry a second wildfire for 30 years after a fire in dry forests in the Intermountain West (Abatzoglou et al. 2021a). In forests in the western Cascade Range and coastal and southwestern Oregon, where plants grow more rapidly, fuel loads may constrain wildfires for shorter periods of time or may even increase wildfire frequency. For example, several short-interval megafires (e.g., Tillamook Fires, Yacolt Fires) occurred in highly productive, mesic forests in the Coast Range and western Cascade Range. Also, in the forests of southwestern Oregon, a high proportion of trees resprout and increase flammability following wildfire before the coniferous tree canopy closes (Odion et al. 2010, Tepley et al. 2017). Fire severity in Oregon's productive timber plantations is higher due to their shorter stature, spatial homogeneity, and lower bulk density (Zald and Dunn 2018, Evers et al. 2022).

In the semi-arid Big Wood River Basin in south-central Idaho, which is ecologically similar to much of south-central Oregon, the Regional Hydro-Ecologic Simulation System (RHESSYS)

model projected that increased aridity alone may reduce fuel loading by reducing productivity and increasing decomposition rates, whereas increasing carbon dioxide (CO_2) concentrations are projected to increase productivity (J. Ren et al. 2022). From about 2031–2060, the projected effects of the CO_2 increase exceeded those of the aridity increase, and both fuel loading and burned area increased under RCP 4.5 and 8.5 (J. Ren et al. 2022). By 2061–2090, the projected effects of the aridity increase exceeded those of the CO_2 increase under RCP 8.5, and burned area decreased.

Climate change-mediated shifts to larger, more severe, and more frequent wildfires may also affect tree species composition and vegetation structure in the relatively cool, moist Cascade Range (Enright et al. 2015, Halofsky et al. 2020). For instance, in some upper-montane and subalpine forests, few wildfires occurred or were suppressed during the past several hundred years. In these areas, assuming seeds are available, frequent fires and drier and warmer postfire growing seasons may lead a transition to patchy, low-density, conifer-dominated forests that are better adapted to warmer and drier conditions (Busby et al. 2020, Busby and Holz 2022).

COVID-19 and Wildfire

Restrictions and shutdowns in response to the COVID-19 pandemic caused a reduction in emissions from industry, transportation, and other activities. The sudden decrease in fine particulate matter (aerosols) in the atmosphere during the pandemic may have led to an increase in air temperature and a reduction in precipitation and relative humidity from August through November 2020, and therefore made conditions more favorable for wildfire (L. Ren et al. 2022). The strongest modeled effect was in the southwestern United States, whereas the effect in Oregon was small.

The pandemic may also have changed the incidence of human-caused ignitions. Fewer active wildfires in the southeastern United States were reported following shutdowns beginning in March 2020, although the decrease largely was attributed to the cancellation of prescribed burns used to manage wildfire hazard (Poulter et al. 2021). Unintentional wildfire ignitions, however, may also have been affected. Visits to state and national parks across the northwestern United States were positively correlated with county-level COVID-19 case numbers before the peak 2020 wildfire season, suggesting people looked to parks for temporary relief from restrictions on other common social activities (Yang et al. 2021). More park visitors, and possibly a larger proportion of visitors with little outdoor experience, could have led to a greater number of unextinguished or unattended campfires, and therefore a higher probability of wildfire, although any connection is still speculative.

Because the fine particulate matter in wildfire smoke can adversely affect the human respiratory system, it is likely that the 2020 wildfires in the western United States contributed to the adverse health effects of COVID-19 (Zhou et al. 2021). In 18 of 19 Oregon counties analyzed, the number of reported COVID cases increased on days on which concentrations of $PM_{2.5}$ exceeded 21 $\mu g\ m^{-3}$ (Zhou et al. 2021).

There is general agreement that wildfire hazard in the western United States has increased over the last few decades and will continue to increase over the next several decades. The average annual area burned in Oregon's forests is expected to increase by at least 50 percent, and fire seasons are expected to become more extreme than any in recorded history. The risk to human life and property is considerable, particularly in western Oregon where communities have little historical experience with major wildfires (Dye et al. 2021, McEvoy et al. 2021). Past, present, and future land use will also affect wildfire hazard during the coming decades (Hanan et al. 2021, Prichard et al. 2021).

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Lightning-Caused Wildfires

Dmitri Kalashnikov

Lightning in Oregon is most frequent over the high terrain east of the Cascade Range, and relatively rare west of the Cascade Range (Figure 1a). The density of lightning is particularly high over mountain ranges that intersect with monsoonal flow from the south during summer, including the Wallowa Mountains, Blue Mountains, and portions of the central and southern Cascade Range (Figure 1a). The annual number of cloud-to-ground lightning flashes peaks in nearly all locations east of the Cascade Range, and many locations in Oregon's southwestern interior valleys, during June, July, and August (Figure 1b) (Kalashnikov et al. 2020).

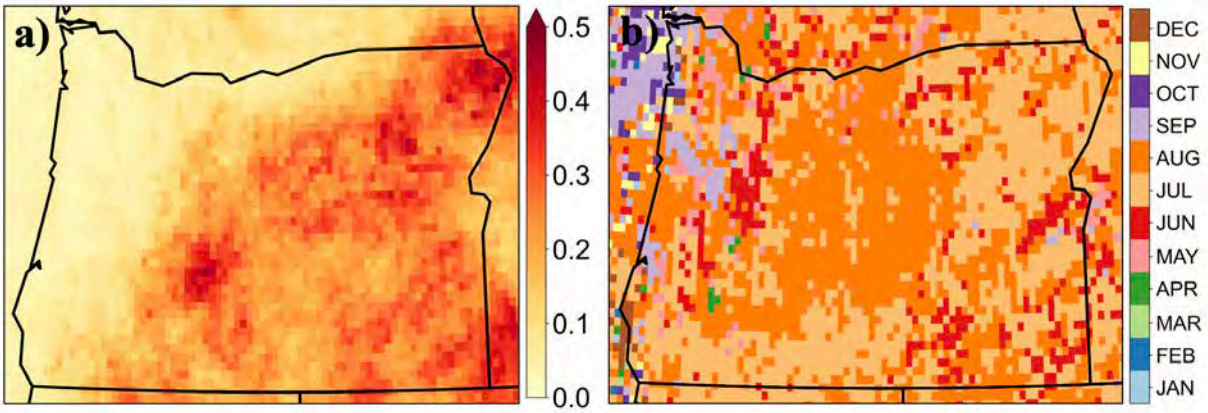

Figure 1. Mean annual cloud-to-ground lightning density (flashes/km^2/year) (a) and peak month of cloud-to-ground lightning activity from 1988–2017 (b). Lightning data are from the National Lightning Detection Network. Figures adapted from Kalashnikov et al. 2020.

Although some summer thunderstorms produce heavy rain and flash flooding (Smith et al. 2018), in other situations rainfall passes through a dry layer of the atmosphere and evaporates before reaching the ground. Lightning that strikes the ground without substantial rainfall at the surface is known as dry lightning (Rorig and Ferguson 1999, Abatzoglou et al. 2016). When rainfall accompanies lightning, any fires sparked by lightning are more likely to be extinguished, which does not happen in situations with dry lightning.

Dry lightning is a major cause of wildfire ignitions east of the Cascade Range during summer, when live and dead vegetation is dry (Rorig and Ferguson 1999, Abatzoglou et al. 2016, Balch et al. 2017). Lightning-caused ignitions outnumber those caused by human activity in central and eastern Oregon (Figure 2a), with most fires due to lightning occurring from May through September (Figure 2b). The likelihood of large, lightning-caused fires is especially acute during drought years, as wildfire burned area is more strongly correlated with climatic conditions than with the density of lightning flashes (Barbero et al. 2014, Abatzoglou et al. 2016, Brey et al. 2021). During the summers of 2020 and 2021, drought across large parts of Oregon east of the Cascade Range was moderate to severe, leaving vegetation more flammable than normal (Higuera and Abatzoglou 2021). As a result of conducive weather and climate conditions, some lightning-caused wildfires (Figure 3), including the Lionshead Fire, which started on the Confederated Tribes of Warm Springs Reservation (205,000 acres [83,000 ha] burned in 2020), and the Bootleg Fire, which started in Klamath County (414,000 acres [167,000 ha] burned in 2021), grew into megafires that burned for several weeks, destroyed

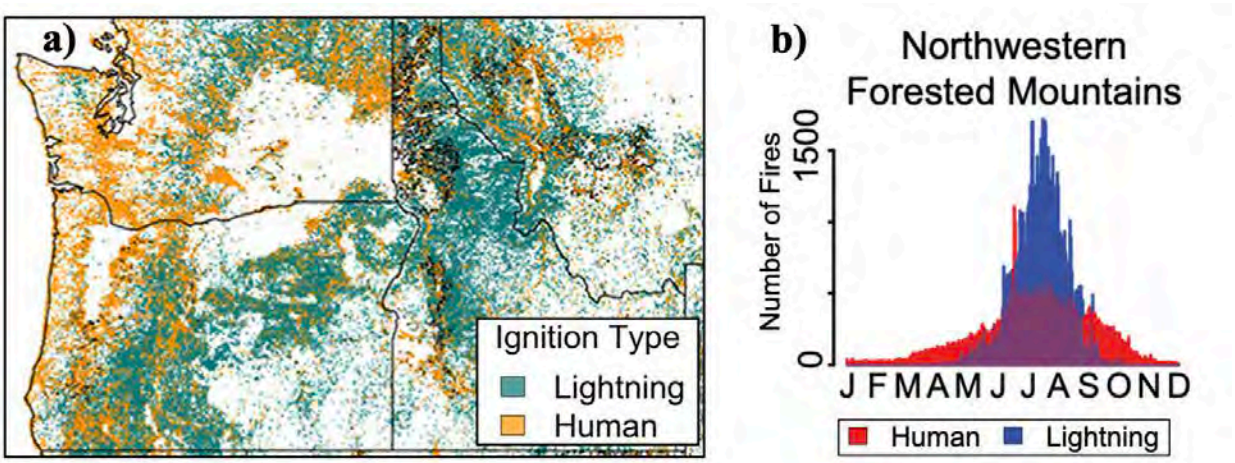

Figure 2. (a) Location and ignition type of wildfires from the federal Fire Program Analysis Fire Occurrence Data (1992–2015) from Brey et al. 2018. Reprinted with permission from John Wiley and Sons. (b) Seasonal distribution of human and lightning-caused wildfires over the Northwestern Forested Mountains ecoregion (1992–2012) from Balch et al. 2017. Reprinted with permission from the journal.

many homes, and exposed communities to high concentrations of smoke, which is associated with numerous public health impacts (see *Public Health*, this volume).

Lightning, and lightning-caused wildfires, are an inherent part of Oregon's climate and ecology east of the Cascade Range (Agee 1993). Nevertheless, human-caused climate change has the potential to increase the number, severity, and size of wildfires. Across Oregon, the number of wildfires ignited by lightning has increased in the past three decades (Dalton and Fleishman 2021). A warming, drying climate has similarly caused increases in the area burned by wildfires across the western United States in recent decades, irrespective of ignition source (Abatzoglou and Williams 2016, Holden et al. 2018). Trends in lightning are more difficult to ascertain due to inconsistencies in the observing network over time (Cummins and Murphy 2009), and future projections of lightning for Oregon also are uncertain (Villarini and Smith 2013, Hoogewind et al. 2017). However, the area burned by lightning-caused fires in central Oregon (Barros et al. 2021) and the western United States (Li et al. 2020) is projected to increase during the twenty-first century due to anticipated further warming and drying of the region during summer.

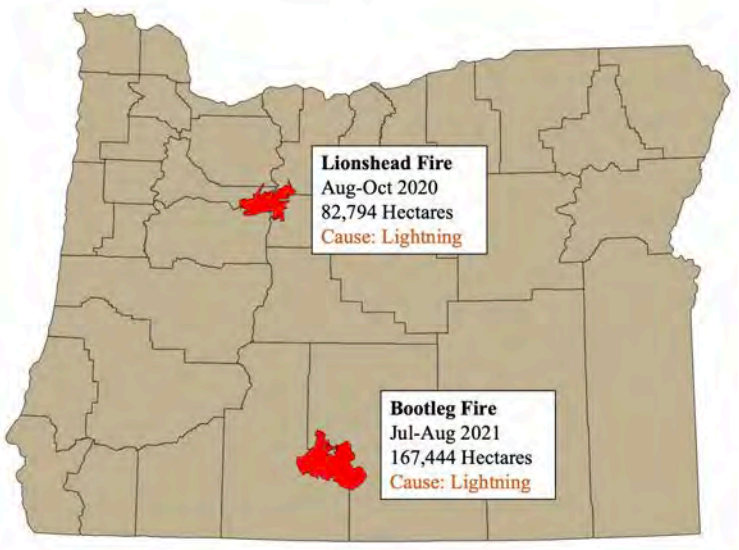

Figure 3. The Lionshead and Bootleg Fires. Wildfire perimeters and burned area from the National Interagency Fire Center (2022).

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Wildfires, Behaviors, and Policy Support

Hilary Boudet, Leanne Giordono, Muhammad Usman Amin Siddiqi, Greg Stelmach, Chad Zanocco, and June Flora

Extensive wildfires in September 2020 (see *Wildfire Trends and Drivers*, this volume) shaped Oregonians' disaster preparedness and support for climate mitigation and adaptation policies. From 28 December, 2020, through 23 February, 2021, we administered a survey to a sample of 1308 Oregonians whose distribution of gender, age, and education mirrored that of the general Oregon population. We asked survey recipients about their experience with the wildfires, their attitudes and beliefs about the link between the wildfires and climate change, their behaviors related to personal and property protection, and their support for policies designed to reduce the risk from future wildfires (Boudet et al. 2021, 2022; Giordono et al. 2021).

Factors Associated with Disaster Preparedness and Community Helping Actions

We examined and compared factors associated with two types of individual-level behaviors, disaster preparedness and community helping (volunteering and donations), after the wildfires (Siddiqi et al. unpublished ms). Disaster preparedness can mitigate risks associated with future wildfires, whereas volunteering and donations can add surge capacity that aids trained emergency personnel in responding to more-frequent disasters in the future.

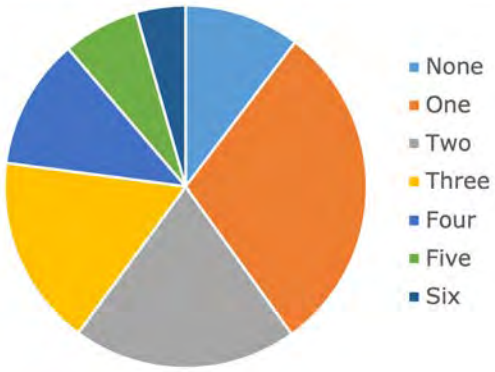

Figure 1. Number of personal actions taken to prepare for future wildfires.

Ninety percent of our survey respondents reported engaging in at least one personal action to prepare for future events (Figure 1). Common actions ranged from evacuation planning to mitigating health threats to vegetation management (Figure 2). Forty-four percent of respondents reported either donating to or volunteering with a group responding to the 2020 wildfires. Those who reported a higher number of disaster preparedness actions also were more likely to report community helping behavior. For example, 15 percent of those who took no action, 33 percent of those who took one action, and 69 percent of those who took five actions reported such helping behavior.

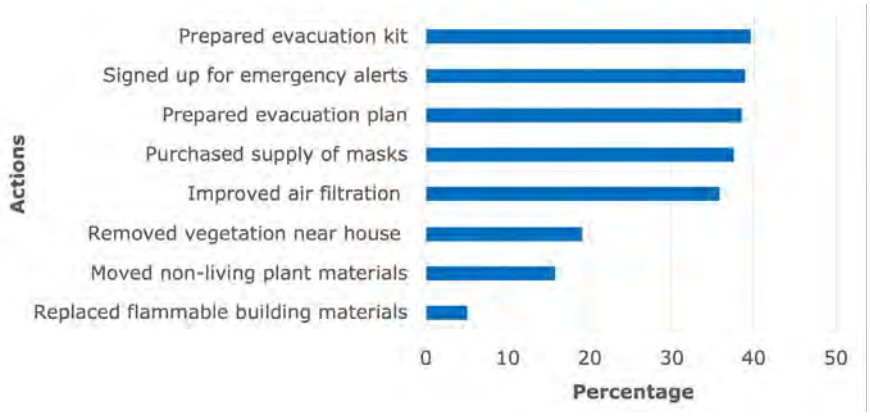

Figure 2. Types of actions taken to prepare for future wildfires.

We conducted multivariate analyses to assess the effects of social and demographic variables, beliefs, event-related harm, social interactions, descriptive norms, and information sources on disaster preparedness (ordinal logistic regression) and community helping behaviors (logistic

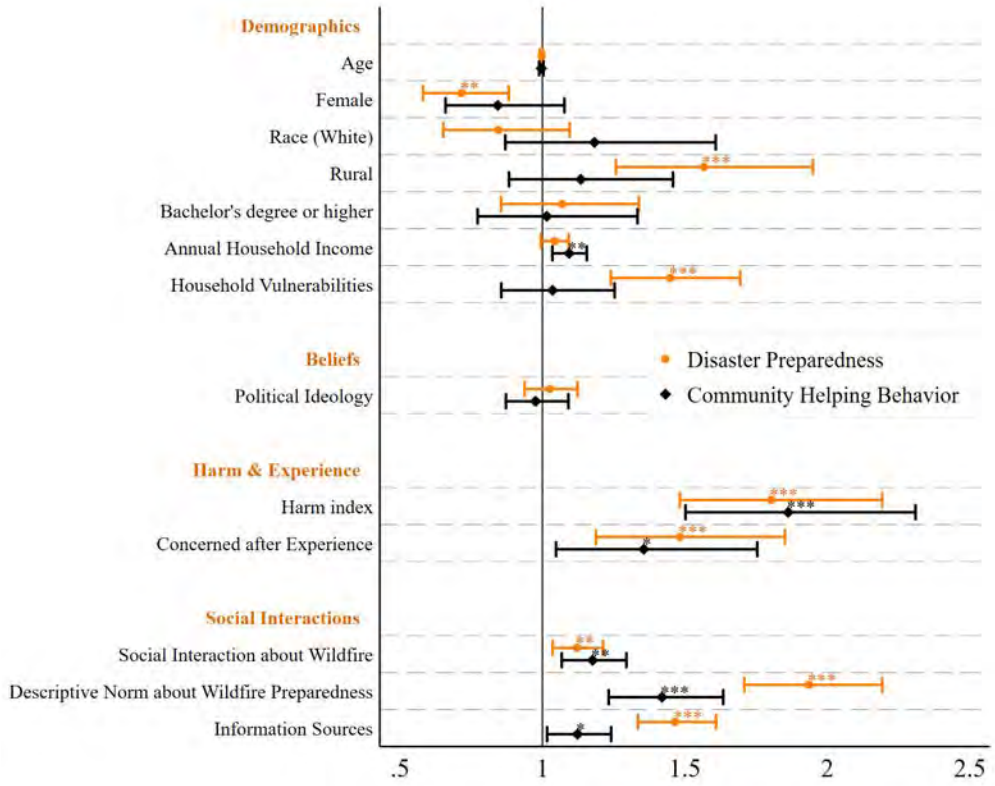

Figure 3. Factors associated with disaster preparedness (number of actions taken to prepare for future wildfires) and community helping behavior (donating or volunteering at least once). Estimates and 95% confidence intervals (capped lines) that did not overlap 1.0 were considered to be statistically significant (*, p <0.05; **, p <0.01; ***, p <0.001).

regression). Male respondents, those living in rural areas, and those who had vulnerable individuals in their households were significantly more likely to report that they took a greater number of actions to prepare for future wildfires (Figure 3). People from higher-income households were more likely to report that they donated or volunteered. Age, race, educational attainment, and political ideology were not significantly associated with disaster preparedness and community helping actions (Figure 3).

Reported harm from the 2020 Oregon wildfires and social and media interactions were also linked to disaster preparedness and community helping actions. We developed a composite mean index of reported harms from the fires to daily activities, property, finances, physical health, and mental health. Those who reported experiencing a higher degree of harm from the wildfires reported taking a greater number of disaster preparedness actions, and they were more likely to report a community helping action (Figure 3). We also developed a second experience-related variable, whether a respondent reported being more concerned about climate change after their experience with the wildfires. Although neither disaster preparedness nor community helping actions were associated with respondents' political ideology, those who reported more concern about climate change after experiencing the 2020 wildfires were more likely to report preparedness and community helping actions (Figure 3).

Our findings were consistent with earlier research on the role of information sources, wildfire-specific social interactions, and subjective norms in shaping behavioral intentions and outcomes. Respondents who sought information about the wildfires from more sources (e.g., television news, local newspapers, online sources); talked more frequently with friends and family about the wildfires; and thought that higher percentages of their friends, neighbors, and community members were taking actions to prepare for future wildfires were more likely to report preparedness and

community helping actions. These results suggested that information seeking, communication, and experience affect individual actions after wildfires.

Drivers of Support for Climate Policies

Among our respondents, 59–89 percent reported strong support for policies designed to mitigate carbon emissions (Figure 4), and 50–93 percent reported strong support for adaptation policies designed to limit the impacts of future extreme events (Figure 5).

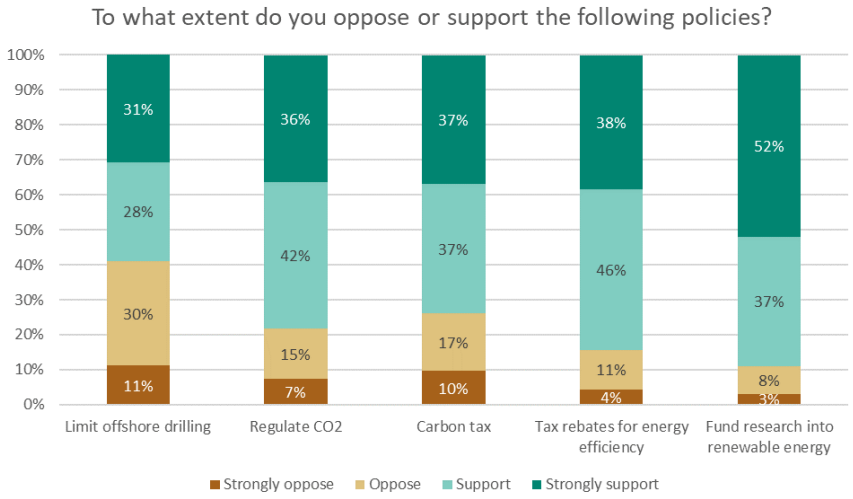

Figure 4. Public support for climate mitigation policies.

We used ordinary least squares models to estimate associations between key factors (e.g., social and demographic factors, event experience, event attribution beliefs, risk perceptions, information processing) and policy support. Our dependent variables included five adaptation policies and an index of mitigation policies. We then used seemingly unrelated estimation to formally assess similarities and differences between drivers of support for mitigation and adaptation policies (Figure 6).

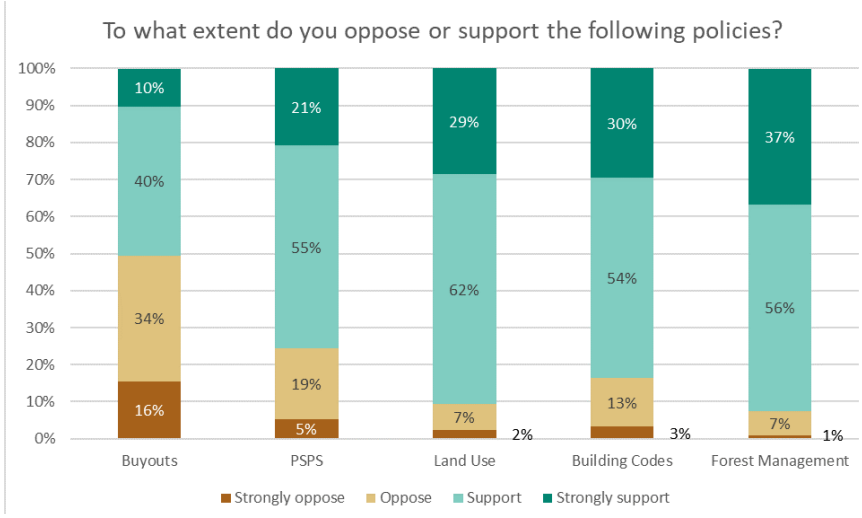

Figure 5. Public support for climate adaptation policies.

Common drivers of support for both mitigation and adaptation policies included political ideology, perceived causes of the wildfires, and climate change concern. Conservatives expressed less support for both types of climate policies than liberals, whereas more support was expressed by individuals who attributed the wildfires primarily to climate change and those who reported more concern about climate change after experiencing the 2020 wildfires. However, the effects differed in magnitude. Political ideology was more strongly associated with support for mitigation policies than for adaptation policies, whereas causal attribution and climate change concern were more strongly associated with adaptation-policy support. Our results suggest that attitudes toward adaptation policies may be less politicized than attitudes toward mitigation policies.

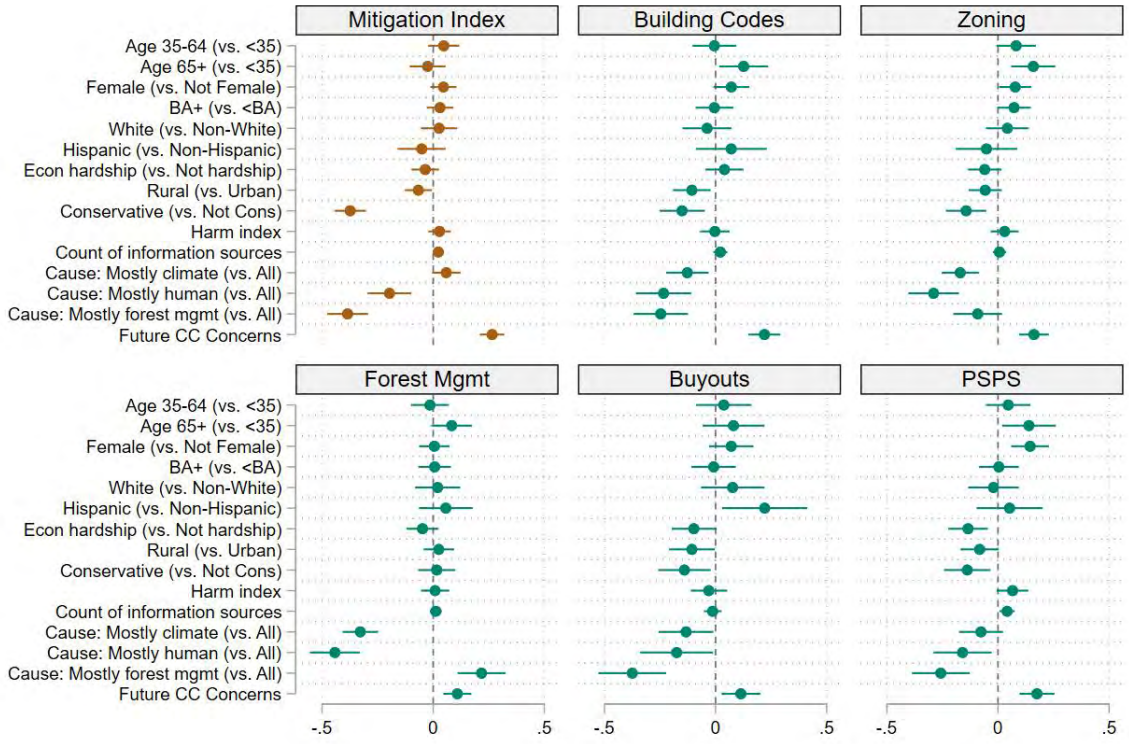

Figure 6. Factors associated with support for mitigation and adaptation policies. PSPS, public safety power shutoffs. Estimates (circles) and 95% confidence intervals (lines) that do not overlap 0 were interpreted as evidence of strong associations.

We also found evidence of associations between demographic characteristics and policy support. Respondents living in rural areas, compared to those in more urban settings, expressed less support for mitigation policies and selected adaptation policies—especially stricter building codes, property buyouts, and public safety power shutoffs (when utility companies shut off electricity to limit wildfire risk). These results may reflect the locally accrued costs of such adaptation policies, which are likely to place more burden on rural residents, especially homeowners, than on urban residents. Although there was no association between age and support for mitigation policies, there was a positive association between age and support for selected adaptation policies, including building codes, land use, and public safety power shutoffs.

Furthermore, the survey responses indicated a link between respondents' exposure to poor air quality during the wildfires and support for public safety power shutoffs (Zanocco et al. 2022). Not only did a strong majority support public safety power shutoffs as an adaptation strategy (Figure 5), but exposure to higher concentrations of wildfire smoke was correlated with higher levels of support. We used U.S. Environmental Protection Agency monitoring station data to estimate daily average air quality index (AQI) values for each respondent's zip code during September 2020. Survey respondents who experienced the worst air quality during that month, as measured by the maximum AQI and the number of days on which air quality was unhealthy, were more likely to support public safety power shutoffs than those who lived in areas with better air quality.

Although public safety power shutoffs are only one among many means of reducing wildfire risk, high levels of support for the shutoffs, especially among those who were exposed to wildfire smoke, suggest that Oregonians may be receptive to shutoffs. An important caveat, however, is

that public safety power shutoffs have not been widely deployed as a mitigation strategy in Oregon, and widespread implementation may reduce support. Additionally, at least in the near term, the effects of public safety power shutoffs are unlikely to be equitable. Sustained power outages can pose substantial health risks, especially to vulnerable populations, due to loss of home cooling and medical equipment. Public safety power shutoffs are most likely to occur in rural areas, which often lack public resources to offset such losses for those who do not have financial resources to secure backup power sources such as gasoline-powered generators or solar-plus-storage battery systems.

There was an equally strong and consistently positive association between concerns about future risks from climate change and support for mitigation and adaptation policies. Our results suggest that concerns about the climate change-driven risks of similar future events surpass, or potentially supplant, the effects of harms experienced during the event in shaping policy support.

Individuals who attributed the wildfires primarily to climate change tended to express consistently less support for adaptation policies than those who attributed the wildfires to a more-diverse set of causes. This suggests a reluctance among individuals who attributed the wildfires almost solely to climate change to shift from mitigation-oriented solutions to adaptation-oriented solutions. It is possible that a strong social identity (for example, as a climate-change fighter) may preclude alternative actions. In contrast, those who attributed the wildfires to forest management practices tended to be less supportive of mitigation policy and more supportive of changes in management.

Our results suggest that Oregonians took personal and community helping actions in the wake of the wildfires to better protect themselves from future events and to help their communities recover. The results also suggest relative high levels of support for climate policies designed to limit emissions (mitigation) and the impacts of future extreme events (adaptation). Nevertheless, people took different pathways to these actions and support. Policy support, especially for or against mitigation policy, appeared more strongly related to political ideology, whereas personal preparedness and community helping actions were more strongly tied to information seeking, social interactions, perceived norms, and event experience.

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Public Response to the 2020 Wildfire Smoke Event in Oregon

Michael Coughlan, Heidi Huber-Stearns, Benjamin Clark, and Alison Deak

Introduction

In September 2020, smoke from multiple large wildfires covered much of the west coast of the United States, causing an unprecedented decline in air quality for consecutive days. During this period, the Oregon Department of Environmental Quality (DEQ) observed record-high levels of hazardous air pollution in six of Oregon's major population centers (Figure 1). Air quality in some communities in Oregon was so hazardous that it exceeded the maximum value, 500, on the U.S. Environmental Protection Agency's air quality index (AQI). Air quality in Eugene, Oregon, was hazardous (AQI 301–500) for eight consecutive days. Although this event was unusually severe and occurred over an extraordinary large area and time period, the frequency and severity of wildfire smoke events in Oregon has increased over the past decade and is projected to increase further (Yang et al. 2022).

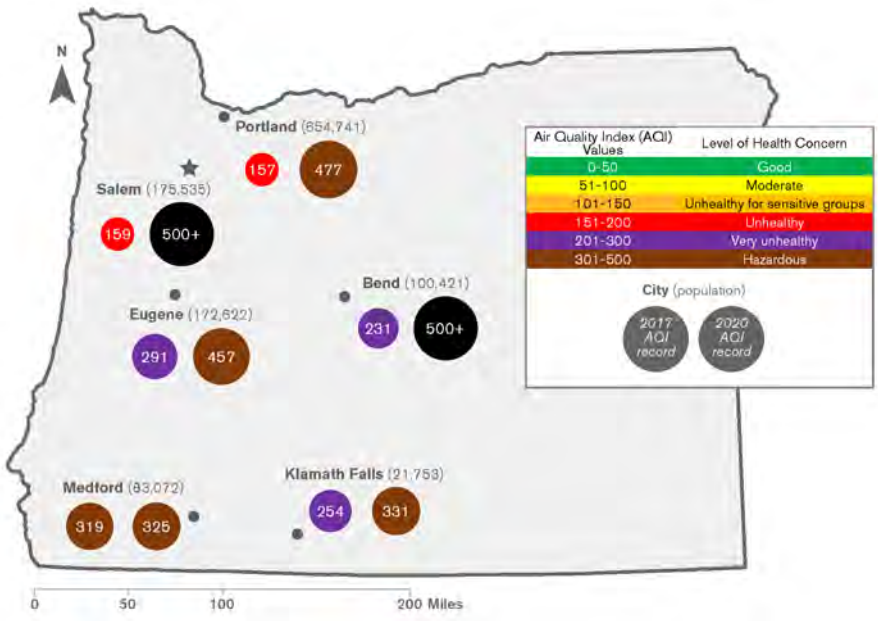

Figure 1. Air Quality Index (daily $PM_{2.5}$ and other health-related pollutants) records set in 2017 (left circle) and 2020 (right circle) in Oregon's six largest population centers.

Public attitudes, knowledge, and behavioral responses to wildfire smoke are not well studied, in part because wildfire-related research has primarily focused on responses to the fires (e.g., suppression, mitigation, evacuation, recovery) rather than the hazards of smoke. Yet wildfire smoke is a serious concern for public health because it is a substantial source of aerosols (particulate matter <2.5 microns in diameter, or $PM_{2.5}$) and other air pollutants (Wiedinmyer et al. 2006, Yu et al. 2022). High $PM_{2.5}$ levels (>150 AQI) can yield adverse respiratory outcomes, particularly asthma and chronic obstructive pulmonary disease, increased heart disease, and cardiac arrest (Dixon and Robertson 2018; also see *Public Health*, this volume). Exposure to wildfire smoke is the most common way that people experience wildfires (Navarro et al. 2018). It is becoming increasingly clear that smoke from wildfires poses an order of magnitude greater threat, in terms of deaths and total costs to society, than wildfire flames themselves (Doerr and Santín 2016; also see *The Economic Implications of Climate Change for Oregon*, this volume). Although U.S. air quality improved in recent decades due to the regulation of transportation and industrial pollution, an increase in the number and size of wildfires in the western United States has contributed to declining air quality through the associated smoke (McClure and Jaffe 2018, O'Dell et al. 2019, Yu et al. 2022).

Climate change is a major driver of increases in wildfire occurrence, severity, and wildfire smoke exposure in the western United States (Westerling et al. 2006, Westerling 2016, Iglesias et al. 2022). Given current climate trends, wildfire smoke hazards will likely continue to grow in this region (Wiedinmyer et al. 2006, Liu et al. 2016, Yang et al. 2022). The challenge is not only learning how to live with the increased frequency and severity of wildfires but learning how to respond to smoke. Here, we present the results of a state-wide survey, conducted in summer 2021, that asked respondents about their experiences with smoke and air quality during the 2020 wildfires. Given the widespread acknowledgment of the magnitude of smoke, its duration, and the number of communities and individuals exposed during those events, it will be highly informative and useful to track changes in public knowledge, attitudes, and behaviors surrounding smoke in the future. We suggest that our survey can serve as a baseline reference for future assessments of Oregon residents' concerns and responses to wildfire smoke.

Methods

We designed a social survey instrument to collect data on Oregon residents' concerns, communication needs, and responses to wildfire smoke during the 2020 wildfire season. We administered the survey electronically via the Qualtrics software application for data collection. Respondents could take the survey in either English or Spanish. To maximize data collection efficiencies and retain respondent attention by minimizing total response time, many of the survey questions allowed for multiple response options and used display logic tied to the previous responses. The survey instrument is available from the University of Oregon Scholars' Bank (scholarsbank.uoregon.edu/xmlui/handle/1794/26984).

We distributed the survey through two recruitment efforts that we refer to as recruitment A and recruitment B. Recruitment A relied on an internet audience panel, and provided participants with a hyperlink to the Qualtrics survey. Although the goal of recruitment A was to obtain a representative sample, rural populations were oversampled to provide a more-even distribution of urban and rural perspectives and experiences. Recruitment B was designed to draw a targeted sample of Oregon residents who identify as Hispanic or Latinx to better understand one of Oregon's largest historically under-represented groups. Sampling for recruitment B relied on a Facebook marketing campaign, provided a monetary incentive (gift card), and targeted Oregon residents who speak Spanish or identify as Hispanic or Latinx. The two recruitment methods have distinct potential sampling biases. Different assumptions and considerations are necessary to understand how the resulting samples relate to the whole population. Given these issues, we conducted separate statistical analyses for each recruitment and describe many of the responses with respect to each sample.

We hypothesized that past experiences with smoke, urban or rural residency, housing situations, language preferences, ethnicity, physical ability, and other demographic factors that make people more or less vulnerable to smoke impacts would influence their communication preferences and how they experienced wildfire smoke during the 2020 wildfire season. Consequently, in addition to asking respondents for standard demographic information, we collected data about where they live, how often they are exposed to smoke, and characteristics of their household. We used these data to construct explanatory factors for statistical analysis (Table 1). For example, respondents with rural zip codes were coded as members of the rural demographic explanatory factor (rural = 1), and those with urban zip codes were coded as not belonging to the rural demographic (rural = 0). Similarly, we asked respondents to report their age by categories: 18–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and 85 or older. Respondents who selected age categories of 65 years or older

were coded as older respondents (older = 1), and those who selected age categories as under 65 years of age were coded as not older (older = 0).

Explanatory factor groups	Type of factor	Definition	Recruitment
Rural	Geographic	Respondent zip code	A&B
Older	Age	Respondents 65 years of age or older	A
Lower income	Household income	Respondents who reported that their household rarely or sometimes has enough money to pay bills	A&B
Disability	Abilities	Respondents who reported living with one or more disability	A&B
Non-homeowner	Housing	Respondents who did not own a home	A&B
Non-English language	Language preference	Respondents who reported a preference for a language other than English	A
Spanish	Language preference	Respondents who reported a preference for Spanish	B
Hispanic/Latinx	Ethnicity	Respondents who self-identified as Hispanic or Latinx	A
Non-white or Hispanic/Latinx	Ethnicity	Respondents who self-identified as an ethnicity other than White, Hispanic, or Latinx	A
High exposure	Smoke exposure	Respondents who reported more than five days of exposure to smoke per year	A&B
Vulnerable populations	Multiple	Respondents who either met the U.S. Environmental Protection Agency criteria for populations more vulnerable to smoke or who reported that one or more members of their household fit those criteria[1].	A

[1]Vulnerable populations are considered to be at higher risk of health impacts from wildfire smoke. These groups include people with asthma, other respiratory diseases, or cardiovascular disease, children, pregnant women, adults 65 years of age or older, people of low socioeconomic status, and outdoor workers (U.S. EPA 2021).

Table 1. Demographic explanatory factor groups, definition, and applicability to recruitment groups.

Due to sampling criteria and limitations, some factors were only applicable for analysis of one of the recruitment groups. For example, we could not assess statistical relationships for the older demographic factor for recruitment B because no respondents in that sample were 65 or older. Similarly, we did not assess the Hispanic/Latinx demographic factor for recruitment B because that group comprised 100 percent of the sample. By contrast, we did not assess Spanish language preference in recruitment A because too few respondents indicated a preference for Spanish.

Because multiple response options were possible for many of the questions, we used logistic regression to assess whether relationships between a response option and membership or non-membership in an explanatory demographic were statistically significant ($p < 0.05$). Below, we report odds ratios and p-values for a selection of our statistically significant results. Odds ratios are measures of association between an explanatory factor (in our case, membership in a particular demographic group) and an outcome (selection of a given response). In our analysis, odds ratios indicate the probability that a response was selected relative to the probability that it was not selected, given membership or non-membership in each of the set of demographic criteria (Table 1). Data, including the coding used in the logistic analysis, are available from the University of Oregon Scholars' Bank (scholarsbank.uoregon.edu/xmlui/handle/1794/27175).

Results

We obtained 1200 responses from Oregon residents who experienced the 2020 wildfire smoke events, 971 from recruitment A and 229 from recruitment B. Responses were split between rural and

urban zip codes. Fifty percent of respondents in recruitment A, and 23 percent in recruitment B, were rural (45 percent rural total) (Figure 2). Full demographic details are archived at scholarsbank.uoregon.edu/xmlui/handle/1794/27179. Approximately 85 percent of recruitment A respondents identified as White, compared with 87 percent of Oregon residents (Figure 3) (www.census.gov/quickfacts/OR). The 6 percent of respondents who identified as Hispanic or Latinx represented the largest non-White identity. By contrast, 13 percent of Oregon residents identify as Hispanic or Latinx. However, across the two recruitments, 24 percent of respondents identified as Hispanic or Latinx. Across the two recruitments, 91 percent of respondents selected English as their

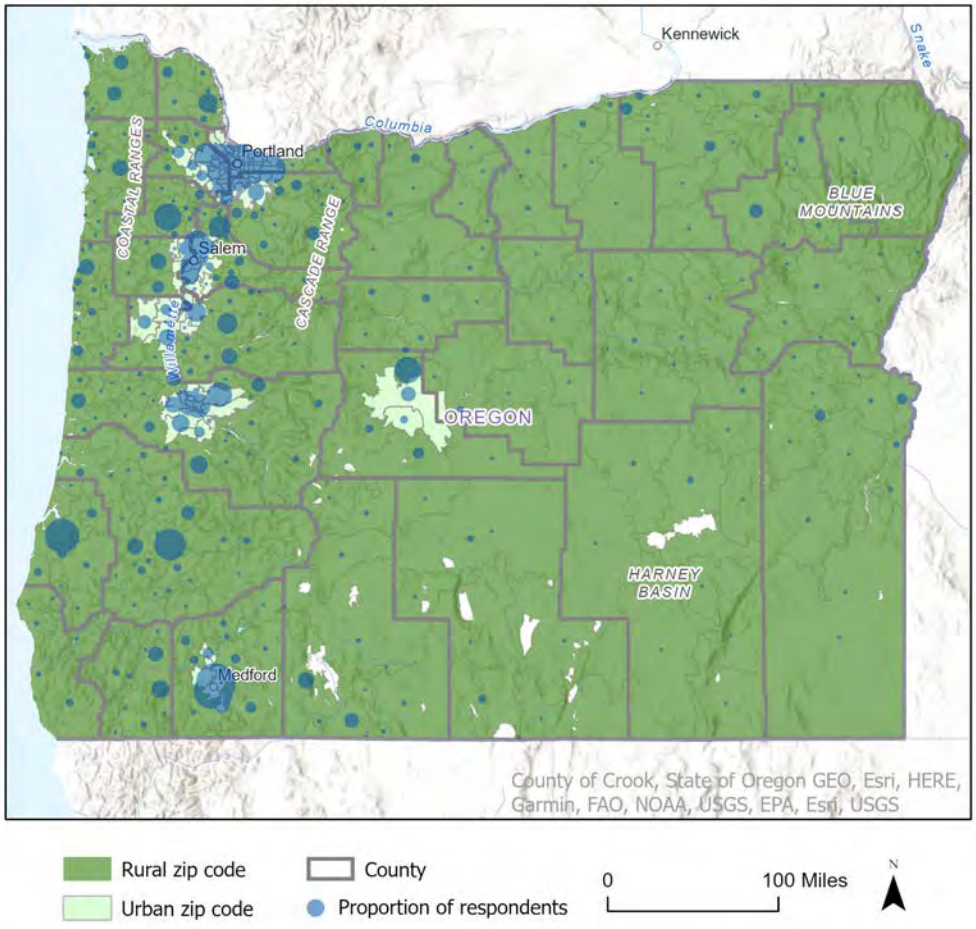

Figure 2. Urban and rural zip codes, counties, and the proportion of respondents from each zip code. The proportion of respondents is represented by blue circles centered on the zip code geography.

preferred spoken language (Figure 3). Another 7 percent selected Spanish, followed by Vietnamese (n=4), Russian (n=2), Mandarin (n=2), Cantonese (n=2), and simplified and Chinese (n=1). Ten respondents selected "other" as a preferred language; text entry included two Japanese and one each Norwegian, German, and Korean. Respondents' ages were fairly evenly distributed across age categories, but with lower representation of populations 75 years old or older; no individuals over 55 were represented in recruitment B. For gender identity, 49.5 percent selected "woman", 47.5 percent "man", 2 percent "non-binary/non-conforming", 0.5 percent "prefer to self-identify", and 0.5 percent "prefer not to answer." Approximately 45 percent of respondents reported having at least

one disability, with physical disabilities (16 percent) and mental health disabilities (15 percent) the most common.

We identified 99 positive and 85 negative statistically significant associations (of 688 possible) between a given explanatory factor and question response (Table 2; respondents could select multiple responses for many questions). Below we highlight several of the more relevant results.

Vulnerable Populations Within Respondent Households

Respondents' demographics and responses to a question about the potential vulnerability of respondents' household members suggested that one or more members of the households of 85 percent of respondents, including themselves, are potentially more vulnerable to harm from wildfire smoke. In total, 36 percent of respondents met one or more criteria for increased vulnerability to wildfire smoke impacts, whereas another 49 percent responded that at least one of their household members met those criteria. For some groups, this percentage was even higher. For example, 86 percent of respondents from recruitment A who identified as Hispanic or Latinx reported that their household included members of vulnerable populations. By comparison, nearly 100 percent of recruitment B respondents reported household members who could be considered more vulnerable. Across the two recruitment efforts, 97 percent of Hispanic/Latinx respondents and 83 percent of rural respondents reported that at least one member of their household could be considered more vulnerable to wildfire smoke.

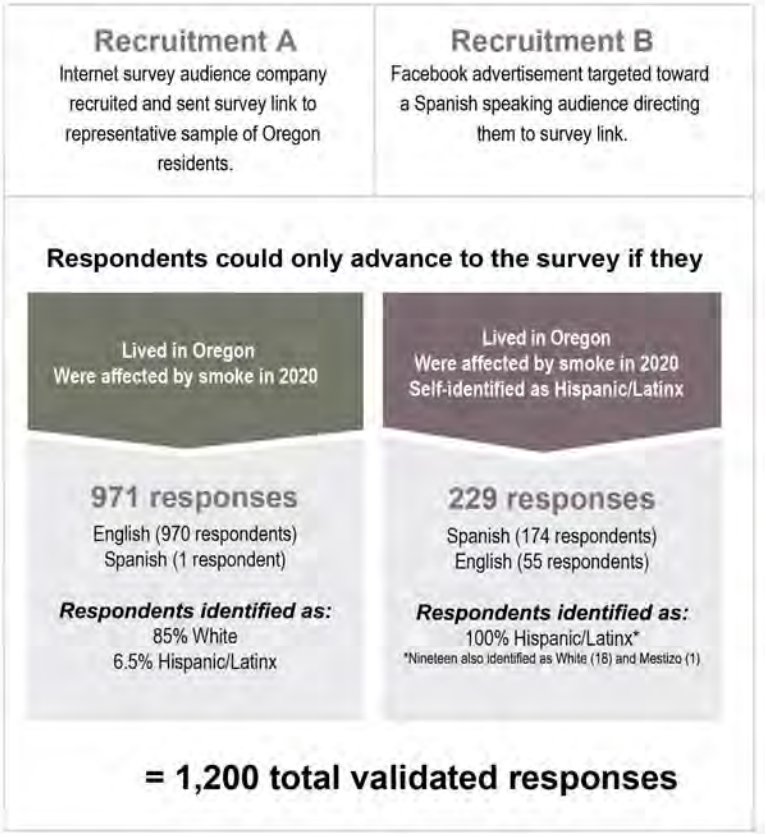

Figure 3. Survey response results for the two recruitment efforts.

Smoke Exposure

We asked respondents how often they think they are exposed to unhealthy air quality from wildfire smoke in a given year (Figure 4). Across the two recruitment efforts, 38 percent of respondents reported perceived exposure on five or more days per year. Twenty-three percent of rural residents, and 16 percent of all residents, reported perceived exposure over more than two weeks per year.

Evacuations

We asked respondents if they evacuated to a different location because of smoke or wildfire in 2020. Over 25 percent reported that they evacuated. The percentage of evacuees in recruitment B

Table 2. Associations between recruitment-specific explanatory factors and question responses. Odds ratios <1.0 and >1.0 indicate negative and positive associations, respectively (respondents within the specified group were less likely or more likely than not, respectively, to select the response). Negative associations are shaded gray.

Question	Response	Recruitment	Explanatory factor	Odds ratio	P-value
Q3.2 Did you have any concerns about air quality during the 2020 wildfire season?	I was concerned about the risks of smoke to my health	A	Rural	0.61	0.001
		A	Exposed	1.91	0.000
Q3.7 Which of these factors contributed the most to your preparedness?	I have experienced smoke events before	A	Rural	1.58	0.035
		A	Exposed	1.66	0.020
Q3.8 Would you have felt more prepared if you had access to . . .	Clean air shelters in my community	A	Low income	1.88	0.004
		A	Vulnerable household	1.66	0.023
		A	Do not own home	1.54	0.018
Q3.9 Did you take any protective measures or make changes to your routine outdoor activities?	Yes	A	Low income	0.67	0.047
		A	Do not own home	0.65	0.005
		B	Low income	0.22	0.032
		A	Vulnerable household	1.55	0.011
		A	Exposed	1.41	0.029
Q3.10 Which of the following protective actions for outdoor air did you take?	Stay home or reduce the number of times I left my home	A	Low income	0.67	0.041
		B	Exposed	0.38	0.017
	Avoid or reduce the total time I spent in usual outdoor recreation or exercise	A	Do not own home	0.58	0.000
		A	Rural	0.75	0.035
	Use a N95, KN95, or respirator when outdoors	A	Rural	0.53	0.000
		A	Vulnerable household	1.77	0.013
		B	Exposed	3.49	0.004
	Use another type of mask outdoors	A	Exposed	1.40	0.039
Q3.11 Did you take any protective measures while indoors?	Yes	A	Low income	0.64	0.027
Q3.12 Which of the following protective actions did you take while indoors?	Installed or used HEPA air purifiers	A	Rural	0.67	0.028
		A	Vulnerable household	1.25	0.335
	Installed or used a homemade box fan HEPA air filter indoors	A	Vulnerable household	2.18	0.023
	Installed or used a commercial HEPA or HVAC air system	A	Exposed	2.44	0.008
	Created a cleaner air space in my home (e.g., kept windows and doors shut)	B	Exposed	2.71	0.029
		B	Do not own home	0.28	0.001
		B	Low income	0.25	0.002
	Used a N95, KN95, or respirator when indoors	B	Disability	13.91	0.000
		B	Exposed	4.95	0.000

Question	Response	Recruitment	Explanatory factor	Odds ratio	P-value
Q3.5 What information about smoke-related air quality would you like to have? (Select all that apply)	How to stay safe while engaging in outdoor activities	A	Exposed	1.50	0.004
		B	Exposed	4.71	0.000
	Information about personal protective equipment	A	Exposed	1.78	0.000
		B	Prefer Spanish	3.11	0.004
		B	Disability	3.75	0.001
	Forecasts about air and smoke conditions	A	Exposed	1.93	0.000
		B	Prefer Spanish	4.49	0.001
		B	Disability	6.30	0.000
	Safety of food from my garden or the market	B	Prefer Spanish	3.29	0.007
	How to stay safe while indoors	B	Disability	4.29	0.000

(76 percent) was considerably higher than that in recruitment A. Although this result should not be interpreted as representative of the entire Hispanic/Latinx population in Oregon due to the methods used for recruitment, it is notable.

Concerns About Smoke During the 2020 Wildfire Season

Approximately 72 percent of respondents indicated that during the 2020 wildfire season they were concerned about the effects of smoke on their health. A similar percentage indicated that they were concerned about the health of vulnerable people. High-exposure respondents (those who reported that they were exposed to five or more days of wildfire smoke per year) from recruitment A were more likely to indicate health concerns than respondents who reported less exposure. However, rural respondents from recruitment A were less likely than urban respondents to indicate health concerns.

Preparedness for the 2020 Wildfire Smoke

Nineteen percent of respondents from recruitment A reported that they were prepared for the 2020 wildfire smoke event before it happened, and 68 percent reported that they were not prepared. By contrast, approximately 85 percent of the target Hispanic and Latinx survey respondents (recruitment B) reported that they were prepared for the 2020 smoke event. Across recruitments, 72 percent of the 378 individuals who felt prepared reported that previous experience with smoke contributed to their preparedness. High exposure and rural populations from recruitment A were statistically more likely to indicate that prior experience contributed to their preparedness. Across recruitments, 63 percent of respondents indicated that they already had emergency supplies at home, and 53 percent indicated that their community had a response plan for wildfire and smoke. Among respondents who said they were not prepared or were unsure, 62 percent said they would have felt more prepared if they had access to adequate household protections such as air filters, doors and windows that seal, and emergency supplies. About 53 percent said they would have felt more prepared if they had access to information about the possibility of a smoke event, and just under 50 percent said they would have felt more prepared if they had access to personal protective equipment such as respirators, masks, and asthma medications. Within recruitment A, lower-income populations, non-homeowners, and vulnerable populations were more likely to indicate that access to clean air shelters would have made them feel more prepared.

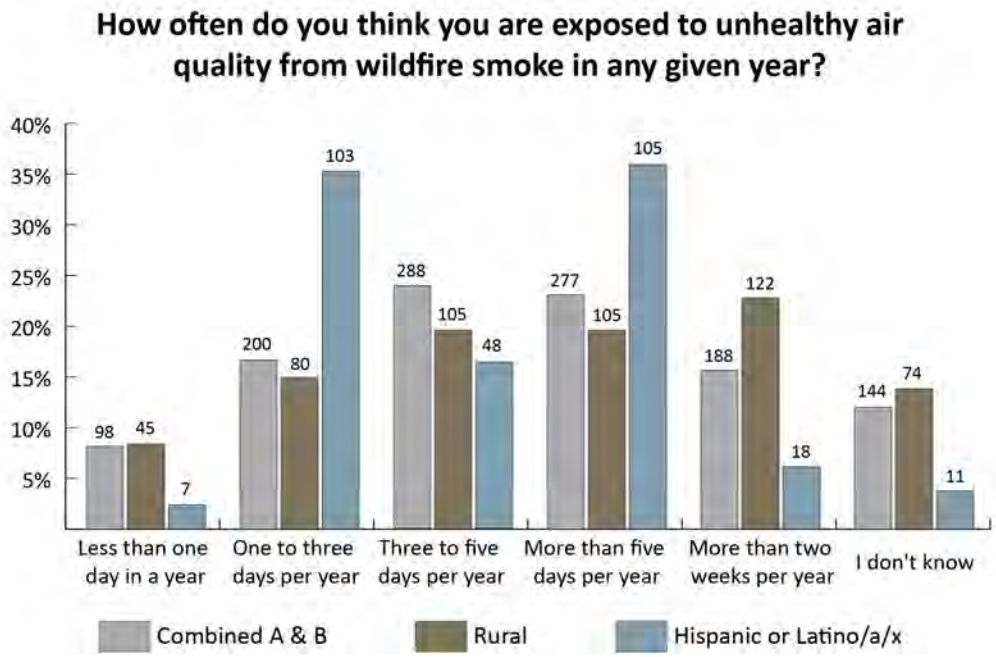

Figure 4. Self-assessed annual exposure to wildfire smoke across recruitments A and B. X-axis, perceived annual frequency of smoke exposure; Y-axis, percentage reporting. Numbers above each bar indicate the number of respondents who selected each option.

Protective Action Responses to Smoke During the 2020 Wildfire Season

Most respondents in both recruitments (77 percent) reported that they took protective measures or changed their daily routine while outdoors. However, lower-income respondents were less likely to indicate that they took protective actions, as were non-homeowners from recruitment A. These lower-income and non-homeowner populations were less likely to indicate that they stayed home, avoided going outside, or reduced their total time outdoors. Similarly, rural populations from recruitment A were less likely to report that they avoided or reduced time spent outdoors or used an N95 mask, KN95 mask, or respirator. Nevertheless, high exposure and vulnerable populations were more likely to indicate that they took protective measures outdoors. For example, vulnerable populations were more likely to indicate that they used an N95 mask, KN95 mask, or respirator outdoors, whereas high exposure populations were more likely to indicate that they used other types of masks, such as cloth or surgical masks used to prevent the spread of COVID-19.

A clear majority of respondents from recruitment B (95 percent) said they took protective actions while indoors. However, fewer than half of respondents from recruitment A (42 percent) said they took protective measures while indoors. Again, lower-income respondents in recruitment A were less likely to say they took protective actions indoors. Rural respondents from recruitment A were less likely to have used a portable, high efficiency particulate air (HEPA) filter. In comparison, vulnerable populations from recruitment A were more likely to have used a portable HEPA air purifier or a homemade box fan HEPA air filter. High exposure populations from recruitment A were more likely to have installed a commercial HEPA heating, ventilation, and cooling (HVAC) air system, and high exposure populations from recruitment B were more likely to have created a cleaner air space in their home or have used an N95 mask, KN95 mask, or respirator in their home.

Informational Preferences and Needs

Most respondents (63 percent) indicated that they relied on their observations to provide information about air quality during the 2020 wildfires. Among media sources, the internet (websites, email, social media) was selected by 67 percent of respondents, and television was chosen by 58 percent of respondents. High exposure populations from both recruitments were more likely to select multiple sources of information, including television and friends and family. Within recruitment A, lower-income and rural populations were less likely to choose television. Populations other than White and Hispanic/Latinx in recruitment A were more likely to select friends or family.

Most respondents (79 percent) indicated that they would like more forecasts related to air and smoke conditions. Many respondents also said that they would like more information about how to stay safe indoors (58 percent), how to stay safe while engaging in outdoor activities (52 percent), and personal protective equipment (55 percent). Members of high exposure populations from recruitment A, respondents with a preference for Spanish from recruitment B, and respondents living with disabilities from recruitment B were more likely to indicate multiple informational needs.

Discussion

Survey Limitations and Caveats

We acknowledge that our sample was limited to people who regularly use the internet, therefore excluding those who lack access and ability to use the internet and those who choose to avoid internet use. Furthermore, because recruitment A was administered via a commercial internet survey panel audience, we cannot verify that the sample truly represents Oregon residents. According to the American Community Survey, from 2016–2020, 9.9 percent of people in Oregon were living with a disability. By contrast, 45 percent of respondents to our survey reported living with at least one disability. We suggest that this apparent oversampling of individuals with disabilities may relate to how the commercial panel recruited and maintained their audience. We observed similar issues related to recruitment B. Because recruitment B was distributed through a Facebook advertisement that relied on preexisting social networks and offered a monetary incentive, the sample did not represent Hispanic/Latinx Oregon residents. Indeed, recruitment B sampled a population with unusually high exposure to wildfire smoke, experience with wildfire evacuation, and preparedness for smoke events. Half of the respondents from recruitment B still reside in communities that were under evacuation orders during the 2020 wildfires (Talent and Phoenix, Medford, and McKenzie River). Others, we suspect, were part of the diaspora that resulted from the loss of homes during those fires. Therefore, recruitment B responses must be interpreted within this context.

Concerns About Smoke

Consistent with previous findings (Ellison et al. 2021), we found that most respondents were concerned about the impacts of smoke on their health or the health of vulnerable people. On the one hand, although it is relatively novel for people to be concerned about ephemeral and superficially innocuous hazards such as wildfire smoke, our survey demonstrated that increased exposure to smoke is correlated with health concerns. On the other hand, this effect may vary on the basis of geography. For example, although rural respondents may be more exposed to wildfire smoke for longer durations during the year, they were less likely to be concerned about the effect of smoke on their health or the health of vulnerable populations.

Preparedness for Smoke

Previous experience with smoke also appeared to correspond with people's level of preparedness for coping with wildfire smoke. For those who were not prepared for the 2020 smoke event, increased availability and access to adequate household protections, information about the possibility of a smoke event, and access to personal protective equipment would contribute to better preparedness. These results suggest the need to increase the number and reach of public programs focused on dissemination of smoke-related information as well as programs that assist in the distribution of air filtration devices such as HEPA air filters, HEPA HVAC systems, and masks that filter $PM_{2.5}$. It also is evident that there is a demand among lower-income populations, non-homeowners, and vulnerable populations for public access to clean air shelters. For some populations (e.g., outdoor workers), staying indoors with filtered air is not an option. We highlight this as a key area for public health focus as exposure to wildfire smoke increases in the Pacific Northwest (see, for example, the state of Oregon's rules to address employee exposure to wildfire smoke: osha.oregon.gov/OSHAPubs/factsheets/fs92.pdf).

Protective Action Responses

Although most of our respondents indicated that they took some protective actions during the 2020 smoke event, most actions applied to outdoor activities. Less than half of respondents within recruitment A indicated taking protective measures indoors. The lack of protective actions was even more pronounced for lower-income populations from both recruitments. This suggests a need to improve communication and outreach about how people can improve their indoor air quality during a wildfire smoke event. Furthermore, informational outreach to lower-income populations and non-homeowners may need to be paired with programs that provide assistance with the purchase of upgrades for HVAC systems, stand-alone air purifiers, and other protective equipment.

Informational Needs

Given that most respondents indicated that they relied on their observations to inform them about smoke, it appears that people were tracking changes in air quality on some level. However, some of the most volatile pollutants from smoke are invisible to the naked eye, and accurate air quality assessments require more-sophisticated instrumentation. The availability of local to regional air quality monitoring sensors and resulting dissemination of information has markedly improved in recent years with advances in cellphone, internet, and computing technologies. In addition, most respondents indicated that they would like to have more information on smoke conditions and forecasts of smoke. Although there are numerous options for obtaining air quality information, such as smartphone apps and text alerts, reaching a wider audience with timely information may require additional creative efforts in a range of culturally appropriate modalities.

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Coastal Hazards

Felicia Olmeta Schult, Peter Ruggiero, Meredith Leung, and Mohsen Taherkhani

The changing climate will continue to affect hazards along the coast and estuarine shorelines of Oregon, with social and economic effects on coastal communities. Property owners, businesses, and local governments will need to respond to these hazards and impacts while evaluating trade-offs between public and private interests. Recent assessments, analyses, and reports have documented increasing rates of sea-level rise and erosion along Oregon's coasts, and measures are being implemented or considered to adapt to these changes.

Observed and Projected Trends in Sea Level

The Oregon coast is within Cascadia, which is defined by the subduction of the Juan de Fuca Plate under the North American Plate. The imminent rupture of the Cascadia Subduction Zone will greatly affect the Oregon coast's inhabitants, infrastructure, and ecosystems. The probability of a Cascadia-wide, tsunami-generating earthquake in the next 50 years is approximately 15–25 percent, and the probability of a partial rupture on the southern Oregon coast is about 37–43 percent (Atwater 1987, OSSPAC 2013, Frankel et al. 2015). Tectonics has a substantial effect on the region's exposure to chronic coastal hazards through its influence on geomorphology and rates of relative sea-level rise (Burgette et al. 2009, Komar et al. 2011).

Primarily due to tectonic uplift, relative sea-level rise rates are slower in Oregon than in many other coastal regions of the United States. In some areas of the Oregon coast, tectonic uplift has kept pace with increases in sea level. However, relative sea-level rise rates along much of the Oregon coast are at least 1 mm per year less than the current global average (~3.4 mm [0.13 in] per year; Sweet et al. 2022). For example, whereas relative sea level in southern Oregon (Coos Bay and south) and northern Oregon (Cannon Beach and north) is either falling slightly or stable, relative sea-level rise rates in central Oregon have been 1–3 mm (0.04–0.12 in) per year since at least the 1970s (Komar et al. 2011). Developing high-resolution estimates of alongshore vertical uplift rates, which affect local projections of relative sea-level rise and chronic coastal hazards, is a high priority.

The National Oceanic and Atmospheric Administration (NOAA) recently released regional sea-level rise scenarios for the United States coastline from 2000–2150 that incorporate the best estimates of uplift at a resolution of one degree (about 111 km [69 mi]) (Sweet et al. 2022). By 2050, the expected rise in sea level will cause total water levels to increase and change coastal flood regimes throughout the United States, with major and moderate high-tide flood events occurring as frequently as moderate and minor high-tide flood events occur today. The emissions-based, probabilistic sea-level rise projections included low (0.3 m [1 ft] of global mean sea level rise by 2100), intermediate-low (0.5 m [1.6 ft.]), intermediate (1.0 m [3.3 ft]), intermediate-high (1.5 m [4.9 ft]), and high (2.0 m [6.6 ft]) scenarios. These projections (Table 1), combined with observed sea-level rise at NOAA tide gauges in South Beach and Astoria, Oregon, highlight the wide range of sea-level rise expected along this tectonically active coastline (Figure 1).

Effects of Climate Change on Storminess Patterns

Substantial uncertainties hamper quantification of how climate change will affect storminess patterns. The El Niño-Southern Oscillation is a key driver of interannual global climate variability. El

	Year								
	2040			2070			2100		
City	Low	Intermediate	High	Low	Intermediate	High	Low	Intermediate	High
Port Orford	6	11	16	11	32	78	16	79	182
Charleston	7	11	17	13	33	78	18	81	183
Newport	9	14	19	17	37	82	25	87	187
Astoria	3	7	12	6	25	68	9	69	167

Table 1. Projected sea-level rise (cm) over time at four cities in Oregon given scenarios of low (0.3 m [1 ft]), intermediate (1.0 m [3.3 ft]), and high (2.0 m [6.6 ft]) global sea-level rise (Sweet et al. 2022).

Niño events, which are characterized by considerable warming of sea surface temperatures in the central and eastern equatorial Pacific (Lindsey 2009), affect the physical drivers of coastal hazards during winter storms in the Pacific Northwest, such as variation in wind direction, increased wave energy, and elevated water levels along the coast (Barnard et al. 2015). The frequency, intensity, and location of El Niño events vary within the Pacific Ocean basin, and forecasting of El Niño events and their future climatology is an area of active research (e.g., Yan et al. 2020). Historically, major coastal flooding and erosion along the Oregon coast was more likely during El Niño years (e.g., Barnard et al. 2015). Due to anomalies in physical processes, such as elevated water levels and higher wave energy from the southwest, local erosion along the west coast of the United States tends to be high during major El Niño seasons. For example, many of the beaches in Tillamook County eroded substantially and either took many years to recover, or have not yet recovered, from the effects of the 1997–1998 El Niño and the severe winter of 1998–1999 (Ruggiero et al. 2013). Areas of erosion included the village of Neskowin immediately north of Cascade Head, Rockaway Beach, and Cape Lookout State Park (Ruggiero et al. 2013). The most recent major El Niño event (2015–2016) caused the average seasonal erosion on the Oregon coast to be up to 30 percent greater than the previous year. Coastal flooding and erosion deplete sand from beaches and make them more susceptible to elevated water levels and enhanced wave energy during future storms. Higher precipitation rates during El Niño seasons can increase runoff and compound flooding hazards by elevating the local sea surface.

Despite growing attention to improving data and modeling techniques, there is considerable uncertainty about climate change-induced shifts in long-term trends in the frequency and intensity

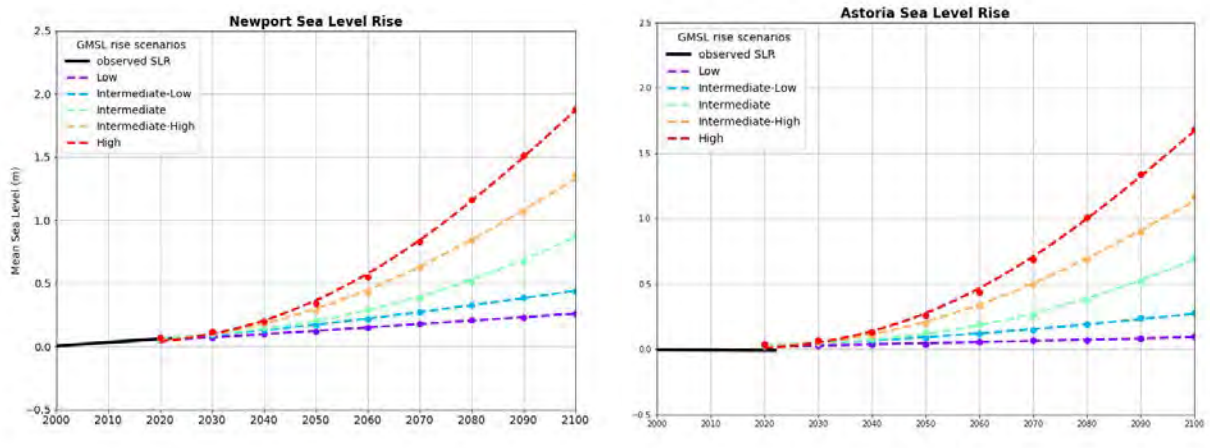

Figure 1. Observed and projected regional sea-level rise (Sweet et al. 2022) from 2000 through 2100 at two tide gauges in Oregon. Local tectonic and hydrodynamic processes affect differences among local projections.

of extreme El Niño events (Collins et al. 2010). One study projected that the magnitude of El Niño events in the twenty-first century would be indistinguishable from those in the twentieth century (Stevenson 2012), whereas another found that the frequency and intensity of extreme El Niño events may increase by as much as 100 percent by 2100 (Cai et al. 2015), potentially intensifying hazards along the Oregon coast. It also has been suggested that the strength of El Niño will weaken over millennia as carbon emissions increase (Callahan et al. 2021).

Effects of Climate Change on Coastal Erosion and Flooding

Relative sea-level rise narrows the gap in elevations between commonly occurring high tides and the thresholds above which coastal flooding and erosion begin. Therefore, increases in extreme coastal water levels along the Oregon coast increase coastal erosion and coastal flooding impacts.

			Percentage of transects eroded, 2002–2016		
Littoral cell (south to north)	2002–2016 (m/year)	1967–2002 (m/year)	Total	More than -1 m / year	More than -3 m / year
Brookings	-1.50 ± 0.04	-0.05 ± 0.10	90	59	18
Pistol	-1.10 ± 0.06	0.50 ± 0.10	75	56	11
Gold Beach	-1.60 ± 0.03	0.60 ± 0.10	83	63	22
Nesika	-0.70 ± 0.30	-0.40 ± 0.20	67	41	8
Humbug	-0.50 ± 0.03	-0.40 ± 0.10	81	24	0
Port Orford	-1.00 ± 0.03	-0.30 ± 0.10	64	41	23
Bandon	-0.60 ± 0.03	0.20 ± 0.10	65	40	7
Coos	-1.00 ± 0.03	0.03 ± 0.10	75	52	11
Heceta	-0.20 ± 0.05	-0.10 ± 0.10	60	26	0
Newport	0.20 ± 0.04	-0.50 ± 0.10	50	24	2
Beverly	-1.00 ± 0.08	-1.1 ± 0.10	84	55	0
Lincoln	-0.80 ± 0.03	-0.30 ± 0.10	71	50	10
Neskowin	-1.90 ± 0.06	-1.10 ± 0.10	85	70	27
Sand Lake	0.50 ± 0.10	-0.50 ± 0.10	36	20	1
Netarts	-0.40 ± 0.10	-1.00 ± 0.10	65	28	0
Rockaway	0.02 ± 0.06	0.60 ± 0.10	44	25	7
Cannon Beach	0.30 ± 0.08	-0.50 ± 0.10	39	13	4
Clatsop	0.30 ± 0.02	1.90 ± 0.10	40	19	1
Oregon average	-0.70 ± 0.01	0.03 ± 0.02	65	42	9

Table 2. Average rates of shoreline change (meters per year) along the Oregon coast from 2002–2016 and associated uncertainties (Light 2021). Red, statistically significant erosion; blue, statistically significant accretion. Average rates of shoreline change and values from 1967–2002 from Ruggiero et al. 2013.

A multi-decadal, statewide analysis identified both a general increase in shoreline erosion along the Oregon coast in recent decades and significant spatial variation within and among littoral cells (coastal compartments within which sediment movement is self-contained) (Light 2021). Shoreline change was statistically significant in seventeen of the eighteen primary littoral cells (all but Rockaway) along the Oregon coast from 2002–2016 (Table 2). Furthermore, the shoreline in five littoral cells in southern Oregon (Coos, Bandon, Gold Beach, Pistol, and Brookings) accreted from 1967–2002 but eroded from 2002–2016. By contrast, shorelines in three littoral cells in central and northern Oregon (Newport, Sand Lake, and Cannon Beach) eroded from 1967–2002 and accreted from 2002–2016. The average statewide rate of change from 2002–2016 was -0.7 m (-2.3 ft) per year; 65 percent of locations (transects) studied eroded, and 42 percent eroded at rates more than 1 m per year. The highest average erosion rates tended to be in southern Oregon. A larger percentage of transects in Oregon eroded during 2002–2016 (65 percent) compared to the 1967–2002 period (54 percent).

Figure 2. Coastal erosion at Gleneden Beach, Lincoln County, March 2021. Photograph by Hailey Bond.

Additionally, although erosion exceeded -1 m (-3.3 ft) per year in 18 percent of transects along the Oregon coast from 1967–2002, erosion exceeded -1 m per year in 42 percent of transects from 2002–2016 (Figure 2). Estimates of shoreline change from 2002–2016 (Light 2021) likely include the impacts of the major 2015–2016 El Niño event and are therefore biased toward erosion.

Taherkhani et al. (2020) used data from tide gauge stations and projections of future sea-level rise (Kopp et al. 2014) to investigate continuous shifts in flooding along coastlines in the United States. They found that approximately 7 cm (2.8 in) of sea-level rise along the Oregon coast doubles the odds that annual flood levels will exceed the 50-year event threshold (a level with a 2 percent chance of occurring in a given year). The odds of this magnitude of flooding double approximately every 6 years until 2075. These results were based on the high emissions scenario in Sweet et al. (2022) and assumed climate stationarity.

Effects of Coastal Hazards on Communities and Infrastructure

Increases in water levels due to sea-level rise and possible changes in patterns of storminess will increase the frequency and magnitude of coastal erosion and flooding (e.g., Figure 3). Below, we highlight potential effects on coastal communities and infrastructure and efforts being implemented or considered to adapt to these hazards.

Figure 3. Coastal flooding in Nehalem, Oregon, on 6 November 2021. Photograph by Tyler Sloan, Oregon King Tides Project (CC BY-NC-SA 2.0).

The U.S. Army Corps of Engineers used Climate Central's (2021) Surging Seas Risk Finder to estimate the potential effects of 1 and 2 feet (0.3 and 0.6 m) of sea-level rise on populations, land, property, and infrastructure within the United States (USACE 2022). On the Oregon coast, approximately 781 homes and 1318 people are

within the area that would be inundated by 1 foot of sea-level rise (Table 3) (USACE 2022). An estimated 18 percent of those individuals have high social vulnerability as estimated on the basis of 29 variables related to wealth, racial and social status, ethnicity, age, health insurance, special needs, ethnicity, employment, and gender. An additional 307 homes and 627 individuals, 157 of them with high social vulnerability, are located within the area that would be inundated by 2 feet of sea-level rise.

	Below 1 foot	Below 2 feet
Population	1318	1945
High social vulnerability population	238	395
Homes	781	1088
Roads (miles)	30	51
Wastewater treatment sites	12	14
Land (square miles)	58	75
Protected land (square miles)	15	20

Table 3. People, infrastructure, and land in Oregon below 1 and 2 ft (0.3 m and 0.6 m) of sea-level rise (data source: Climate Central 2021; table adapted from USACE 2022). These estimates should be used for planning-level purposes only. The values in the table may overestimate or underestimate exposure to flooding. Protected land records are from the U.S. Geological Survey. Protected areas are those dedicated to the preservation of biological diversity and to other natural, recreational, and cultural uses, and managed for these purposes through legal or other effective means.

In 2018, the Oregon Department of Geology and Mineral Industries (DOGAMI) assessed the risks of natural hazards to the communities of Coos County, Oregon (Williams et al. 2021). This risk assessment estimated that 1870 buildings will be damaged by a 100-year flood scenario (i.e., 1 percent chance of flooding in a given year), causing an estimated loss of $125 million, damage to 13 critical facilities, and displacement of as many as 2116 individuals. For example, 95 percent of flood-exposed buildings in the City of Coos Bay are not elevated above the 100-year flood level. The assessment's analysis of whether a building is within or outside of a hazard zone also estimated the number of people whose mobility may be limited by floodwaters. Many residents in the cities of Coos Bay (773), Lakeside (253), and Myrtle Point (119) may need evacuation assistance during a flood.

Figure 4. Coastal erosion at Beverly Beach and U.S. Highway 101, Lincoln County, Oregon, February 2021. Photograph by Hailey Bond.

Sea-level rise on the Oregon coast also may lead to changes in navigation channels (e.g., leading to an increase in dredging and adjustment of channel location and dimensions), increased scouring at structure foundations, and decreased clearance under bridges and port infrastructure (USACE 2022). U.S. Highway 101 and other major transportation routes and facilities along the Oregon coastline will become increasingly susceptible to erosion, flooding, and landslides as climate changes (Figure 4). The Oregon Department of Transportation has supported research with the aim of enhancing the resilience of Highway 101 to coastal hazards (Box 1).

Approaches to Coastal Climate Change Adaptation

Many climate-change adaptation measures are being implemented or considered in coastal Oregon. These include hard structures (gray infrastructure), soft structures (natural and nature-based features), a combination of hard and soft structures, and nonstructural measures (e.g., policies and regulations) (Table 4). Hard structures are typically designed to armor the backshore to prevent erosion landward of the structure (e.g., riprap revetments). Soft structures, such as salt marsh restoration, beach nourishment, and dynamic cobble revetments, are intended to maintain or restore the shoreline by mimicking natural processes (USACE 2022). The function and performance of new hard and soft structures will be affected by sea-level rise. For example, increased wave attack associated with sea-level rise may reduce the stability of hard protective structures (USACE 2022). Sea-level rise will also likely erode foredunes, potentially necessitating repeated nourishment.

Substantial efforts are underway to use dredged sediments and soft structures (e.g., dynamic revetments, dune restoration) instead of shoreline hardening to maximize ecological benefits. For example, a dynamic revetment is dissipating wave energy and slowing erosion at Cape Lookout State Park (Figure 5) and the Columbia River South Jetty.

Structural adaptations		
Type	**Strategy**	**Description**
Hard structures	Jetties	Jetties extend into a body of water to direct and confine a stream or tidal flow to a selected channel and to limit shoaling of the channel. Jetties at the entrance of a bay or river also protect the entrance channel from storm waves and crosscurrents.
	Riprap revetments	A layer of stone intended to limit erosion and create hard armoring (Johannessen et al. 2014).
	Seawalls	Concrete structures that are built to withstand storm waves and protect costly infrastructure.
	Dredging	Primary method of managing sediment accretion along harbors, ports, and jetties to maintain draft for ship traffic and channel depth for navigation. In some cases, the dredged material is used rather than deposited offshore.
Soft structures	Wetland and salt marsh restoration, enhancement, or creation	Creation of a wetland on a site that was historically non-wetland, rehabilitation of a degraded wetland, or reestablishment of a wetland so that soils, hydrology, vegetative community, and habitat are a close approximation of the original natural condition that existed prior to modification to the extent practicable (USDA 2021). Among the benefits of wetlands and salt marshes are flood-risk reduction and buffering against erosion of adjacent uplands.
	Dune restoration, replenishment	Dune grass planting, fencing, and other techniques to trap sand.
	Beach nourishment	Replenish eroding beaches while maintaining recreational uses and habitat that would be lost with a hard structure. May involve use of dredged materials (Stronkhorst et al. 2018).
	Use of dredged materials	Intentional placement of dredged sediment to provide economic, environmental, and societal benefits by supporting beach nourishment, wetland construction, and replenishment of the littoral zone (Gailani et al. 2019).
	Dynamic revetments or cobble berms	Gravel or cobble beaches constructed at the shore in front of a property to be protected. The sloping, dynamic, porous cobble beach disrupts and dissipates wave energy (Allan et al. 2005).
Nonstructural adaptations		
Type	**Strategy**	**Description**
Policies	Zoning restrictions	Reduce the number of structures built in high-risk zones. Require developers to construct structures that are more resilient to erosion, flooding, or other expected impacts of climate change.
	Managed retreat	As the shoreline migrates inland, move people, critical facilities, and structures further inland to avoid coastal hazards.

Table 4. Approaches to coastal climate-change adaptation (modified from USACE 2022).

Knowledge Gaps and Adaptation Efforts

Knowledge Gaps and Needs

Figure 5. Dynamic revetment at Cape Lookout State Park, Tillamook County, Oregon, March 2021. Photograph by Hailey Bond.

The U.S. Army Corps of Engineers recently compiled research and management recommendations, actions, and needs from regional stakeholders and tribal partners to improve coastal resilience to current and future climate change in the Pacific Northwest (USACE 2022). Stakeholders indicated a clear need for sustained monitoring of shoreline change, increased frequency of airborne LIDAR surveys, and digital open-source repositories of regional shoreline-change data. High-priority research includes the prediction of future shoreline erosion and accretion from multiple stressors. Although concentrations of accretion and erosion are known, sediment sources, sinks, and transport pathways in Pacific Northwest estuaries are not well quantified. A better understanding of sediment movement and sediment budgets would improve overall sediment management, inform dredging in Pacific Northwest estuaries, and create opportunities for use of dredged sediments. Furthermore, standardized criteria for evaluating project success are needed to understand the geophysical, ecological, economic, and cultural impacts of projects.

In Oregon, over 3500 oceanfront parcels without shoreline armoring, about 40 percent of the oceanfront parcels in the state, are eligible to install armoring (Beasley and Dundas 2021) because they were developed before 1977. Ongoing public engagement and outreach are necessary to inform property owners about the anticipated evolution of the coastal zone and trade-offs associated with shoreline management options (Mills et al. 2018). Given that shoreline management decisions have diverse environmental, economic, and community impacts, a single infrastructure investment is unlikely to result in sustainable long-term shoreline management. Integrating shoreline management with coastal resilience planning can improve emergency response plans, habitat restoration plans, and community development.

Technical and financial support is needed by small, under-resourced, and traditionally under-represented communities that struggle to apply for planning and implementation grants to adaptively manage their shorelines. Barriers include matching-fund requirements and traditional National Economic Development Plan benefit-cost analysis ratios. Some of these communities have high relative social vulnerability and will face disproportionate burdens of coastal flooding and hazards.

Potential flood mitigation by wetlands is well established in the literature. However, reduction in flood risk by wetlands restoration in the region to date, and by potential future restoration under a range of sea-level rise scenarios, is not well understood. State and federal agencies and

Box 1. Monitoring and adaptation along U.S. Highway 101

The Oregon Department of Transportation commissioned two research projects with Oregon State University to inform their proactive management of sea-level rise induced sea cliff erosion, landslides, and flooding on U.S. Highway 101. The first project used advanced sensors to monitor and evaluate stability and activity of steep sea cliffs and slopes due to climate change at five sites where

Figure B1. Damage resulting from a landslide along an unstable, erosion-prone section of U.S. Highway 101 south of Port Orford, Oregon (June 2022). Photograph by Michael Olsen.

erosion has been prevalent (Senogles et al. 2022). The second project evaluated hazards at over 70 sites on Highway 101 and prioritized the sites on the basis of their levels of risk (Alberti et al. 2022). At five of those sites, the project quantified the benefits and costs associated with alternatives such as no mitigation and eventual loss of that section of highway, rerouting, natural revetments, and different levels of structural accommodation.

In addition to informing potential revisions of state planning goals, this research is building a common understanding of risks and needs associated with the management of coastal hazards and building partnerships among federal, state, and local stakeholders, which include the Federal Highway Administration, Oregon Department of Geology and Mineral Industries, Oregon Parks and Recreation Department, and Oregon Department of Land Conservation and Development. Furthermore, the research addresses the resilience and reliability of Oregon's transportation system for the traveling public.

nongovernmental organizations participating in wetlands restoration in the region note that information is inadequate to support planning and engineering for natural and nature-based features in the Pacific Northwest (Janousek et al. 2019).

Project and Resource Highlights

Many recent and ongoing efforts in Oregon aim to increase understanding and knowledge of the effects of climate change on coastal hazards and promote actions to create and maintain resilient coastal communities. These projects and resources target diverse audiences, including coastal homeowners, businesses, visitors, planners, scientists, communities, state agencies, and tribal staff.

The Oregon Climate Change Adaptation Framework identifies high-priority climate risks, their expected impacts, and short-term actions by which state agencies might reduce these risks. Actions addressing sea-level rise include updates to the state's residential design standards and building codes in floodplains and acquisition of homes at risk from coastal flooding. The updates to the floodplain design standards and residential building codes now require that structures constructed in coastal high-hazard areas be elevated by at least 1 foot (0.3 m) above the 100-year flood base elevation, and prohibit the construction of basements (DLCD 2021).

The Cascadia Coastlines and Peoples Hazards Research (CoPes) Hub, funded by the U.S. National Science Foundation, seeks to inform and enable integrated hazard assessment, mitigation, and adaptation—including comprehensive planning, policy-making, and engineering—through targeted scientific advances in collaboration with communities. The processes that the Cascadia CoPes Hub is studying include increasing total water levels due to climate change, coastal erosion trends, subduction megaquake frequency, movement of debris by tsunamis, best management practices to maintain connections among coastal communities and protect the communities from hazards, and exclusionary, regional risk governance processes. To achieve equitable and just outcomes, the Cascadia CoPes Hub strives to respect and incorporate traditional and local ecological knowledge.

The Oregon Department of Land Conservation and Development's Oregon Coastal Management Program received funding from the National Fish and Wildlife Foundation's Coastal Resilience Fund to engage coastal communities in Coos and Tillamook counties in identifying resilience needs and planning estuary restoration projects. The aims of the process include empowering local communities to implement coastal resilience activities and increasing local understanding of trade-offs among coastal resilience projects (M. Reed, personal communication).

In addition to clarifying what is and is not a beachfront protective structure, the Oregon Coastal Management Program's erosion control guidebook provides information on Statewide Planning Goal 18 (beaches and dunes), the policies and land-use goals most relevant to the Oregon coast, typical and atypical permitting processes for erosion control, and details about erosion control measures that are viable for the Oregon coast. Implementation requirement 5 of Statewide Planning Goal 18 limits the placement of beachfront protective structures to areas that were developed before January 1977. This policy effectively places a cap on the amount of ocean shore that may be hardened, and therefore limits the cumulative impacts of such hardening. Shoreline armoring fixes the shoreline in place, traps sediment, and causes scouring and lowering of the beach profile. Over time, these actions can lead to the loss of Oregon's public beaches. The Oregon Coastal Management Program also is developing a guide for local coastal jurisdictions to evaluate risks from sea-level rise and potential adaptation strategies consistent with Oregon's existing regulations (M. Reed, personal communication).

Information, strategies, and lessons learned from mitigation, adaptation, and preparedness projects along the Oregon coast are not always effectively shared among stakeholders. Therefore, Oregon Sea Grant developed the Oregon Coastal Hazards Ready (OCHR) Library & Mapper (bit.ly/OCHR-Mapper), an ArcGIS StoryMap that displays 39 case studies of coastal hazards preparedness (Oregon Sea Grant 2021). The Mapper is designed to assist individuals, communities, and tribal and local governments in identifying approaches to prepare for acute and chronic coastal hazards. In partnership with the Cascadia CoPes Hub and the Washington Department of Ecology, Oregon Sea Grant sends a monthly Pacific Northwest Coastal Hazards Resources Newsletter to the OCHR Mapper listserv, which has more than 100 subscribers.

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The Economic Implications of Climate Change for Oregon

Steven J. Dundas, Susan Capalbo, and James Sterns

Assessments of the economic impacts of a changing climate on key sectors in Oregon and the Pacific Northwest have been included in previous Oregon Climate Assessments (Dello and Mote 2010; Dalton et al. 2013, 2017; Mote et al. 2019; Dalton and Fleishman 2021). The first and second Oregon Climate Assessments provided in-depth overviews of the methods and approaches used to value these impacts and the challenges and opportunities to designing policies to enhance mitigation and adaptation. Collectively, the previous five assessments provide content on the economic impacts that remains pertinent, and we encourage readers to refer to them for further background on methods and regional economic impacts.

Here, we update previous Oregon Climate Assessments in two ways. First, we provide a more robust discussion of economic concepts and tools to better understand Oregon's climate challenges and opportunities and associated public policies and programs. Second, we highlight recent insights on climate change impacts as they relate to Oregon sectors and economic activity or to similar sectors in the Pacific Northwest. This chapter begins with a few observations from past research that are brought to bear on the design of our economic assessment efforts, continues with a discussion of climate change economics and policy tools, and then presents an update on sector-specific economic impacts in Oregon and the region.

Two Decades of Research

Oregon's economy and gross domestic product (GDP) remain highly impacted by the changing climate (e.g., increases in temperature, increased variation in the timing and intensity of precipitation). As noted in the first Oregon Climate Assessment (Dello and Mote 2010), it is nearly impossible to provide a comprehensive economic assessment of the effects of climate change on Oregon due to the breadth and diversity of Oregon's natural-resource based economy; the complexity of the interactions among sectors, climate variables, and climate-related variables; and limited empirical assessments in key areas, such as public health, migration, and sector-specific agricultural markets. Prior Oregon Climate Assessments also emphasized that many assessments have sidestepped the issue of behavioral responses and instead projected economic impacts under business-as-usual scenarios. Although business-as-usual projections provide useful information, they are best viewed as an upper bound on costs or impacts of climate change, capturing the likely impacts assuming that groups such as producers, stakeholders, and land managers do not adapt or respond to changing economic, social, biological, or physical conditions.

Over the past decade, frameworks for conducting economic assessments and for integrating site-specific evidence on the level and extent of changes in underlying biological and physical conditions into empirical findings have improved. Real-time, site-specific economic and behavioral data, better data-transfer technologies, and increases in the breadth and resolution of biological and physical information contribute to a more robust foundation of information for these assessments. Increases in stakeholder engagement are providing stronger pathways to understand and design effective policies for addressing climate change at local and transformative extents (Moore et al. 2017, Auffhammer 2018, Antle 2019). Furthermore, behavioral responses to extreme climate events that are being observed in real time can serve as the basis for ground-truthing and refining economic frameworks and predictions.

The magnitude of regional impacts of climate change hinges on the magnitude of the impacts (i.e., net costs) to local communities and businesses, changes in natural assets and ecosystem services, and behavioral responses both to these climate-induced changes and to climate policies and programs. Economists have made substantial progress in addressing the challenges associated with estimating the cost of climate impacts and valuing changes in ecosystem services and natural capital. The information in this section on key sectoral impacts in Oregon and the Pacific Northwest is testimony to such efforts. Applying sound economic principles and values to ecosystem changes conveys to society that ecological services contribute to human well-being (Figure 1). As noted nearly 25 years ago by Geoffrey Heal (1998:3), "we are coming to realize, in part through the process of losing them, that environmental assets are key determinants of the quality of life."

Figure 1. Changes in the timing and form of precipitation have substantial effects on Oregon's economy and the well-being of its residents. Photograph by Erica Fleishman.

Climate Change Economics and Policy Tools

Much of the current economy involves, directly or indirectly, the combustion of fossil fuels, which results in emissions of greenhouse gases (GHGs). The core economic problem with GHG emissions is that those who produce the emissions do not pay for that privilege, and those who are harmed are not compensated. Since the beginning of the industrial revolution, Earth's atmosphere and oceans have been treated as free resources that absorb emissions from industrial activity.

When one buys corn from a supermarket, they pay for the costs of producing the corn, and the farmers and retailers are compensated for their provision of the corn to the consumer. But when production of that corn requires the combustion of fossil fuels, whether to pump the water that irrigated the corn field or to fuel the truck that delivered the corn, an important cost is not covered: the social damage caused by GHGs that are emitted. Economists call such costs *externalities* because they are external to the market. An externality is a byproduct of economic activity that causes damages to a third party that did not participate in the market transaction.

Modern life is full of externalities. Some are harmful, such as when runoff of agricultural fertilizer enters a river, kills fish, and degrades water quality. Others are beneficial, such as when researchers discover a polio vaccine. Climate change is likely the most complex of all externalities because it involves so many activities, affects the entire planet, has enduring effects, and no individual can do much to slow the changes.

Economics teaches one major lesson about externalities: markets that fail cannot solve the problems they generate. In the case of externalities from GHG emissions, unregulated markets produce too

much because markets do not put a price on the external damages from those emissions. The market price of gasoline does not include the costs imposed on society by GHG emissions, and so gas is cheaper, people drive more, and more emissions are generated. Because an unregulated market sets prices incorrectly, governments must step in and regulate, control, or tax the activities that have significant harmful externalities. Climate change is no different from other externalities: it requires considerable governmental action to reduce harmful spillovers. This leads to a second economic challenge: a collective action problem. This problem arises when the best outcome for all would be cooperation to solve climate challenges, but many individuals, firms, and governments choose their own economic best interests, which often conflict with joint actions.

Economic Challenges to Effective Policy Decisions

Addressing the externalities that contribute to climate change, and the collective action needed for effective climate policies, present distinct challenges for five core economic reasons: the need for global cooperation, scale and irreversibility of impacts, intergenerational nature of impacts, uncertainties involved in climate systems and estimation of impacts, and unequal distribution of those impacts. In other words, the effects of climate change are likely to be costly, irreversible, unequally distributed, and experienced by current and future generations. Definition of policy goals must address uncertainties in future outcomes and the global nature of the problem.

These five challenges are complex and sometimes daunting to overcome. Regardless of where GHGs are emitted, they mix uniformly into the atmosphere and cause problems for all. Incentives exist for a collective action problem in climate change mitigation efforts because economic damage may not occur in the country that generated the emissions, and the emissions-generating country may not benefit from incurring expenditures to mitigate the problem. Low-income countries have argued that high-income countries have historically received a large share of the benefits of GHG emissions and should now bear the costs of mitigating climate damages.

Because climate change does not respect national boundaries, effective policy solutions require global cooperation. This has been a contentious debate in international discussions since the Kyoto Protocol in 1992. The economic threat from climate change often is not as recognizable as the threats that have galvanized international support for action (e.g., the Montreal Protocol to protect the stratospheric ozone layer). The fact that climate change is both external to markets and requires global cooperation is the central hurdle that policymakers must overcome if they are to slow the pace and avoid the dangers of climate change.

Providing a sense of the magnitude of impacts, an insurance industry report suggested that economic damages associated with climate change could reduce global GDP by up to 14 percent by the year 2050 (Swiss Re Institute 2021). That percentage reduction reflects damages of up to $23 trillion per year. Furthermore, many of the damages are irreversible—Earth's climate is likely to change for up to 1000 years after emissions stop due to the nature of the interaction of GHGs and the atmosphere. This suggests that some increases in temperature, aridity, and sea levels have been unavoidable since the beginning of the industrial revolution. Those effects are likely to continue further into the future the longer humans continue emitting GHGs, casting a long shadow on people and natural systems. The problem of intergeneration equity can best be described as the consequences for future generations of harm done by the current generation. Climate change experts have cited myopia, or short-term thinking, as a barrier to action on climate policy. Fundamentally, humans are an impatient species: we would rather benefit from something now and

pay for it later. This innate tendency slows progress on climate policies when the effects are not yet fully visible. It takes considerable political will to advocate for taking costly action now that will result in an uncertain amount of benefits for future generations.

Climate change requires individuals and governments to make long-term decisions with incomplete knowledge about future impacts. Knowledge of the climate system is incomplete, and future projections have uncertainties that complicate measurement of economic impacts. Economic analysis can contribute to identifying and reducing such uncertainties and informing public policy on climate change even when knowledge of how risks may play out is incomplete, but many uncertainties are likely to persist. The primary sources of uncertainty include future emissions trajectories, future changes in societal preferences, modeling limitations, measurement errors, and feedback loops. Uncertainty can affect a policymaker's degree of confidence about possible outcomes of specific decisions. Uncertainty works in both directions: the effects of climate change could be less severe than currently estimated, but could also be much more severe. Economist Marty Weitzman long argued that it is important to incorporate uncertainty and the potential for low-probability but high-impact climate events into economic and policy decisions about mitigating climate change (e.g., Weitzman 2009). The concept of irreversibility also creates its own uncertainties. On the one hand, there are well-acknowledged tipping points in the climate system (e.g., rapid melting of the Greenland ice sheet; Figure 2) that generate additional incentives to policymakers to mitigate GHG emissions now to avoid potentially catastrophic impacts. On the other hand, investments from policy actions that are not easily reversible, such as shifting economies away from fossil fuels to renewable technologies, may create a value to waiting for more information before making extensive changes. These two forms of irreversibility compound uncertainty-related issues in crafting effective climate policy (Pindyck 2021).

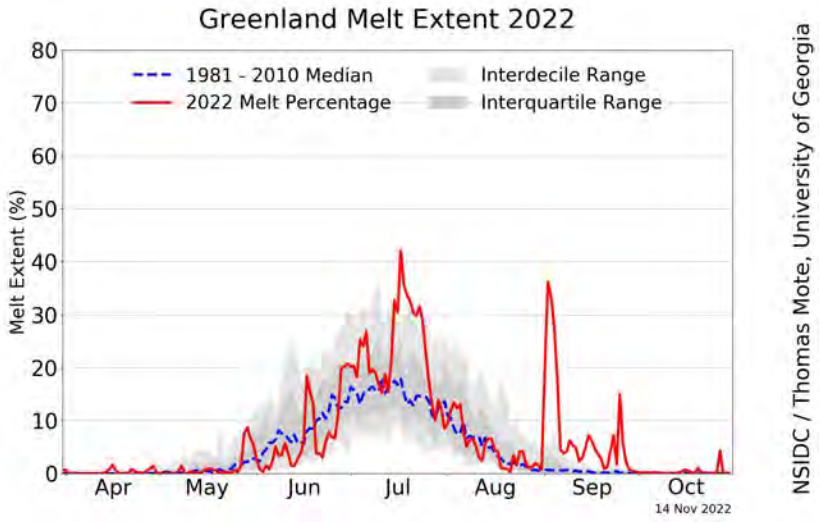

Figure 2. Recent and longer-term melting of the Greenland Ice Sheet. Source: National Snow & Ice Data Center.

The impacts of climate change vary across geographic location and social and economic status. For example, climate change is predicted to continue having a larger impact on the poorest, most vulnerable people, and there is evidence that climate change has already increased economic inequality among countries by about 25 percent (Diffenbaugh and Burke 2019). The poorest countries (and poor areas of high-income countries) are facing the worst effects of climate change, yet they are least responsible. In a system where global natural resources are shared, people often prioritize their self-interest instead of the common good, which disadvantages marginalized groups.

In the United States, there is some good news. According to the World Resources Institute, between 2005 and 2017, 41 states reduced GHG emissions while increasing their economic output (GDP),

suggesting a decoupling of economies and fossil fuel use (Saha and Jaeger 2020). Oregon was one of the 41 states that achieved decoupling, although it ranks near the bottom of the list in terms of GHG reductions (6 percent, compared to top-ranked Maryland at 38 percent).

Assessing the Economic Impacts of Climate Change

Economic impacts from recent climate-related extremes reveal substantial vulnerability and exposure of human and natural systems to climate variability. These impacts have economic consequences across a range of goods and services, such as food production and water supply, housing and transportation, and human health and mortality. For example, the Fourth National Climate Assessment suggested that climate change could reduce GDP in the United States by up to 10 percent by the year 2100 (Reidmiller et al. 2018).

Understanding the magnitude of the economic and ecological impacts of climate change is critical because most policies that can be used to reduce emissions and impacts are costly. For example, funding is needed to research and develop new technologies to make homes and other buildings more energy efficient. Market-based approaches, such as a carbon tax, would increase the cost of goods and services produced with methods that contribute significantly to climate change. An effective climate policy design would have to account not only for the economic costs that arise from policy implementation, but also for the benefits of mitigating future impacts of climate change. Estimating these impacts, and therefore the potential benefits of taking action now, is difficult. There are uncertainties in emissions trajectories, climate model outputs, and human behavior in response to policy changes. Estimation of impacts often is based on models that include sets of assumptions about the range of potential outcomes and how systems will respond to change. Hence, as recent research has shown, global economic impacts of climate change are often hard to identify and estimate because these efforts have covered a variety of economic sectors and relied on different foundational assumptions, such as the discount rate and responses to catastrophic changes.

An additional key challenge in estimating economic damages from climate change is understanding the causal links among elements of the climate system and society. Attribution of climate impacts must be separated from the impacts of day-to-day weather while accounting for humans' adaptive capacity. As explained in the fifth Oregon Climate Assessment, attribution of climate phenomena is "the process of evaluating the relative contributions of multiple causal factors to a change or event with formal assessment of confidence." For example, it was estimated that the intensity of precipitation during Hurricane Harvey, which generated extreme flooding in Texas in 2017, was 20 to 40 percent greater due to climate change (Risser and Wehner 2017). Attribution more commonly is applied to estimate changes in the likelihood of an event or class of events because of human activities than to gauge whether climate change caused a certain event.

Improving attribution can support estimation of the quantity of damage from climate change, but prices also are needed to value economic impacts of climate change. An important economic price in this context is the social cost of carbon (SCC). The SCC is an estimate, in dollars, of the economic damages that would result from a marginal change in emissions (an additional ton of GHGs) and its consequent effects on climate change, society, and ecosystem function. The impacts are estimated in dollars to help policymakers understand the outcomes of decisions that would increase or decrease emissions. The SCC is used by local, state, and federal governments in the United States and other countries to inform billions of dollars of policy and investment decisions. The SCC in the United States is around $185 per ton of carbon dioxide (Rennert et al. 2022).

Valuation of market impacts can translate climate to physical changes in economic output and then use market prices, or the SCC, to estimate damages. However, there is no market for important features of society and the natural world, such as ecosystem services, wildlife species, and human well-being and health (Figure 3), and these are often not included in SCC estimates. Although these items are not bought and sold in a manner that can reveal an economic price, they have economic value and warrant consideration when estimating impacts from climate change. Three primary sources of nonmarket economic value are likely to be affected by climate change. The first, use value, is the utility or benefit an individual receives from consuming a good or using a service. The second, option value, is a value that is placed on maintaining the environment or a particular resource so an individual has the option of enjoying it in the future even if they currently do not use it. The third, nonuse value, is the value that people assign to goods even if they never have and never will use the good. Examples include existence values, where people receive benefits from knowing that a particular resource exists (e.g., an endangered species), and bequest values, where benefits arise from preserving the availability of a resource to future generations.

Figure 3. There is no market for many features of the natural world. Photograph by Erica Fleishman.

Although many tools exist to estimate nonmarket values, the magnitude of economic loss from nonmarket environmental damage remains difficult to assess at scales relevant for integration into global climate policy discussions.

Climate Policy Options: Economic Efficiency Versus Political Feasibility

There are two primary policy avenues to address the economic effects of climate change: mitigation and adaptation. Mitigating the effects of climate change requires actions to limit the magnitude and rate of change, typically through reducing emissions of GHGs. Climate mitigation often focuses on reducing the use of fossil fuels by limiting energy production from fossil fuels, switching to low carbon fuels or renewable energy production, or increasing systems' energy efficiency. Damages can also be mitigated by enhancing the capacity of carbon sinks by preserving or restoring natural ecosystems, such as forests, or inventing new carbon-capture technologies. Adaptation involves practical and realistic actions to manage risks from climate change, protecting and strengthening communities, and improving resilience of the economy to future effects of climate change.

The primary goal of mitigation policies is to stabilize GHG levels in a time frame sufficient to allow humans and ecosystems to adapt naturally to climate change, to ensure, for example, that agricultural

systems can maintain levels of production to prevent food shortages. The three general policy strategies to mitigate GHG emissions are market-based approaches, regulatory approaches, and voluntary agreements. Economists often support market-based policy instruments such as carbon taxes or cap-and-trade (i.e., collectively determining the price of carbon) as an incentive-compatible strategy to reduce the use of fossil fuels. Carbon pricing policies function to charge the parties responsible for emissions of GHGs. These strategies are considered cost-effective for four primary reasons. First, a carbon price will minimize the societal costs of emissions reductions. Second, carbon pricing provides firms with flexibility to find the least costly way to reduce emissions. Third, carbon pricing encourages more reduction in GHG emissions than conventional regulations because it also provides an incentive to reduce demand for fossil fuels. Fourth, a price on carbon offers potential for a new revenue stream for government use to invest in renewable energy, offset distributional impacts of the pricing policy, or reduce other distortions in the economy.

Regulatory approaches include technology and emissions standards, product bans, and government investment. An example of regulatory efforts in the transportation sector is the 2020 Safer Affordable Fuel-Efficient (SAFE) vehicles rule, which seeks to increase fuel efficiency standards to reduce GHG emissions from passenger cars and light trucks (model years 2021–2026). Voluntary agreements are made between governments and private actors to achieve an environmental goal. The U.S. Environmental Protection Agency partners with the public and private sectors to oversee voluntary programs aimed at reducing GHG emissions and increasing clean energy adoption (e.g., the Energy Star program, www.energystar.gov).

The aim of adaptation policies is to reduce society's vulnerability to the harmful effects of climate change. In terms of policy options, two important questions are the timing of action and the economic agents. Adaptation can be either reactive—in response to an event or stimulus—or anticipatory, where actions are taken before impacts are observed. An example of reactive adaptation is a farmer planting a new, more drought-tolerant crop this year because of drought-related crop losses last year. An example of anticipatory adaptation is a government agency, such as the Federal Emergency Management Agency, providing funding to homeowners in a floodplain to elevate their homes now to avoid potential future flood damages. Adaptation actions can be taken by different entities. Private adaptation is a behavioral response by one individual for their own benefit. For example, an individual in Oregon might install air conditioning in their home in response to higher temperatures. Joint or public adaptation actions benefit many individuals simultaneously. For example, in Florida and other states, the U.S. Army Corps of Engineers adds sediment to widen beaches with the goal of creating a buffer to protect homes and infrastructure from storms.

Some policy options can achieve both mitigation and adaptation objectives. For example, coastal wetlands are a carbon sink, and restoration could enhance their capacity to capture and store GHGs. Wetlands also can absorb water from storm surges and protect infrastructure and homes nearby, providing a public, anticipatory adaptation to climate change. A recent coastal restoration project in Oregon suggested that a single policy intervention can meet both mitigation and adaptation objectives while also providing economic benefits at state and local levels (Shaw and Dundas 2021).

Sector-Specific Economic Impacts in Oregon

Agriculture

The breadth and economic importance of Oregon's agricultural sector is reflected in summary statistics derived from the U.S. Agricultural Census (Sorte et al. 2021). In 2017, the total value

of Oregon's agriculture, food, and fiber industry was approximately $42 billion, with farm gate production accounting for $5.5 billion. Almost seven percent of Oregon's jobs directly depended on the agricultural sector. Sixteen million acres in Oregon (60 percent of private land) were dedicated to farming, and over 225 agricultural commodities were produced in the state. This diversity is an economic strength but makes it challenging to draw generalizable themes about the impacts of climate change on Oregon's agricultural sector.

Research on agriculture's role and opportunity in climate policy for mitigating GHG emissions began in earnest more than 30 years ago. A robust body of research has provided measures of the impacts of climate change on agricultural productivity and net returns, and identified policies and programs that could reduce the rate of emissions from agricultural sectors and contribute to net-negative carbon emission goals (Paustian et al. 2006). Technologies and innovations to reduce emissions will only be effective if they are adopted by agriculture and food sector stakeholders, so site-specific research is needed on the economic feasibility and long-term sustainability of proposed climate policies and related changes to production practices and processes.

Several factors limit the impacts of mitigation efforts. One is additionality. The goal of climate policy should be reductions in GHGs above and beyond those that farmers or other stakeholders, including forest owners, would make absent the climate policy. Another issue is permanence. Some changes in agricultural management, notably the sequestration of carbon in soils through photosynthesis and root growth, and incorporation of organic matter into the soil, can be reversed through disruption of the soil by tillage (see *Regenerative Agriculture*, this volume). While the lack of permanence in farm-related carbon sequestration programs has been a long-standing concern, there is some value to creating incentives for temporary carbon sequestration policies to provide more time for permanent solutions to be adopted (Antle et al. 2003). A third issue is leakage or slippage. A policy of encouraging planting and maintaining trees rather than harvesting can raise the price of wood elsewhere and cause more harvesting, thus offsetting the global benefits of the policy. Similarly, conservation policies in a large country such as the United States—for example, the Conservation Reserve Program, in which farmers receive an annual payment to remove erosion-prone land from agricultural production and plant species that will improve environmental quality—can increase the area cultivated elsewhere, releasing carbon stored in soils.

Reliance on voluntary action by consumers or farmers is unlikely to realize the full potential for agriculture to contribute to mitigation because reducing emissions, changing production practices or crops, and sequestering carbon usually is costly to farmers. For example, adoption of precision management technology, such as variable-rate seed and fertilizer applications enabled by machinery equipped with global positioning systems, varies across the United States and is not necessarily economically superior to conventional, uniform management (Basso and Antle 2020). Agrivoltaic farming—co-locating increases in agricultural productivity and generation of renewable energy—is a counter-example of an innovative, voluntary action that may have net gains (Box 1).

Farm-scale decision tools or software enable growers and researchers to better understand the economics of climate trends or changes in site-specific production practices, and provide insights and information on options to modify production practices (Capalbo et al. 2017). Decision-support tools that link with research on climate change and productivity and allow agricultural managers to better understand novel options and opportunities are fundamental to translating research to outcomes. AgBiz Logic™, the Profitability Decision Tool, and the Tradeoff Analysis Project exemplify recent decision tools that are incorporating climate change impacts.

AgBiz Logic™ provides economic, financial, and environmental decision tools for assessing alternative technologies and innovative processes. For instance, the tool has been used to incorporate projected climate changes in farm-based decision planning by apple growers in Washington (Box 2).

The Profitability Decision Tool (www.pnwlit.org/profitability-decision-tool) assists exploration of alternative rotations in dryland farming systems of the inland Pacific Northwest. Alternative cropping rotations can provide feasible options as springs become wetter and summers become drier and hotter. The tool can be used to compare the economic and financial impacts of changing to an alternative crop rotation.

Box 1. Agrivoltaic Farming

Food production and climate change impacts are typically framed in a negative context. The emphasis is often on issues such as changes in growing conditions, frequency and severity of harmful weather events, and a general deterioration in production capacity. Positive contexts, however, also exist, particularly with respect to technological innovations spurred on by anticipated needs to mitigate negative climate change impacts. An example is ongoing development of agrivoltaic farming. The goal of this technology is to combine production of solar energy and food on the same plot of land. "The hallmark characteristic of agrivoltaics is the sharing of sunlight between the two energy conversion systems: photovoltaics and photosynthesis. It essentially mimics what humans have been doing for hundreds of years with agroforestry—think shade-grown coffee—intentionally creating partial shade to create multiple layers of agricultural productivity on the same piece of land" (Macknich as quoted by Gordon 2022). Numerous approaches to agrivoltaic farming are being researched and developed (Figure B1), including placement of solar panels on dry, unirrigated farmland to increase crop yields via reduction of water use and heat stress on plants and grazing animals (Adeh et al. 2019).

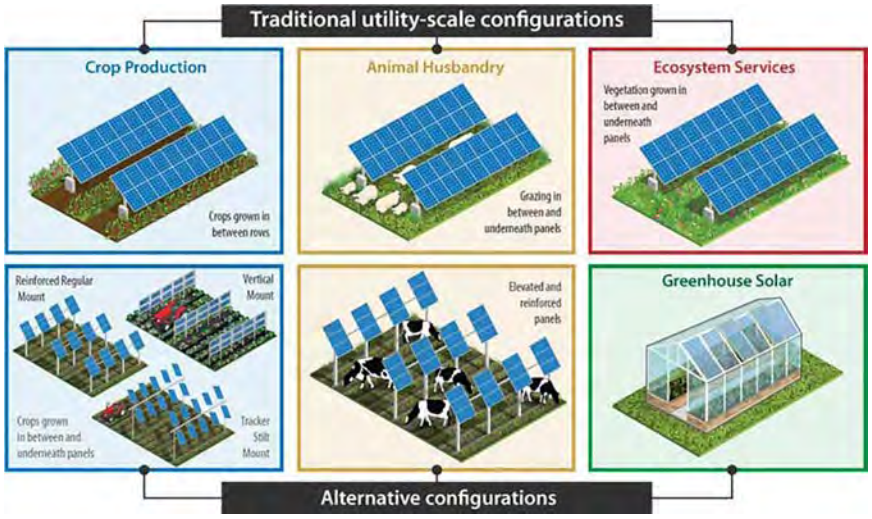

Figure B1. Agrivoltaic systems can be installed in the same basic row layout as a traditional large-scale solar plant. Alternatively, they can be modified to provide extra space for light, animals, or farm equipment to move under and among them. Source: Dreves 2022.

The Tradeoff Analysis Project (agsci.oregonstate.edu/tradeoff-analysis-project) develops modeling tools that can be used to improve understanding of agricultural system sustainability and inform policy decisions. The software is based on the whole farm system (crops, livestock, aquaculture, non-farm income) and simulates economic indicators (per-capita income, income-based poverty) and mean and threshold indicators for economic, environmental, or social outcomes associated with the systems. An application of this tool examines impacts of climate change on the winter wheat sector in the Pacific Northwest and indicates higher yields on average from future climate scenarios, although there are both winners and losers due to variations in weather and biophysical and socioeconomic conditions. (www.reacchpna.org/sites/default/files/tagged_docs/6c.2.pdf).

Specialty fruit crops represent a substantial portion of the value of agricultural production in the Pacific Northwest. Climate change will most likely threaten water sources, lengthen the dry season, raise temperatures during both the winter chilling period and the growing season, and facilitate the

Box 2. Incorporating climate impacts in farm-based decision tools

Van Name et al. (2017) discussed the use of AgBiz Logic™, a decision tool that measures the economic effects of climate change, and illustrated the use of this tool with apple production in the Pacific Northwest. In 2015, snowpack levels in the Pacific Northwest were the lowest on record. Snowpack levels strongly affect the volume of water available for irrigation by those with water rights in the area. Most irrigation replenishes water lost through evapotranspiration, but irrigation also is used to cool crops in hot weather. AgBizClimate, part of the AgBiz Logic™ suite of economic, financial, and environmental decision tools for agricultural businesses (Seavert 2015), was used to inform growers about impacts due to low snowpack. Still in development, AgBizClimate is an online application that delivers essential information about climate change to farmers and land managers, including relevant climate variables modeled into the 2040s.

Van Name et al. (2017) surveyed growers with the goal of obtaining insight into the types of weather that have the greatest effects on crop yields. Apple growers based in Yakima and Wenatchee, Washington, indicated that they most frequently monitored snowpack, accumulated growing degree days, the number of consecutive extremely hot days, and the number of nights below freezing (Table B1).

Variable thresholds and comments
Number of days above freezing • Determines the developmental stage of the fruit
Number of nights below freezing • Winter injury to fruit trees from November through March, spring frost from March through May • Overnight low temperatures in spring can freeze fruit buds • Contributes to cost of frost protection to save fruit buds
Number of consecutive extremely cold days • Three or more days of temperatures below 0°F (-18°C) can cause winter injury to fruit trees
Number of consecutive extremely hot days • Three or more days above 95°F (35°C) can cause sunburn on fruit skins
Accumulated growing degree days • Drives models of pests (especially codling moth [*Cydia pomonella*]) from April through August. Pests can increase chemical costs and the number of chemical applications.
Accumulated chilling hours • Certain apple varieties require more than 400 chilling hours to avoid blush coloring on the skin of the fruit
Snowpack • Amount of snowpack is 100% of the seasonal supply to all water rights holders in the Yakima River basin • Affects the severity of drought, which affects and limits irrigation and overhead cooling strategies

Table B1. Examples of grower-defined thresholds.

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spread of fungal diseases and insects. Such changes have the potential to substantially reduce net returns due to increased input costs and altered yields and product quality. Houston et al. (2018) highlight changes in climate and key vulnerabilities that are already influencing specialty fruit crop production in the Northwest and identify adaptation strategies and actions that improve both yields and quality of crops and retain the economic viability of specialty fruit crops in the region. Many management strategies that are already being used to prolong growing seasons in marginal production areas and to improve production and quality in established production regions may also be useful as adaptation strategies under a changing climate. These near-term strategies involve moderating temperatures through use of overhead sprinklers and shade netting or compensating for mismatches between phenology and seasonal weather conditions. Longer-term strategies include investment in new varieties.

Climate change also appears to be impacting the frequency and severity of wildfires. The 2020 wildfires in Oregon significantly impacted the agriculture, food, and fiber sector (Sorte et al. 2021). Concerns and damages ranged from the taste of the food produced from the tainted crops to the crops absorbing toxicants in the smoke. The Oregon Wine Board estimated approximately a 20 percent decline in industry revenues in the 2020 crop year (Sorte et al. 2021). In Oregon, wine growers are experimenting with alternative varietals. One grower reported that their estate had worked with 28 different varietals in 2019, in part as a "way to be ahead of a changing climate" (Gruber 2020). Both growers and wineries are developing integrated risk management strategies to deal with the ever-increasing likelihood of droughts and wildfires. A

Agriculture, from page 143

To use AgBizClimate, the grower selects previously generated enterprise budgets from AgBiz Logic™ that best reflect their personal economic situation, whether grower data or representative returns and costs from readily available university budgets. These budgets serve as a baseline for estimating subsequent climate impacts. Modifying the base budget (e.g., for Gala apples, Figure B2) for alternative climate and productivity or cost assumptions decreased net returns. In all four scenarios, climate change substantially reduced the net returns per acre, indicating that higher losses of packed fruit sold to the fresh market resulted in a greater loss to net returns than additional chemical costs and application rates.

The AgBiz Logic™ results for apple production illustrate that changes in climate will have a large effect on current agricultural practices and overall net returns in Pacific Northwest apple orchards. With no changes in management practices, apples in the Pacific Northwest will on average fare better during winter due to decreases in winter injuries to trees. Apples will fare worse during summer as the increased frequency of consecutive extremely hot days and accumulated growing degree days affects fruit quality and insect pressures. The downscaled information from AgBizClimate on projected changes in yield and production inputs are the impetus for producer-generated adjustments in input use, management, and technology adoption that may alleviate the negative impacts or take advantage of adaptation opportunities.

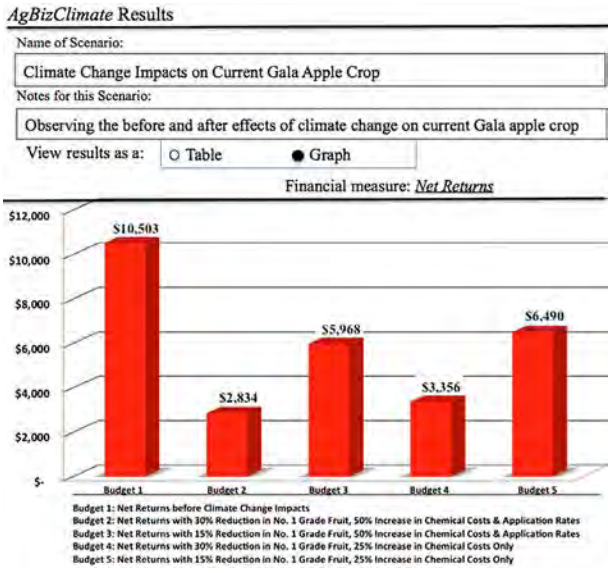

Figure B2. Example AgBizLogic™ results for Gala apples.

group of researchers in the western United States have launched a multi-state, multi-year project to develop best practices in response to drier, more extreme weather and smoke events (Box 3).

Similarly, wildfires in northern California adversely impact wine grape growers and wineries directly, via destruction of property (vineyards and facilities), and indirectly, by making the grapes unsuitable for wine production (Kropp and De Andrade 2022). In 2020, over $600 million of wine grapes went unharvested. Wildfires have resulted in changes in contracts among growers and wineries and changes in purchasing of crop insurance policies to mitigate direct and indirect risks to this sector. A record number of grapes under contract were rejected in 2020, representing nearly a 20 percent decline in tons of crushed grapes relative to 2018 (Kropp and De Andrade 2022).

Climate change also has the potential to significantly affect irrigation practices and the availability and use of scarce water in Oregon. Bigelow and Zhang (2018) provided a direct assessment of climate adaptation through the lens of agricultural irrigators in Oregon. The findings highlighted how agricultural producers in Oregon have already adapted to changing climate by acquiring supplemental irrigation rights, which allows producers to diversify their irrigation water sources. Supplemental water rights give irrigators access to another source of water if they cannot withdraw the full amount of water granted to them through the primary water right from the primary source (e.g., if junior surface water users are regulated off in a given basin, a supplemental groundwater right could be used to make up the shortfall). Olen et al. (2016) highlighted how three primary aspects of irrigation decision-making (share of farm irrigated, irrigation water application rate, and technology adoption) change with climate conditions and drought across various production specialties. The general findings suggested that temperature is a more important driver of these choices than precipitation. The study went on to highlight how these

decisions are altered when the motivation for irrigation is to mitigate damage resulting from heat versus frost.

Research on water scarcity in the Willamette River basin and policies to mitigate and adapt to changes in water scarcity due to climate change have focused on changes in the availability of water that are priced and exchanged in markets (e.g., urban water) and changes in the values of resources not exchanged in markets (e.g., instream flows, forest health, flood risk protection, recreational opportunities) (Jaeger et al. 2017, 2019). This research projected trajectories of change on the basis of interactions between biophysical and human processes and is used as a tool to describe a range of future conditions associated with climate and water scarcity scenarios. The project indicated that a decline in snowpack in the next 80 years will reduce the amount of snowmelt runoff by 600,000 acre-feet of stored water. Reduced snowpack, when combined with higher summer temperatures, will increase stress on upland vegetation and increase the risk of wildfires. Furthermore, precipitation will have a far greater role than snowmelt in determining spring stream flows in the Willamette River basin. The project found that climate change is projected to result in earlier crop planting, which will lead to more crop growth during the months when temperatures are cooler and soil moisture is greater. Earlier planting will also lead to an earlier start, and completion, of irrigation. Moreover, the potential use of stored water to expand irrigation to farmlands that currently do not have irrigation water rights is limited by economic realities; conveyance costs are high relative to the economic gain from irrigating. Also, the project concluded that thirteen federal storage reservoirs in the Willamette River basin reduce the risk of flooding. This benefit has been estimated to be more than $1 billion per year. As urban areas expand and climate change leads to increases in the frequency and magnitude of high flows, the value of potential damages associated with flood events will rise.

Box 3. Research on threats of wildfire smoke to the wine industry

For the West Coast wine industry, the 2020 growing season left an enduring and unsettling memory. Large wildfires that burned across California, Oregon, and Washington destroyed some wineries and vineyards. Moreover, smoke circulated and settled into some vineyards for an extended period. Persistent exposure to smoke compromises the quality and value of wine grapes and adversely affects wines. The estimated financial loss of $3.7 billion will extend into 2023 because many wineries decided to not produce wine from grapes grown in 2020, and winery sales lag for more than one growing season because wines are aged and stored before sale (Adams 2021).

Image by Jill Wellington from Pixabay.

A team of researchers from Oregon State University, Washington State University, and University of California, Davis, supported by a $7.5 million grant from the U.S. Department of Agriculture, is collaborating to better understand how smoke density and composition affect grapes, grape vines, wine composition, and sensory perception of wine in a glass. They also aim to provide decision-support tools and guidelines to assist the grape and wine industries during future smoke events.

Reimer et al (2020) used a multi-sector economic simulation tool to estimate the overall robustness and resilience of the Hermiston economy to environmental shocks due to a changing climate. Regions with vulnerabilities in their food-energy-water nexus are likely to have economic vulnerabilities, and steps to address any environmental vulnerabilities (such as increasing water

scarcity as a result of climate change) may conflict with regional and county-level concerns about employment and overall economic health as measured in terms of current and near-term economic vitality. The Hermiston area's water is allocated to different uses, such as electricity generation, farmland irrigation, municipal water, fisheries, and data center cooling. The multi-sector simulation model predicted that a one percent increase in surface water availability would lead to a $1.05 million increase in the size of the Hermiston economy, which translates into a little less than one percent.

A few takeaway messages for assessing the economic impacts of changes in climate, water availability, and resilience of local economies with a multi-sector simulation tool are as follows. First, it is important that economic models account for availability of key ecosystem services and levels of natural resources, and likewise that engineering models include behavioral information on how economic decision-makers reallocate resources under scarcity scenarios. Additionally, when a simulation tool provides information on the overall robustness and resilience of a local or regional economy to changes in water availability or other environmental shocks due to a changing climate, the tool also can provide further information on the benefits and costs to the local economy of actions to enhance other environmental outcomes such as ecological restoration, recreation, or wildfire mitigation.

Forests

Nearly 47 percent of Oregon is forested, and forestry contributes ~2.1 percent to the state's GDP. Annual timber harvests average ~3.8 billion board feet, and the industry supports around 3 percent of jobs (~62,000) in the state (OFRI 2022). Oregon is the leading U.S. producer of softwood lumber, plywood, and value-added engineered wood products. Early economic work on the impacts of climate change on forests in the United States suggested that timber stocks may expand and market benefits are possible (Sohngen and Mendelsohn 1998). The state's forests also support outdoor recreation, provide habitat for endangered species, and protect water supplies.

Forests can mitigate climate change by acting as carbon sinks, absorbing GHGs from the atmosphere and storing them in biomass and soils. When cleared, degraded, or burned, they can become sources of GHG emissions. In Oregon, forests act as a carbon sink, removing nearly 31 million metric tons of carbon dioxide from the atmosphere each year (Christensen et al. 2019). This estimate accounts for GHG absorption by live tree growth, net emissions from harvesting, and mortality events (including wildfire). The economic value of this ecosystem service, assuming $185 per metric ton as the social cost of carbon (Rennert et al. 2022), translates to a benefit of over $5.7 billion per year. This economically significant service suggests that forest management plays a crucial role in climate policy.

Although nearly 62 percent of forest carbon-storage capacity in Oregon is from national forests (Christensen et al. 2019), private timberland management also plays a role. Net carbon flux from forest management can be impacted by decisions on both the intensive (i.e., choices such as rotation length and thinning) and extensive (i.e., changes in size of forest or forest type) margins. A vast literature on the topic suggests that incentives (e.g., subsidies or taxes) could induce landowners to sequester carbon by planting or maintaining trees as a cost-effective means to meet policy goals (e.g., Lubowski et al. 2006), although consensus on the best approach has not been reached (Li et al. 2022). In fact, a carbon tax may lead to net emissions and loss of forest, suggesting that the climate policy tools applicable to land use may be different than those applicable to other regulated sectors of the economy (Li et al. 2022).

Box 4. Switching from Douglas-fir to ponderosa pine

Climate change may bring significant changes to private timberland in Oregon and the western United States (Hashida and Lewis 2019). Author David Lewis said, "About half of all non-federal forestland that is harvested in Oregon and Washington is currently replanted with Douglas-fir by landowners. But Douglas-fir will be less productive in a warming climate. The tree's ability to sequester carbon will diminish and landowners are more likely to switch to other trees." The proportion of land planted with Douglas-fir may decline to 25 percent by 2100 as landowners change their planting decisions in response to climate change (Hashida and Lewis 2019).

Hashida and Lewis (2019) also explored the impact of a policy that would pay landowners to delay or forgo harvest in order to sequester carbon. Current policy examples of carbon sequestration in forests include the use of carbon offsets in California's cap-and-trade program for carbon, which was a model for a program in Oregon that was proposed but not passed by the legislature. Such a carbon pricing policy would accelerate the transition from planting Douglas-fir to planting hardwoods and ponderosa pine. This policy, combined with landowner adaptation decisions, would further reduce the proportion of land planted with Douglas-fir to 15 percent (Figure B3).

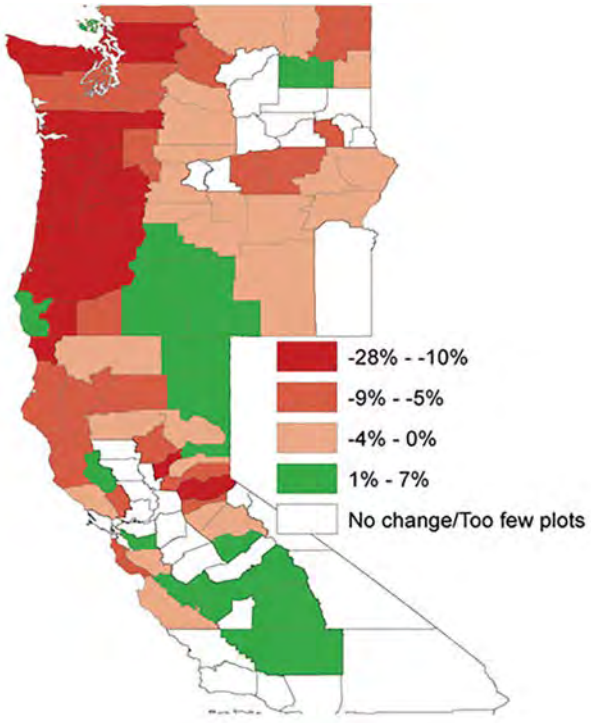

Figure B3. Effects of climate change and carbon pricing on Douglas-fir planting. Source: Hashida and Lewis 2019.

Climate change also has the potential to change the compositions of Oregon's forests. It is estimated to be a contributing factor to reducing the productivity of Douglas-fir (*Pseudotsuga menziesii*) across western states (Crookston et al. 2010, Restaino et al. 2016, Weiskittel et al. 2012) and reducing post-fire viability of Douglas-fir (Davis et al. 2020). A warmer and drier climate is projected to induce a gradual shift by private landowners in Oregon away from Douglas-fir, the state's currently most valuable tree species, toward hardwood species (Hashida and Lewis 2019; Box 4). An economic model estimated that climate change will induce a loss of private timberland value of 39 percent by the year 2050 in western Oregon and Washington (Hashida and Lewis 2022). The results of these economic studies are also consistent with a recent simulation that suggested climate change and increased wildfire activity will drive a shift from coniferous forests to shrubland-hardwood forests in the Klamath region (Serra-Diaz 2018).

Furthermore, recent modeling efforts demonstrated that there are likely to be additional trade-offs associated with a transition from Douglas-fir to other trees. For example, the projected total loss of habitat for 35 species of amphibians, birds, and mammals of conservation concern in the western states exceeded the total area of habitat gained, and the net loss of habitat accelerated over time as climate changed (Hashida et al. 2020). Accordingly, adaptations by private landowners to climate change can induce social costs to non-landowners (Hashida et al. 2020).

Oceans and Coasts

Oregon's coastline stretches over 575 km (360 mi) from the California border to the Columbia River. The coastal zone is home to 225,000 people, less than 7

percent of the state's population, but supports vibrant tourism and fishing industries. According to Travel Oregon (2022), tourism in Oregon generates $5.4 billion (~2 percent of state GDP) annually. Tourism along the Oregon coast supports nearly 253,000 jobs and $1.93 billion in visitor spending each year, with a significant increase over the last decade (Travel Oregon 2022). Commercial fisheries in the state also generate substantial revenue and employment. In 2019, commercial landings generated nearly $560 million in statewide income and supported 9200 jobs (The Research Group 2021). Dungeness crab is the most valuable commercial fishery in the state, representing about one-third of the economic value from the industry. Recreational fisheries also generate considerable economic returns ($120 million in income, 2000 jobs supported in 2019; The Research Group 2021).

Climate change is already affecting tourism and fishing in Oregon, and an organization representing Dungeness crab boats is suing oil and gas companies for climate damages for harmful algal blooms caused by warming ocean waters (Box 5). Dungeness crab and Pacific oysters are valuable commodities that are also susceptible to ocean acidification, which has potential to result in loss of fisheries productivity and reduced economic opportunity. Action plans at the state level aim to develop solutions to mitigate these potential economic impacts (Whitefield et al. 2021).

Oregon's oceans and coasts are also an area for harnessing wave and offshore wind energy in an effort to expand capacity for renewable energy production. The U.S. Department of Energy recently funded PacWave (pacwaveenergy.org) to develop a wave energy testing facility off the coast of Lincoln County. The facility, which was granted a license by the Federal Energy Regulatory Commission to begin operations, will be the first commercial-scale grid-connected test site for wave energy. In September 2022, the Biden administration announced plans to develop floating platforms for offshore wind off the Oregon coast (Daly and McDermott 2022). The economic implications of increasing Oregon's renewable energy capacity are uncertain, but a government report suggested that offshore wind could generate up to $5.7 billion in economic activity and support 66,000 jobs during the construction phase, and billions in state GDP and thousands of employment opportunities over the long term (Jimenez et al. 2016).

Salmon in the Pacific Northwest are also susceptible to the effects of climate change. All salmon are anadromous, spawning in fresh water but maturing in oceans, and most spawn only once before dying. Pacific salmon are threatened by water diversions, dams, and logging when in their freshwater habitats. For populations to remain viable, adults must migrate to spawning habitat, and survival of the eggs and larvae requires cool water, gravel substrates, and sufficient water flow and oxygen. There also must be enough water flow to support migration back to the sea. Climate change is affecting all of these elements in ways that threaten the survival of salmon runs, and several of the region's populations may be approaching physiological temperature tolerances (Crozier et al. 2019).

Maintaining salmon populations as climate changes will require restoration of large patches of connected habitat. Residents of the Pacific Northwest place significant value on such restoration efforts for threatened Oregon Coast coho salmon populations (Lewis et al. 2019, 2022). A nonmarket valuation survey estimated that the regional willingness to pay for restoration efforts that increase coho runs by 100,000 fish approaches a half a billion dollars per year (Lewis et al. 2019). Restoration of salmon habitat in coastal and marine environments could also provide co-benefits of carbon sequestration and buffers against sea level rise and storm surges (Dundas et al. 2020).

The risk that erosion will affect coastal housing and infrastructure in Oregon is increasing due to climate change effects on winter storms, El Niño–Southern Oscillation (ENSO) events, and sea level rise. Increased erosion creates a fundamental tension between coastal property owners who want

to protect their homes and investments, often with hardened shoreline armoring such as sea walls or rip-rap revetments, and the public right to recreate on the coast as codified by the 1967 Beach Bill. Recent research examined the economic value to coastal housing markets generated by state land-use regulations that limit armoring (Dundas and Lewis 2020). Homes in areas with the option of hardening the shoreline for erosion protection sold for 13 to 22 percent more than similar homes without the option of protection. Additionally, the right to armor may impose costs on neighbors that are not eligible to armor, reducing their land value by nearly 8 percent. Landowners' decisions about whether to armor their shoreline are highly influenced by the observed actions of neighbors (Beasley and Dundas 2021). Scenario-based simulations suggested that private armoring along the Oregon coast would increase 70 percent if Goal 18 land use regulations (www.oregon.gov/lcd/OP/Pages/Goal-18.aspx) were removed. Currently, Goal 18 limits private shoreline armoring to properties that existed prior to 1 January, 1977, when the armoring prohibition went into effect. Coastal land-use policy generates value and loss, and may be a key factor in how the Oregon coast adapts to climate change.

Box 5. Oregon's Dungeness crab fishery sues 30 fossil fuel companies

An extensive area of unusually warm water in the northern Pacific Ocean in the mid-2010s, known colloquially as The Blob, led to a surge in toxic algae. These events led to an increase in domoic acid, a neurotoxin that cost the West Coast Dungeness crab fishery more than $150 million in 2015. This disruption, and other season delays in subsequent years, led to many boats moving to different fisheries or going out of business. In 2018, the Pacific Coast Federation of Fishermen's Associations, which represents commercial harvesters and onshore processors and wholesalers, decided climate change was the culprit and initiated a lawsuit against fossil fuel companies for actively covering up their role in climate change. The lawsuit also sought damages for anglers impacted by these events. This was the first time a private organization attempted to sue the oil and gas industry for climate damages. As of November 2022, the legal case is ongoing.

Image by Sabrina Eickhoff from Pixabay

Other Important Economic Impacts

Public Health

Nationwide, the impact of climate change on public health, including mental health, is receiving serious attention. Oregon Health Authority (OHA) provided two reports, one each in 2014 and 2020 (OHA 2014, 2020). The message of the 2020 report is clear: climate change is a public health threat disproportionately affecting lower income communities, communities of color, tribal communities and frontline workers. " . . . agricultural workers, fishers, forestry workers and hunters account for 20 percent of heat-related deaths in the United States . . . In urban areas, people who work and reside in urban heat islands (i.e., construction workers) are also more at risk of climate-related health hazards" (York et al. 2020:39). The report notes that lower income and rural Oregonians have a harder time adapting to climate change because they have fewer options available to them and less financial stability. They also tend to work in jobs that are outside or on the front lines and live in hotter areas that will be more vulnerable to climate-related food and housing insecurity. Additionally, recent

research suggests that rates of traumatic injuries for outdoor workers (e.g., heat stroke, dehydration) are significantly higher during hotter weather, especially for agricultural workers (Evoy et al. 2022).

In recent summers, Oregonians have experienced unprecedented wildfires and record setting heat waves. These heat waves bring an increase of heat-related hospitalizations and respiratory illnesses, in addition to increased water insecurity, ozone pollution, airborne pollutants, molds, and allergens in the air. The OHA 2020 report notes, "if greenhouse gas emissions remain high, most of the state will experience significantly more days with temperatures above 86°F . . . by the year 2040." This projection was borne out in record-setting heat waves from June through August of 2021 and 2022. The Oregon Environmental Council (OEC) summarized the OHA 2020 report, noting estimates of the health costs of climate change on selected health outcomes (heart disease, stroke, asthma and premature births) at nearly $10 billion per year (oeconline.org/oha-report-climate-crisis-a-current-and-growing-threat-to-the-health-of-oregonians).

Increasing frequency of wildfires also produces public health concerns for Oregon. Dittrich and McCallum (2020) provide a review of the health impacts of wildfire smoke and economic approaches to estimate damages, with a focus on the Pacific Northwest. Their findings suggest costs could be in the billions of dollars, driven mostly by increases in premature mortality related to smoke exposure. Fine particulate matter ($PM_{2.5}$) in wildfire smoke can increase the incidence of violent crime (Burkhardt et al. 2019), worsen health outcomes (Bishop et al. 2018, Deryugina et al. 2019), and reduce labor productivity (Graff Ziven and Neidell 2012). Furthermore, current government policies that rely on individuals to protect themselves from wildfire smoke, such as by staying inside or buying air filters, are likely to have minimal benefits that are likely to be unequally distributed across household-based income (Burke et al. 2022).

Recreation

Outdoor recreation contributed 1.8 percent (~$375 billion dollars) to U.S. GDP in 2020 (Bureau of Economic Analysis 2021). The contribution of outdoor recreation to Oregon's state GDP (2.2 percent) is higher than the national average. In Oregon, outdoor recreation supported 224,000 full-time jobs and $15.6 billion in spending in 2019 (Mojica et al. 2021).

Recent empirical research suggests that climate change is likely to affect many forms of outdoor recreation and that impacts are likely to vary across seasons, locations, and activities. Increases in the incidence of days with extreme heat are likely to have negative economic effects on marine recreational fishing, but the magnitude of the impact will depend on the adaptability of recreators to adjust the timing of fishing (Dundas and von Haefen 2020). By contrast, climate change may improve economic welfare for the cycling sector by expanding recreation windows in spring and autumn (Wichman and Chan 2020). Recent research suggests some Oregon-specific impacts of climate change on winter recreation. Peak annual snowpack in the Oregon Cascade Range may decline by 25 percent by 2050 and 75 percent by 2100 (Siirila-Woodburn et al. 2021). Reduced snowpack in the Oregon Cascade Range may result in nearly $19 million annually in total damages to activities related to skiing, and damages are projected to $425 million per year in California (Parthum and Christensen 2022).

Wildfires also are likely to have substantial negative impacts on outdoor recreation. Not only do wildfires create smoke, which may limit many types of outdoor recreation across a large geographic area, but they also precipitate closures of popular recreation areas in the name of public safety. For example, in late September 2022, hundreds of kilometers of forest roads and nearly 150 trails

were closed due to the Cedar Creek Fire in the Willamette and Deschutes National Forests. The U.S. Forest Service also closed 86 recreation sites, including 28 campgrounds, and large sections of the Pacific Crest Trail across the two national forests. These closures came on the heels of the 2020 Labor Day fires (e.g., Beachie Creek, Lionshead), which led to closure of 19 popular trailheads, eight recreation sites, and numerous forest roads. Many of these closures may persist until summer 2023. The full economic impact of these and other recent fires, such as the Eagle Creek fire in the Columbia River Gorge, on Oregon's outdoor recreation economy has not yet been estimated. More assessment is also needed to understand the economic impact of a recreation experience that is affected by a prior wildfire (e.g., hiking through a burned area rather than an old-growth forest). Initial work suggests that the Eagle Creek fire may have reduced overall recreational visits to the area and induced a spatial redistribution of visits to specific sites (White et al. 2022).

Migration

Key factors in people's motivation to live in Oregon are the local environmental quality and the amenities associated with our climate. In other words, climate is a key factor in state residents' quality of life. A recent national analysis of predicted quality-of-life changes due to climate change suggests declines across much of the country (Albouy et al. 2016). Areas of Oregon west of the Cascades are an exception, and people in that region may benefit from climate change because of improvements to climate amenities in the future (Albouy et al. 2016). This result suggests people may want to move to Oregon due amenity shifts from climate change.

Climate migration is the temporary or permanent movement of a person or groups of persons, primarily in response to sudden or progressive changes in the environment due to climate change, within a country or across an international border. Although transboundary climate migration receives the most media attention, the majority of migration is within-country. Challenges result from the speed of climate change the number of people it affects. Temporary migration in response to climate stressors is already happening on a regular basis (e.g., evacuation associated with wildfires). The ability to migrate is a function of mobility and resources. Accordingly, the people most vulnerable to climate change are not necessarily those most likely to migrate.

In the United States, 162 million people—nearly half of the country's population—will most likely experience hotter temperatures and less rainfall. By 2070, if carbon emissions continue to rise, at least four million Americans may live in places outside the ideal range of conditions for human life (Xu et al. 2018). One in 12 residents of the southern United States may move toward California, the Mountain West, or the Pacific Northwest over the next 45 years because of climate influences alone (Fan et al. 2018). Such a shift in population is likely to increase poverty and widen the gulf between the rich and the poor. It will accelerate rapid urbanization of cities not prepared for the burden. People are likely to move to Oregon in response to climate change, and the population and economic production of the Pacific Northwest and Intermountain West may increase by 15 percent and 10 percent, respectively, by 2065 due to climate migration from other areas of the country (Fan et al. 2018). On paper, increased population and economic productivity may be viewed favorably, but such changes may create economic disruption, such as housing shortages and stressed infrastructure, if areas receiving migrants are unprepared for the magnitude of the change.

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Natural Systems

Natural systems, a term used in Oregon's 2021 Climate Change Adaptation Framework to encapsulate terrestrial, aquatic, coastal, and marine ecosystems, encompass the structure, composition, and function of life at all levels, from genes to biomes (Franklin 1981, Noss 1990). Structure often refers to the complexity of vegetation strata, such as grasses and herbaceous flowering plants, shrubs, and trees. Composition usually means the identities of species. Function generally includes ecological and evolutionary processes that sustain life. The fifth Oregon Climate Assessment explored the extent to which scientific evidence suggests that species in Oregon and the Northwest may be able to adapt to projected changes in climate, and examined the potential responses of several species of concern across the state to anticipated climate change.

In the first half of this section, Still and colleagues describe efforts to document foliage scorch, changes in tree growth, and tree mortality following extreme heat in the Pacific Northwest during June 2021. They also investigate how trees' use of water during that heat wave may have affected scorch and growth. Emerging research, including numerous studies in the northwestern United States, underscores that even when the current ecology of a species is well understood, it often is difficult to predict with confidence how the species will respond to climate extremes and trends. Challenges to such predictions in part reflect that climate change interacts with land-use change, other human-caused and natural environmental changes, and interactions among species (Biel and Hacker 2021, Carlson et al. 2021, Cinoglu et al. 2021, Reed et al. 2021). In both aquatic and terrestrial systems, the duration of a climate anomaly, such as a heat wave, also may affect stress, mortality, and population persistence (Bradford et al. 2022). Furthermore, responses can vary among events; for example, two apparently similar marine heat waves may not induce the same changes in distribution, abundance, or reproduction of a given species (Thompson et al. 2022).

In the second half of this section, Armstrong explains that although seasonally warm waters sometimes have been discounted in efforts to conserve Pacific salmon and other cold-water salmonids, those waters may in fact contribute to the fishes' potential for growth and survival during cooler periods of the year. Additionally, Armstrong and other researchers are discovering that some populations of salmonids may be more tolerant of high temperatures than previously understood. Research in the North Pacific Ocean indicated that pink salmon (*Oncorhynchus gorbuscha*) also may be fairly resilient to ocean acidification (Ohlberger et al. 2021).

When models of species' responses to climate change incorporate probabilities of adaptation, estimates of survival and area occupied usually are higher than if adaptive processes were not modeled (Garzón et al. 2011). In some cases, adaptations of species to environmental change may reflect temporary modifications of behavior, appearance, or physiology. In other cases, adaptive responses may result from adaptive evolution: heritable genetic changes that affect individuals' observable traits and increase probabilities of persistence of populations or species (Reed et al. 2011). Some evidence suggests that increases in temperature have little effect on rapid evolution of body size, developmental rate, or fertility among ectothermic animals (those that cannot regulate their body temperatures) (Grainger and Levine 2022). However, new research on birds and mammals in diverse ecosystems around the world implied that some animals' capacity for adaptive evolution may be as much as double that previously estimated (Bonnet et al. 2022). Similarly, some have suggested that at least until about the year 2100, certain groups of marine invertebrates that form shells may be able to adapt to ocean acidification (Leung et al. 2022). Natural systems are

variable and unpredictable. Some species and processes undoubtedly are being harmed by climate change, yet others may prove surprisingly durable.

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Impacts of the June 2021 Heat Dome on Pacific Northwest Forests

Chris Still, Linnia Hawkins, and Adam Sibley

Introduction

Following two years of drought, many areas of the Pacific Northwest and British Columbia experienced record-high air temperatures during an extreme heat wave ("heat dome") in late June 2021. The heat dome was among the most extreme heat waves ever recorded globally, and the most intense in the observational record for the Pacific Northwest (Thompson et al. 2022). The high air temperature during the heat dome coincided with the longest photoperiod and greatest solar insolation of the year, driving sunlit foliage temperatures 5–10°C (9–18°F) above the air temperature. At midday on the hottest day of the heat dome, the upper canopy air temperature at the H.J. Andrews Experimental Forest, a U.S. National Science Foundation Long Term Ecological Research site near Blue River, Oregon, was ~42–44°C (108–111°F), and sunlit foliage was close to 50°C (122°F) for several hours. This foliage temperature is a known threshold at or above which many plant tissues are damaged, and the combination of excess heat and high light intensity is especially damaging to leaves (Teskey et al. 2014).

Foliage Scorch Reports

Numerous reports of widespread foliage scorch and leaf drop in multiple tree species in forests on the west side of the Oregon Coast Range and Cascade Range followed the heat dome (Figure 1). Western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) seem to have been affected most strongly, but Douglas-fir (*Pseudotsuga menziesii*) and various alder (*Alnus*) and maple

Figure 1. Satellite imagery of an area near Garibaldi, Oregon, from before (10 June) and after (9 July) the 2021 heat dome. Yellow arrows indicate particularly clear foliage scorch. Imagery from Planet Labs, Inc.

(*Acer*) species also were affected. The worst foliage scorch seemed to be on trees and saplings with direct solar exposure and on south-facing slopes (Figure 2). Initial estimates from aerial surveys conducted by the U.S. Forest Service indicated that more than 230,000 ha (888 mi^2) of forest were

Figure 2. Foliage scorch from the 2021 heat dome at the leaf, whole-tree, and landscape levels. Photographs clockwise from top left: Ardeshir Tabrizian (*The Oregonian*), Adam Sibley, Dave Shaw.

affected in Oregon and Washington alone, with some of the most extensive damage in conifer forests dominated by Douglas-fir trees. These surveys also indicated that trees on south- and west-facing exposures were more severely scorched than those on other aspects, and that scorch was more prevalent in typically cooler, coastal mountains and the Cascade Range foothills than in hotter, lower elevation forests.

In response to the initial reports of foliar scorch, a team of scientists and forest managers at Oregon State University and the U.S. Forest Service asked people who observed scorch to report their observations at a website originally created by the Oregon Department of Forestry to survey effects of drought on forests (tinyurl.com/heat-wave-foliage-scorch). Because the website was developed by the Oregon Department of Forestry and the National Drought Mitigation Center to report drought

impacts on trees, we asked participants to note in the "Description and/or caption information" of the survey that they were reporting "impacts of the June 2021 heat wave" and to use the phrase "foliage scorch." These notes and terms allowed us to retrieve the observations and map and analyze this extreme event. Ninety-one reports (Figure 3) and 185 photographs were submitted.

Figure 3. Reports of scorch impacts submitted to the National Drought Mitigation Center and Oregon Department of Forestry website (left panel) and examples of photographs of scorch on a coniferous tree (center panel) and broadleaf tree (right panel).

Biological and Ecological Impacts of Heat Stress

There is increasing recognition that heat waves can lead to widespread reductions in tree growth and eventually mortality (Breshears et al. 2021). As the frequency of coincident heat waves and drought increases across the conterminous United States (Alizadeh et al. 2020), understanding the environmental drivers, biophysical and physiological mechanisms, and ecological consequences of damage to forests is of broad relevance. Despite within-tree and geographic patterns of scorch severity and mortality (Figure 2), the physiological and biophysical mechanisms that led to leaf death in some trees and not others are not known. Several factors could have made some trees relatively more susceptible to scorch, including slope and aspect, genetic differences, temperature acclimation at the time of the heat dome, hydration status of foliage, foliar phenology, and foliar microbes.

Heat Dome Impacts on Ecosystem-Scale Carbon and Water Cycling

The near-term and long-term physiological causes and consequences of foliage scorch and heat stress at leaf, tree, and ecosystem levels are unknown. The numerous effects could range from impaired metabolism of surviving leaves to smaller stem diameter to canopy die-back and eventual tree mortality (e.g., Filewod and Thomas 2014). Meristems—tree tissues that are essential to recovery and plant growth—also may have been damaged by the high temperatures. Prior research on Douglas-fir suggested that growth is likely to cease when heat waves occur during long photoperiods (Ford et al. 2017).

Several research stations throughout the U.S. Pacific Northwest and in British Columbia, Canada, monitor carbon and water exchanges between the atmosphere and forested ecosystems. These data can provide insight into the response of these forests to extreme heat, and how the heat dome affected forest physiology. Two of these stations monitor forests dominated by Douglas-fir

trees: one on Vancouver Island, Canada (CA-Ca3), and one just east of Vancouver, Washington, near the Columbia River (NEON-WREF). These two forest monitoring stations have measured weather, photosynthesis and respiration, and evapotranspiration since 2001. During the 2021 heat dome, temperatures at both sites were the highest recorded since their inception. The maximum air temperatures reached 36°C (97˚F) at CA-Ca3 and 40°C (104˚F) at NEON-WREF, both of which were more than three standard deviations above the mean for this time of year.

During the heat dome, both forests lost considerable water through evapotranspiration (Figure 4). At NEON-WREF, evapotranspiration was more than twice as high as the historical average rate and well outside the range of historic variability. At CA-Ca3, the rate of evapotranspiration was at the upper range of historical rates for June, but in the months following the heat dome the evapotranspiration rate decreased dramatically, falling below the historic range for the remainder

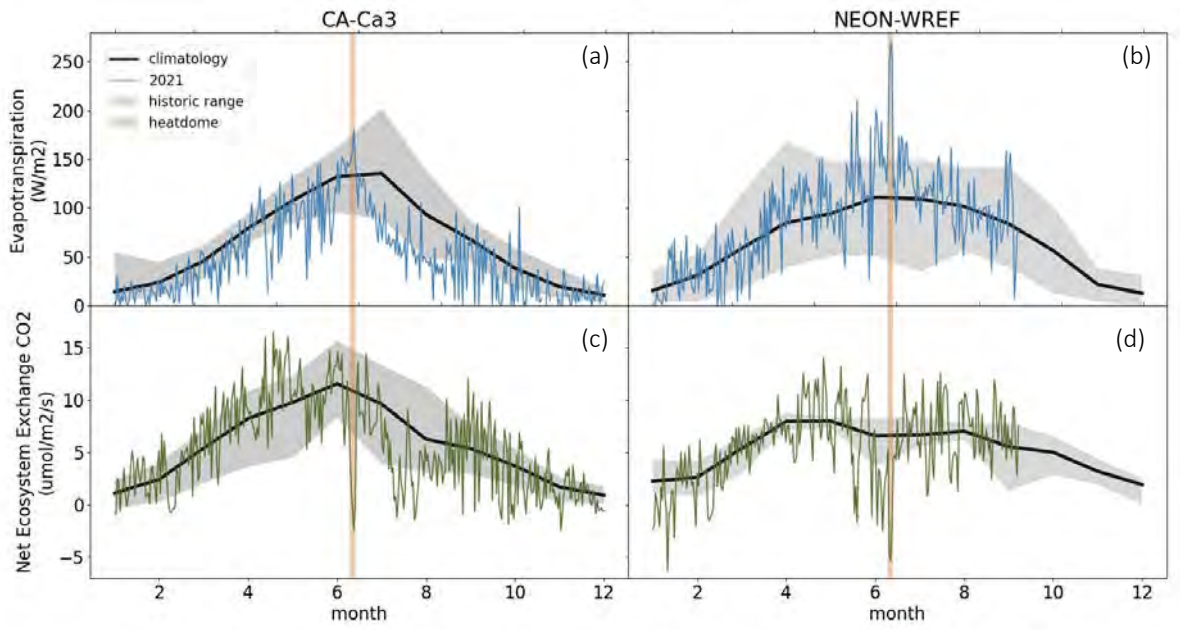

Figure 4. Evapotranspiration (top) and net ecosystem exchange of carbon dioxide (bottom) in two Douglas fir dominated forests in British Columbia, Canada (CA-Ca3, left panels) and the U.S. Pacific Northwest (NEON-WREF, right panels). Black lines represent the monthly mean, averaged across 2001-2021. Grey shading represents the range of historical monthly mean values (maximum and minimum). The time series of evapotranspiration (blue line) and net ecosystem exchange (green line) are daily mean rates during 2021, and the shaded orange band represents the heat dome in late June 2021.

of the growing season. Net ecosystem exchange (NEE) is the difference between photosynthesis and respiration. In an average year, NEE at both sites is positive throughout the growing season: both are removing carbon dioxide from the atmosphere. During the heat dome, NEE was negative, meaning that carbon dioxide was released to the atmosphere. The transpiration and NEE fluxes at these sites indicated that although the stress to trees during the heat dome was extreme at both sites, the trees at NEON-WREF were able to recover, whereas those at CA-Ca3 were stressed throughout the remainder of the growing season. More research is needed to identify the mechanisms and possible thermal thresholds beyond which photosynthesis and transpiration are hindered for prolonged periods, and to clarify the long-term consequences.

Looking to the Future

The June 2021 heat dome in the Pacific Northwest was an example of an extreme event exacerbated by human-caused climate change (Philip et al. in press), and it is highly likely that the duration, intensity, and frequency of heat waves will increase as the climate continues to warm (Perkins-Kirkpatrick and Gibson 2017, Vose et al. 2017). Ecosystems are likely experiencing novel conditions, and the effects are difficult to predict.

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The Contribution of Warm Water to Oregon's Cold-Water Fisheries

Jonny Armstrong

Salmonids, such as Pacific salmon, trout, and char, are among the most important fish taxa in Oregon because they play major ecological roles (Gende et al. 2002) while also provisioning recreational, commercial, and subsistence fisheries. As cold-water fishes, salmonids perform poorly at higher temperatures. In general, any water body that could provide a comfortable swimming hole for humans, with summer temperatures above 20˚C (68˚F), is suboptimal for salmonids. As climate change increases the spatial extent, duration, and severity of summer heat waves, a common conservation and management response is to identify and conserve the portions of basins that are not affected by such events (Isaak et al. 2015). These perennially cool areas almost exclusively are in high elevation tributaries fed by snowmelt. As conservation increasingly prioritizes such salmonid habitat as climate change refugia, the lower, warmer portions of basins are devalued and considered to be poor investments (Armstrong et al. 2021). However, seasonally warm waters may still contribute to fisheries and merit conservation action.

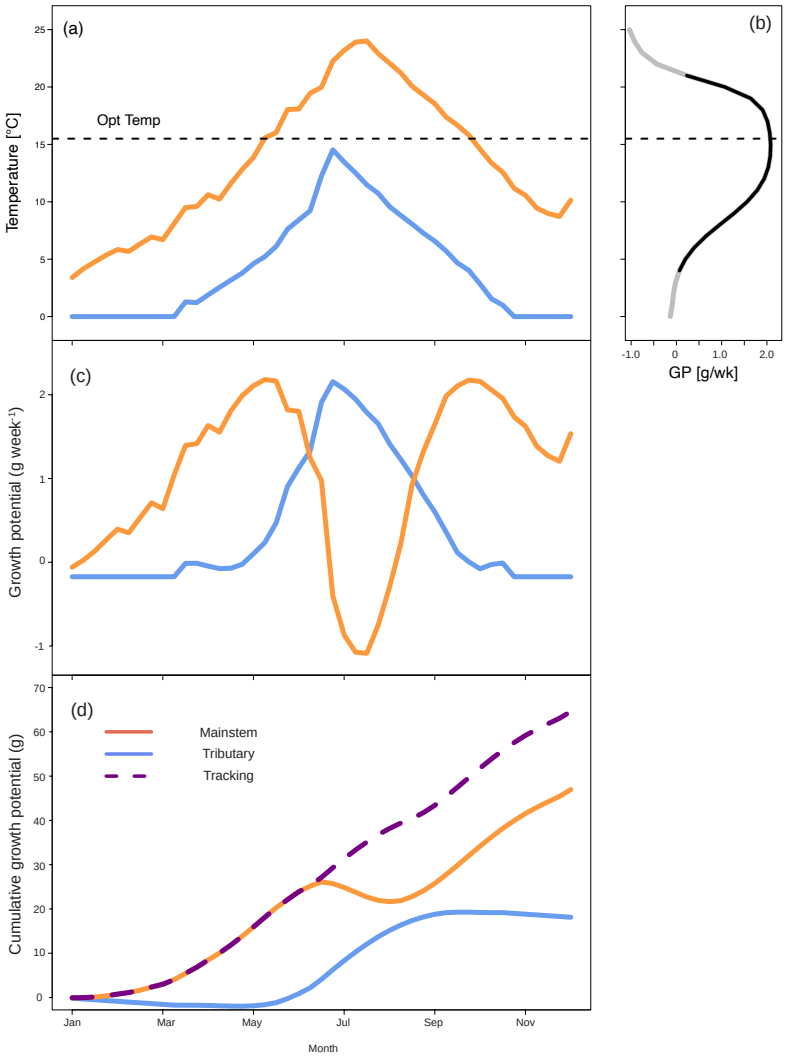

Figure 1. Variation in seasonal patterns of temperature and physiological performance across watersheds. (a) Contrasting mainstem and tributary water temperatures in the John Day River, Oregon. (b) A scope for growth curve for a cold-water fish (shaded black where growth is positive). (c) Incorporating the time series of temperature into the scope for growth model yields seasonal patterns of growth potential for headwater and mainstem habitat. (d) Cumulative growth potential for a sedentary fish in the mainstem or tributary habitat, or for a mobile fish that uses both habitat types to maximize growth potential. Figure adapted from Armstrong et al. 2021.

Water bodies that are too warm for salmonids during summer are thermally optimal at other times of year, when perennially cold habitat may be suboptimal (Figure 1). Temperatures below about 10˚C (50˚F) reduce physiological performance of most salmonids (Brett 1971). Although thermal optima differ among populations and species, peak performance usually occurs at temperatures of about 10–20˚C (50–68˚F) (Zillig et al. 2021). Streams that are thermally suitable in summer

tend to be suboptimally cold during the remainder of the year, whereas streams that are too warm during summer tend to be optimal in both autumn and spring (Figure 1, 2) (Armstrong et al. 2021, Hahlbeck et al. 2022). Indeed, areas with higher summer temperatures typically enable fish to grow more throughout the year than perennially cold areas (i.e., they offer more cumulative growth potential). Thus, cold and warm waters provide asynchronous, high-quality habitat for cold-water fishes (Kaylor et al. 2021), and either habitat type by itself tends to be thermally constraining for much of the year (Figure 1). Spring-fed rivers that have constant temperatures are an exception to this general pattern.

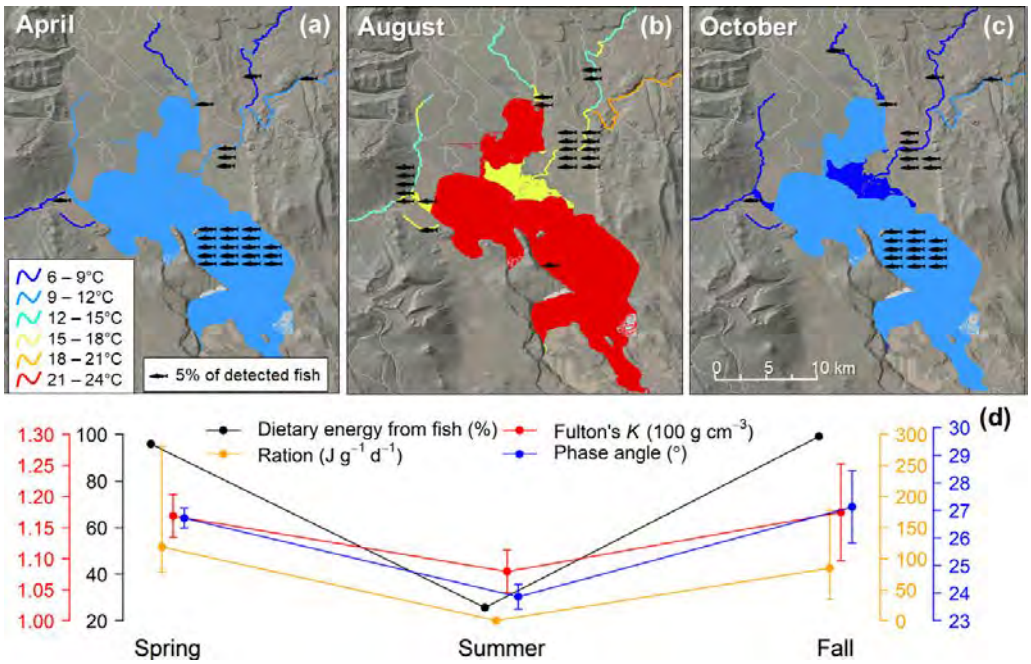

Figure 2. Example of cold-water fish exploiting seasonally warm habitat. Upper Klamath Basin with monthly mean water temperatures and redband trout habitat use during (a) April, (b) August, and (c) October, specified by the legend in (a). Use sums to >100% because some fish used multiple habitats in a month. (d) Foraging and energetic condition of redband trout in spring (in the lake), summer (in tributaries), and fall (in the lake). Each metric and its axis are coordinated by color as specified in the legend. Values of energetic condition metrics (K and phase angle) are expressed as mean (points) and normal 95% confidence intervals (bars). For right-skewed daily ration, a gamma distribution was used to estimate median and 95% confidence intervals. Dietary energy from fish represents the percentage of total dietary energy (summed across individuals) that is derived from forage fish. Figure from Hahlbeck et al. 2022, used with permission.

Although stressful summer conditions may preclude warm habitat from contributing to the growth of fishes that are sedentary, and therefore must tolerate the full range of conditions at a site, salmonids are highly mobile and are known to move among habitats that are complementary (Figure 1d) (Colyer et al. 2005, Petty et al. 2012, Bentley et al. 2015, Hahlbeck et al. 2022). The most striking example of such movement in the Pacific Northwest is the anadromous migrations of salmon and steelhead (*Oncorhynchus* spp.) between marine foraging habitat and freshwater juvenile rearing habitat. Salmonids also move over smaller distances at other times of the year to exploit ephemeral habitat.

Salmonids often exploit productive foraging habitats during autumn, winter, or spring, but leave these areas when they become stressful or lethal during summer. An extreme yet ubiquitous example is that of ephemeral streams that become dry in summer. Stream drying can occur across areas with

diverse climate and hydrology and is a conspicuous threat to juvenile salmon in rain-dominated tributaries in the Coast Range or the Cascade Range foothills. For example, many tributaries of the Rogue River become hot or dry during summer and early autumn (Everest 1973). However, these intermittent tributaries still support large runs of steelhead. Adult steelhead spawn in these tributaries during winter, rear during spring, and emigrate to the perennial mainstem of the Rogue River before summer drying. Similarly, ephemeral streams in the Smith River basin supported high rates of growth of juvenile coho salmon (*Oncorhynchus kisutch*) that moved to these habitats during winter (Ebersole et al. 2006). These ephemeral habitats are important for population productivity, yet are downgraded by climate-informed planning that is based on their poor summer conditions.

Seasonal movement can allow salmonids to exploit water bodies in which temperatures and other conditions during summer are lethal. For example, during summer, intense cyanobacteria blooms occur in Upper Klamath Lake (Platt Bradbury et al. 2004). The lake also has maximum summer temperatures above 25°C (77°F), pH levels approaching 10, and periods of severe hypoxia (low oxygen levels). These conditions generate mass mortality of fish taxa that are far more tolerant than salmon and trout (Martin and Saiki 1999, Perkins et al. 2000). Despite these summer hazards, the lake serves as high-quality foraging habitat during other seasons. Redband trout (*Oncorhynchus mykiss newberri*) move to the lake to gorge on forage fishes, and grow rapidly when temperatures are physiologically optimal in spring and autumn. Trout leave the lake during summer and move to spring-fed tributaries that remain cool year-round (Figure 2). However, although these summer refuges are spatially extensive and less impaired than the lake, redband trout do not grow in them (Figure 3). Accordingly, large-bodied trout require more than perennially cold water. Instead, they feed and grow in waters with seasonally extreme temperatures that would likely receive a low rank in climate-informed planning (Hahlbeck et al. 2022). A key uncertaintly is whether populations of small-bodied nonmigratory trout can persist in perenially cool tributaries without the contribution of large-bodied migratory fish, which produce more eggs and may reduce the risk of extirpation from wildfire or other disturbances.

Although redband trout in the Klamath River basin move long distances among adjacent water bodies, some populations survive in seasonally warm habitat by moving shorter distances within rivers or lakes. For example, some coastal cutthroat trout move to the floodplain of the mainstem Willamette River during summer, where upwelling springs provide thermal refuges that are up to ~7°C (12.6°F) colder than the adjacent mainstem (Barrett and Armstrong 2022). These fish appear to remain in the thermal refuges for weeks or months, but other salmonid populations may continue to exploit mainstem habitat through feeding forays or by feeding at thermoclines between habitat types (Brewitt et al. 2017). Fish may be able to feed for tens of minutes at a time in warm habitat before their body temperatures fully equilibrate (Pépino et al. 2015)

Cold-water fish use three general tactics, migration, movement, and tolerance, to persist in seasonally warm lakes and mainstem rivers (Barrett and Armstrong 2022). As described above, fish can migrate over long distances to cold tributaries, move over shorter distances to cold patches nested within warmer habitat, or tolerate warm conditions through physiological adaptations. There is renewed uncertainty about the temperatures that salmonids can tolerate before their physiological performance declines. For decades, salmonid physiology was assumed to be similar across populations or even species, and bioenergetics models for a given population often were parameterized on the basis of data from other populations or species. However, there is increasing recognition that thermal physiology, like many other traits in salmonids, may be locally adapted and therefore vary within species across space (Zillig et al. 2021). The parameters for bioenergetics

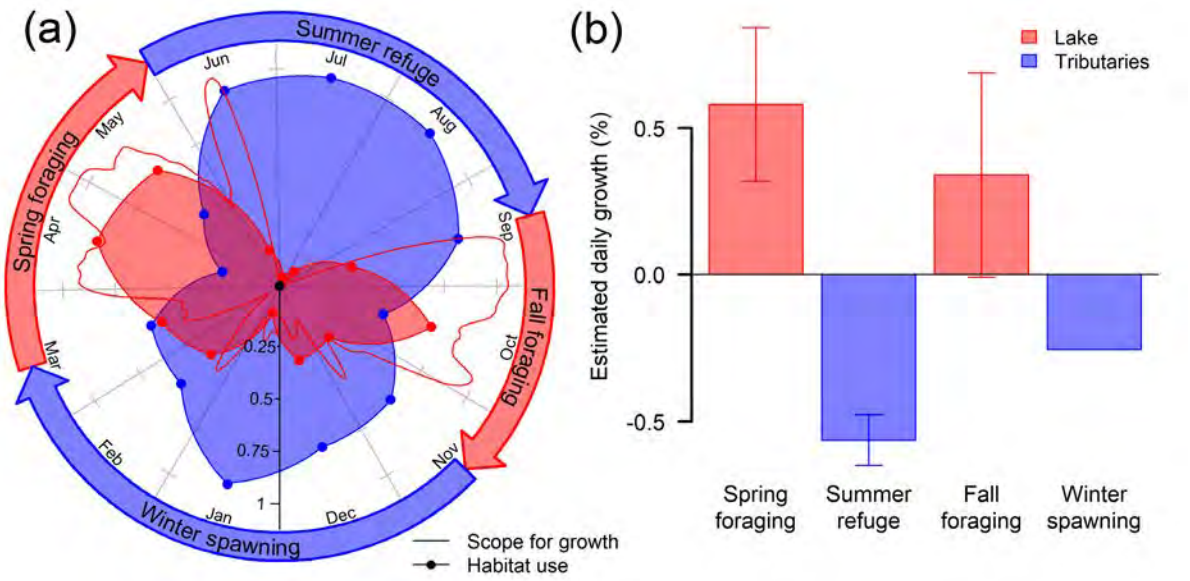

Figure 3. Complementary warm and cool habitat supports a migratory coldwater fish. (a) Biannual migrations between lake and tributary habitat by redband trout in the Upper Klamath Basin. Migration stages (arrows on outer ring) are based on congruence among telemetry, diet sampling, and spawning surveys. Lines bounding shaded areas within plot represent monthly habitat use, expressed as a proportion from 0-1 (shaded area). The red line indicates daily potential for growth in the lake given water temperature, expressed as percent body weight per day. Negative values in summer appear equivalent to zero. (b) Predicted daily growth during each migration stage (mean ± 95% CI), based on bioenergetics modeling and estimated cost of spawning in migratory redband trout. Seasonally warm lakes provide positive growth that appears to fuel the behaviors expressed in cool tributaries. Figure from Hahlbeck et al. 2022, used with permission.

models are now being updated for northern and southern populations. For example, maximum food consumption rates of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) now are known to occur at about 18–22˚C (64–72˚F) in southern populations, whereas the published parameter used for the prior ~20 years was 15˚C (59˚F) (Plumb and Moffitt 2015). Ongoing efforts to quantify thermal performance at the population level should help to refine understanding of variation in physiology among individual members of the same species.

In the wild, many ecological variables interact with a fish's physiology to mediate how well fish can adapt to warming temperatures. Laboratory studies can only go so far in predicting biological responses to climate change. However, to protect wild fishes, researchers are typically not permitted to sample when temperatures exceed 18˚C (64.4˚F). This temperature is about 10˚C (18˚F) below the lethal temperatures for most salmonids, so it cannot simply be assumed that waters too hot to sample are not being used by fish. In fact, recent bioenergetics research suggested that the 18°C threshold could be physiologically optimal for some populations (Plumb and Moffitt 2015). One way to resolve uncertainty about biological effects of water temperature is to implant fish with small transmitters that track their location and provide data on water temperature and the activity and survival of the fish throughout summer. This approach to studying fish distributions can yield novel insights not possible from sampling fish at fixed locations. For example, in the mainstem Willamette River, about 100 trout were tagged in spring and tracked weekly until autumn (Barrett and Armstrong 2022). About 10 percent of the population moved to floodplain thermal refuges or migrated to tributaries, whereas ~90 percent remained in the adjacent mainstem, where the temperatures sensors on their tags transmitted readings up to 22.5˚C (72.5˚F). This result surprised us because cutthroat trout are conspicuously abundant in thermal refuges during summer, but

difficult to observe in the mainstem due to sampling restrictions and low water clarity. Presence-absence data might lead one to assume that the mainstem was too warm for cutthroat trout during summer, yet the vast majority of tracked fish did not leave the mainstem even as it reached temperatures that likely were physiologically suboptimal (Anlauf-Dunn et al. 2022).

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Land-Use Law and Climate Change

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Introduction

Oregon's capacity to adapt to and mitigate climate change is determined in large part by the state's development patterns, including the placement and design of structures and infrastructure. Because state and local land-use laws control how and where development occurs, they play a key role in determining whether Oregon will reduce its emissions of greenhouse gases, preserve and increase the capacity of natural and working lands to sequester carbon, and increase the resilience of human communities to climate change and related risks (Salkin 2008, Stone 2009, Revi et al. 2014, Adams-Schoen 2018, Rogelj et al. 2018, OGWC 2021, Sullivan and Tarlock 2022). Here, working lands refers to forests harvested for timber, lands used for agriculture or livestock grazing, and parks and open spaces used for recreation.

Land-use laws significantly influence the geography of human development, including, for example, the size, shape, and growth rate of cities. Within human developments, land-use laws regulate the intensity and spatial distribution of land uses and strongly affect both the structural resilience of buildings and the resilience of communities to climate-related vulnerabilities such as extreme heat, flood, and wildfire (Rosenzweig 2011, Gencer et al. 2018, Sullivan and Tarlock 2022). For example, land-use laws can help communities avoid or mitigate risks related to development in flood- and wildfire-prone areas by mandating setbacks to maintain defensible space, requiring developments to conform with building criteria, and using regulatory mechanisms to shift development away from vulnerable areas (Adams-Schoen 2018). Land-use laws can also support both mitigation and adaptation strategies by, for example, encouraging or requiring protection and restoration of wetlands, dunes, and other natural systems that store carbon and buffer communities from the impacts of natural hazards such as floods (Telesetsky 2020). Additionally, planned high-density development can reduce carbon emissions from gasoline-powered vehicles and contribute to the maintenance of natural systems (Adams-Schoen 2018, Lwasa et al. 2022).

Oregon is a leader in harnessing land-use law to address several of the key drivers of climate change, such as urban sprawl and accompanying reductions in the area of natural and working lands. Recent reforms of Oregon's land-use and housing laws and related regulations support four climate goals: reduction of greenhouse gas emissions, carbon sequestration, increasing community resilience to climate-related risks, and more equitably distributing environmental benefits and burdens. However, we conclude that Oregon is not fully utilizing state and local land-use laws to support achievement of climate goals (Table 1).

In the following sections, we address six major points. First, the foundation of Oregon's land-use system consists of 19 statewide land-use planning goals and their implementing regulations, which prescribe the content of local land-use plans and laws and the implementation of those laws. The goals have largely shaped Oregon's land uses to address key concerns of the early 1970s, the period in which they were adopted. The goals do not expressly address climate change. Incorporation of climate considerations into the statewide planning goals and their implementing regulations provides a significant but unrealized opportunity to align Oregon land-use law and public and private land-use actions with the state's climate goals.

Second, by prioritizing the prevention of urban sprawl and the preservation of farms and forests for nearly 50 years, Oregon land-use law constrained a development pattern that increases emissions of

		Reduction of greenhouse gas emissions	Carbon sequestration	Reduction of community vulnerability	Equitable distribution of benefits and burdens
Integrated land-use and transportation scenario planning and Climate-Friendly and Equitable Communities regulations	Strengths	Requires and supports metropolitan planning organization scenario planning to reduce vehicle miles traveled; supports preservation of urban growth boundaries (UGBs) and production of energy efficient housing	Supports preservation of UGBs	Supports preservation of UGBs; may increase housing choice and affordability; may increase access to schools and services for historically marginalized populations; may improve public health outcomes for historically marginalized populations; partially implements Anti-Displacement Toolkit	
	Weaknesses	Implementation timeline unlikely to decrease emissions sufficient to support 2035 climate goal	Implementation timeline unlikely to decrease UGB expansions sufficient to support 2035 climate goal	Implementation may displace historically marginalized populations, may not address inequitable distribution of climate-related burdens to low amenity neighborhoods with larger populations of historically marginalized residents, and may increase housing density in areas vulnerable to natural hazards	
Housing-related amendments to state and local law	Strengths	Supports preservation of UGBs and production of energy-efficient housing	Supports preservation of UGBs	Supports preservation of UGBs; supports production of lower-cost housing and increased access to high amenity neighborhoods	
	Weaknesses	Failure to address pre-2021 private land-use restrictions may reduce climate benefits		Potentially increases density in vulnerable areas; does not address inequitable distribution of burdens to low amenity neighborhoods with larger populations of historically marginalized residents	

Table 1. Recent land-use and housing law reforms.

greenhouse gases and vulnerability to climate-related natural hazards while decreasing carbon sequestration. Recent changes in Oregon land-use and housing laws have the potential to further constrain this development pattern.

Third, the gap between emissions reduction targets and performance in the transportation and land-use sectors is wide, largely because state and local land-use and transportation laws have not been amended or adequately enforced to facilitate achievement of the targets. In 2019 and 2020, the governor directed the state's climate agencies, including the Department of Land Conservation and Development and Department of Transportation, to address significant implementation shortfalls that resulted in the discrepancy between targets and performance.

Fourth, the Land Conservation and Development Commission's new Climate-Friendly and Equitable Communities Rules (2022) will, assuming they survive a challenge pending in the Oregon Court of Appeals (City of Cornelius v. Oregon Department of Land Conservation and Development [2022]), contribute to reductions in emissions of greenhouse gases by strengthening climate-responsive transportation and land-use planning in the state's eight major urban areas: Portland Metro, Salem/Keizer, Corvallis, Albany, Eugene/Springfield, Middle Rogue/Grants Pass, Rogue Valley/Medford, and Bend. However, given the rules' implementation timelines, they likely will not contribute appreciably to Oregon meeting its goals for reduction of emissions by 2035.

Fifth, reform of Oregon's housing laws since 2017, and amendment of state and local land-use regulations pursuant to that reform, will contribute to Oregon remaining a national leader in reducing urban sprawl and associated increased emissions, natural hazard vulnerabilities, and

conversion of natural and working lands. However, these laws are unlikely to result in sufficient changes in development patterns within the timeframe needed to support achievement of Oregon's 2035 targets.

Sixth, Oregon's Statewide Land Use Planning Goal 7, *Areas Subject to Natural Hazards*, which directs local governments to address natural hazards in local comprehensive plans, has not been interpreted or enforced to require local governments to plan for and adapt to the current and foreseeable effects of climate change (Sullivan 2020b). The state's recent climate adaptation guidelines place more emphasis on the need to prepare communities for climate-related natural hazards and encourage local governments to adopt adaptation strategies that recognize the disparate burdens that historically marginalized communities bear with respect to climate-related vulnerabilities. However, state law does not require local governments to adopt or implement climate adaptation plans. Additionally, state and local law continues to approach climate adaptation by focusing primarily on the structural resilience of buildings while allowing and, in some cases, encouraging development in vulnerable areas.

Oregon's Land-Use System

Oregon's land-use system, which is built on a foundation of state-developed goals that constrain and guide locally developed and implemented plans, offers opportunities for the state to respond to climate change. Spurred by a desire to prevent uncontrolled development and sprawl, Oregon adopted its state-led model of land-use planning in 1973 (Sullivan 2012). This new system created the Land Conservation and Development Commission, consisting of seven governor-appointed commissioners, as the state policy body to implement state land-use laws. The legislature directed the commission to adopt statewide planning goals, which established the state's policies on land use and development. The commission ultimately adopted 19 Statewide Land Use Planning Goals that address uses of urban and rural lands, coastal resources, farm and forest lands, natural hazards, affordable housing, economic development, and urban growth (DLCD 2019a, Adams-Schoen and Sullivan 2022).

Oregon's land-use system delegates implementation of the statewide goals to local governments, which are required to adopt comprehensive local land-use plans that are consistent with the statewide goals. Following acknowledgment by the Land Conservation and Development Commission that a plan conforms to the statewide goals, the plan becomes the basis for all local land-use laws and public and private land-use actions (Sullivan 2012).

The Land Conservation and Development Commission also adopts administrative rules that implement state land-use policies and oversees the Department of Land Conservation and Development, the state's land-use planning agency, which implements the Land Conservation and Development Commission's policies and supports implementation of these policies by local governments. A separate state agency, the Land Use Board of Appeals, replaces a generalist trial court in adjudicating most land-use disputes (Adams-Schoen and Sullivan 2022).

Role of Land-Use Law in Adaptation to and Mitigation of Climate Change

Oregon's land-use framework provides a significant opportunity to support the state's climate adaptation, mitigation, and sequestration goals. In many cases, changes in land-use laws support multiple climate goals. Adaptation refers to actions that help society adjust to the effects of climate change. Land-use laws are often characterized as facilitating climate adaptation through protection,

accommodation, and retreat (Grannis 2011, Grannis et al. 2012, Nolon 2013, Siders 2013, Adams-Schoen 2018). Protection refers to laws that attempt to maintain existing developments and defend them from climate threats; regulations that permit shoreline armoring are an example. Accommodation-based laws seek to permit continued development in vulnerable locations by aligning structural design with climate risks by, for example, requiring homes built in wildfire-prone areas to have vegetation setbacks or use nonflammable building materials. Retreat-based laws restrict or prevent new development in vulnerable areas and shift existing development to safer locations. Examples include laws that require, enable, or incentivize relocation of uses and structures and laws that prohibit or restrict some or all forms of development in vulnerable areas. The range of retreat regulatory strategies is large and diverse, ranging from buyouts and floodplain and wildfire-risk area regulations to transfers of development rights and urban growth boundary reconfigurations.

Land-use law is also integral to the attainment of mitigation and carbon sequestration goals (Shukla et al. 2019). Mitigation refers to reducing emissions of greenhouse gases. Land-use laws can support mitigation by, for example, prescribing compact development to reduce the distance that people travel from home to daily activities and encouraging low-carbon transportation options (NRC 2009). Other examples include laws that encourage or mandate energy-efficient building design and materials, reduce regulatory barriers to the development of renewable and low-carbon energy, and limit high-emission-generating uses, such as confined animal feeding operations.

Carbon sequestration refers to the capture and storage of atmospheric carbon dioxide. Land-use laws that restrict development of natural and working lands can support sequestration by maintaining carbon sinks, such as old-growth forests, wetlands, and coastal dunes (Sleeter et al. 2018). These regulations prevent the release of stored carbon from the conversion of natural lands and help to maintain existing carbon stores (Graves et al. 2020). Land-use laws that protect natural areas (e.g., by preventing or reducing development-related pollution) can also preserve and enhance the capacity of natural areas to sequester carbon (Graves et al. 2020). Additionally, land-use laws can, if properly tailored, increase the capacity of working lands such as farms and pastures to sequester carbon (Fargione et al. 2018).

Land-use laws that limit urban sprawl can promote the attainment of adaptation goals, targets for reduction of greenhouse gas emissions, and carbon sequestration. Urban sprawl increases the distance that residents typically travel by personal vehicle for work, school, and other activities; contributes to the loss of forests, grasslands, and other ecosystems that, when largely undisturbed, sequester carbon; and can increase the vulnerability of human populations to natural- and climate-related threats, such as by bringing human settlements closer to wildfire-prone vegetation (Stone et al. 2010, Jones and Kammen 2014, Radeloff et al. 2018). A key step in reducing sprawl is a thorough assessment of existing land-use laws and related regulations to identify those that contribute to sprawl. Examples include regulations that prohibit dense housing structures, such as apartment buildings and single-room occupancies; require the construction and dedication of land for off-street parking spaces as a condition of residential development (Figure 1); restrict the number of people who can live in a residential unit or geographic area; limit the percentage of a buildable lot that can be covered by one or more residential units; or limit the geographic expansion of cities. Careful tailoring is required to assure that urban growth boundaries and density increases do not generate offsetting inter-urban commutes and do not entrench existing disparities in access to affordable housing and areas of economic, social, and educational opportunity, which exacerbate climate vulnerabilities.

Figure 1. Off-street parking in downtown Corvallis. Source: Oregon Department of Land Conservation and Development, July 2022.

Although land-use laws have the potential to reduce the adverse effects of climate change, most were developed without consideration of climate science and have not been revised to reflect climate science. Many of these laws increase climate-related risks or create barriers to achieving climate-related goals (Grannis 2012, Siders 2013, Adams-Schoen 2018). For example, land-use laws may continue to permit or even create incentives for development in areas vulnerable to natural hazards or in areas that have mitigation potential. Examples include laws that allow development in flood- or wildfire-hazard areas or in wetlands or other natural areas, or that prohibit or prolong the time necessary to develop renewable energy infrastructure.

To date, many U.S. communities engaged in planning for climate change have focused solely on adaptation strategies (Adams-Schoen 2018, Schipper 2020). These strategies tend to focus on increasing the resilience of buildings by adopting requirements that protect individual structures from climate risks—for example, requirements that structures in flood-hazard areas be elevated at or above the base-flood elevation. However, even when new development can be designed for structural resilience, community resilience requires accounting for the economic and social costs of exposing residents and first responders to climate-related hazards, cost of infrastructure maintenance in vulnerable areas, impact of new development on adjacent areas, and loss of species and ecosystem function (Adams-Schoen 2018). Focusing on buildings while allowing development in vulnerable areas can also perpetuate community misperceptions about the risks presented by development (Schipper 2020).

Additionally, focus on buildings can divert attention from community-level resilience. Community-level resilience strategies require or create incentives to reduce the intensity of land uses in vulnerable areas and areas that can sequester appreciable amounts of carbon (Siders 2013, Adams-Schoen 2018). Examples include land-use regulations that permit only open space or recreational uses in vulnerable areas; designate existing higher-intensity land uses as non-conforming, which, under typical land-use laws, means that the existing use cannot be enlarged, expanded, or rebuilt if destroyed; or provide transferrable development credits that allow owners of property in vulnerable areas to transfer their development rights to parcels in less vulnerable areas, thereby recouping some of the economic value of their initial investment.

Assessment

Since 2004, Oregon policy has called for consideration of the effects of land uses on climate (Governor's Advisory Group on Global Warming 2004). In 2007, Oregon House Bill 3543 created the Oregon Global Warming Commission and adopted greenhouse gas emissions reduction targets of 10 percent below 1990 levels by 2020 and 75 percent below 1990 levels by 2050 (ORS 468A.205). In 2020, Governor Brown updated Oregon's emission reduction targets to 45 percent below 1990 levels by 2035 and 80 percent below 1990 levels by 2050 (Oregon Executive Order 20-04).

Since 2010, the state has recognized that consideration of climate in state and local land-use planning and actions is essential to meeting Oregon's legislatively adopted targets (OGWC 2010).

In 2011, the Oregon Global Warming Commission recommended that land-use planning processes include consideration of carbon emissions and storage. The commission also recommended that urban, forest, and agricultural land-use decision-making align with the state's climate goals (OGWC 2011). To this end, the commission recommended that cities accommodate residential and employment growth within existing urban growth boundaries; make public transit more convenient, frequent, accessible, and affordable; and redesign neighborhoods so schools, services, and shopping are easily accessible by walking, biking, or public transit (OGWC 2011). Furthermore, the commission recommended that transportation plans facilitate more transport by rail and less transport by trucks.

In 2020, the Oregon Global Warming Commission projected that, if current trends continued, the state would exceed its initial 2035 and 2050 targets by 23 and 54 million metric tons (MMT) of carbon dioxide, respectively (OGWC 2020). The Department of Land Conservation and Development subsequently reported that, if current trends continued, emissions from Oregon's transportation sector would exceed the state target by 400 percent by 2050 (DLCD 2022b).

However, in July 2022, the Oregon Global Warming Commission reported that modeling that incorporates 14 adopted and in-development state programs suggests that Oregon can meet the goal of reducing emissions to at least 45 percent below 1990 levels by 2035, assuming timely and complete implementation of the programs (OGWC 2022). The 14 programs do not include regional scenario planning pursuant to the new Climate-Friendly and Equitable Communities rules or urban densification pursuant to the 2017 to 2022 reforms of Oregon's housing and land-use laws.

Oregon's Statewide Land Use Planning Goals

The statewide goals have largely shaped Oregon's land uses to address key concerns of the early 1970s, including limiting urban sprawl and preserving forests, agricultural lands, and coastal dunes and estuaries. Because the goals and their implementing regulations prescribe the content of local land-use plans and laws and the implementation of those laws through, for example, development-permitting decisions, consideration of climate in the statewide goals provides a major opportunity to align Oregon land-use law and public and private land-use actions with the state's climate goals.

However, climate change is not expressly reflected in the goals, the implementing agency and courts have not interpreted the goals to require climate considerations, and Oregon has not reviewed or assessed the capacity of the planning goals and associated regulations to effectively address climate change. Furthermore, in 2021, the legislature did not act on a bill that would have amended Oregon's land-use system to add a twentieth statewide goal, which would have required local governments to integrate climate justice considerations into their comprehensive plans and land-use regulations.

In 2021, the Oregon Global Warming Commission recommended that the Department of Land Conservation and Development, with funding and direction from the legislature, analyze how the statewide planning goals and their implementing regulations could be amended to better protect and restore natural and working lands and increase sequestration (OGWC 2021). As part of the statewide goal analysis, the commission advised the Department of Land Conservation and Development to analyze actions it should take to direct and support local jurisdictions in addressing climate mitigation in their comprehensive plans and land-use regulations. With respect to sequestration, the commission emphasized Statewide Planning Goals 3 (Agricultural Lands), 4 (Forest Lands), 5 (Natural Resources, Scenic and Historic Areas, and Open Spaces), 16 (Estuarine Resources), and 17 (Coastal Shorelands).

Without legislatively enacted statewide planning goals that require climate considerations, local governments have no express mandate to consider climate in their comprehensive plans and land-use actions. Local governments are obligated to consider climate, however, when climate considerations are incident to other factors they are legislatively mandated to consider. For example, local governments must consider "social, economic, energy and environmental consequences" when expanding their urban growth boundaries under Goal 14 (Urbanization), establishing programs to protect open space and natural resource areas under Goal 5 (Natural Resources, Scenic and Historic Areas, and Open Space), adopting exceptions to statewide goals under Goal 2 (Land Use Planning), and identifying lands "suitable" for residential use under Goal 10 (Housing) (DLCD 2019a). Additionally, Goal 7 (Areas Subject to Natural Hazards) mandates that "Developments subject to damage or that could result in loss of life shall not be planned or located in known areas of natural hazards without appropriate safeguards" (DLCD 2019a).

Moreover, the state has no basis for reviewing plans with respect to climate responsiveness or requiring modifications of local comprehensive plans that do not address climate mitigation, and the state has not interpreted the Natural Hazards Goal to require plans to address climate adaptation. As a result, many current, approved comprehensive plans do not substantively consider climate adaptation or mitigation, and local land-use laws and decisions do not reflect state climate change goals and climate vulnerabilities.

Although the absence of explicit climate considerations in the statewide goals does not prevent local governments from adopting land-use laws that integrate climate science and state climate goals, most have not done so. Key barriers to local action include a lack of technical capacity, insufficient funding, and political constraints. Furthermore, land-use planning is often contentious because it affects private land uses, and local elected public officials are unlikely to act in the face of strong public opposition.

Decreasing Emissions of Greenhouse Gases

Transportation and Land-Use Sector Emissions Reduction Targets and Performance

The transportation sector accounts for nearly 40 percent of Oregon's greenhouse gas emissions (OGWC 2020). The majority of these emissions are from cars and light trucks in the state's eight major urban areas: the Portland metropolitan area (Metro), Salem and Keizer, Corvallis, Albany, Eugene and Springfield (Central Lane), Middle Rogue and Grants Pass, Rogue Valley and Medford, and Bend (OGWC 2018). As required by federal transportation law, the state has designated metropolitan planning organizations (MPOs) to coordinate transportation planning in each of these urban centers (49 U.S.C. § 5303, 1000 Friends of Oregon 2022).

The state passed laws in 2009 and 2010 that required the eight MPOs to consider how regional transportation plans could be revised to reduce emissions (HB 2001 [2009], sections 37–39; HB 2186 [2009], section 10; SB 1059 [Chapter 85, Oregon Laws 2010, Special Session], codified at ORS 468A.205). The 2009 and 2010 laws also required the Portland Metro MPO to develop and implement an integrated land-use and transportation scenario plan to reduce emissions from cars and light trucks. The laws directed the Land Conservation and Development Commission to adopt emissions reduction targets for each MPO; the Oregon Department of Transportation (ODOT) to adopt a state transportation strategy to reduce greenhouse gas emissions; and the Land Conservation and Development Commission and Oregon Transportation Commission to provide MPOs with policy leadership and decision-support tools, such as planning guidelines and computer modeling, to

forecast the emissions consequences of land-use and transportation actions. The Jobs and Transportation Act of 2009 directed the Land Conservation and Development Commission and ODOT to provide technical and financial support to the Portland Metro and Central Lane MPOs for scenario planning. Portland Metro completed its scenario plan in 2014 and subsequently amended its land-use laws pursuant to the plan (ODOT 2018). Central Lane completed a draft of its plan in 2015 but has not adopted the plan.

Figure 2. Cycling over Tilikum Crossing Bridge, Portland, Oregon. Photograph by Cole Keister.

The Statewide Transportation Strategy identified efficient land use as one of six general categories of strategies necessary for the transportation sector to contribute to achieving Oregon's emissions reduction goals (ODOT 2013). Efficient land-use strategies are those that promote efficient transportation via compact growth and development, reducing travel distances and enabling use of lower energy and zero energy transportation (Figure 2) (ODOT 2013). Examples of laws consistent with these strategies include those that support mixed-use development, limit expansion of urban growth boundaries, and promote consolidation of urban centers for freight shipping and operations (ODOT 2018). Although ODOT reported in 2018 that compact urban development is reliant on housing costs, generational preferences, and job locations (ODOT 2018), economics, urban studies, and land-use law research suggests that land-use regulations affect variation in the price of urban housing and play a larger role in shaping urban development than factors such as generational preferences and job location (Been et al. 2018).

In its most recent Statewide Transportation Strategy monitoring report, ODOT estimated that current and planned implementation of statewide transportation strategies would reduce emissions to 15–20 percent below 1990 levels by 2050, far short of the goal of reducing carbon emissions from the transportation sector to 75 percent below 1990 levels by 2050 (ODOT 2018). As of 2022, only the Portland Metro and Central Lane MPOs have undertaken scenario planning, and only Portland Metro has adopted and begun implementing a scenario plan. The Corvallis Area and Rogue Valley MPOs voluntarily completed strategic assessments of their existing plans and policies, identified potential approaches for reducing transportation-related emissions, and revised their regional transportation plans. Four of Oregon's eight MPOs have not conducted scenario planning or strategic assessments.

Although ODOT's 2018 monitoring report stated that the rates of limitation of urban growth boundary expansions and creation of dense mixed-use areas were consistent with goals in the

Statewide Transportation Strategy (ODOT 2018), data in the report indicated otherwise, and Appendix A of the report included the Department of Land Conservation and Development's finding that the state was not meeting the goal of limiting expansions of urban growth boundaries. Additionally, the goal of 20 percent of households living in mixed-use areas by 2020 was already met when the Statewide Transportation Strategy was published in 2012, and the data in the 2018 monitoring report suggested that Oregon is unlikely to meet the goal of 30 percent by 2035. The Department of Land Conservation and Development reported that most progress toward the goal was in the Portland metropolitan area, and other metropolitan areas have not progressed above the baseline (ODOT 2018).

Effects of Climate-Friendly and Equitable Communities Rules

In 2019, responding to slow progress toward meeting Oregon's emission reduction targets, Governor Brown sent a letter to the state's climate agencies—the Departments of Land Conservation and Development, Transportation, Environmental Quality, and Energy. The letter directed the Departments of Land Conservation and Development and Transportation to prioritize implementation of the Statewide Transportation Strategy. On 19 March, 2020, Governor Brown issued Executive Order 20-04, which included four directives to the Land Conservation and Development Commission and Oregon Transportation Commission: prioritize implementation of the Statewide Transportation Strategy, establish emission reduction-performance metrics, expedite amendment of transportation planning rules to ensure that the state's MPOs meet their regional emissions reduction goals, and comply with the legislative mandate to provide local governments with the funding and technical assistance needed to revise and implement their plans for reducing vehicle emissions. Executive Order 20-40 reiterated the need to amend state and local land-use and transportation regulations to implement state law.

Recognizing that the state is not meeting its emissions reduction targets for the transportation sector, the Land Conservation and Development Commission initiated a rulemaking proceeding in September 2020 to respond to Executive Order 20-04. The commission directed the rulemaking advisory committee to prioritize social equity in recognition of Oregon's record of inequity and bias in land-use planning, zoning law, and transportation investment (DLCD 2022a). After two years of community engagement, the Land Conservation and Development Commission adopted Climate-Friendly and Equitable Communities administrative rules on 21 July, 2022. The rules are intended to increase housing options and affordability in mixed-use neighborhoods designated by the MPOs as Climate-Friendly Areas (CFAs); improve walkability and alternative transit options in CFAs so residents can access jobs, schools, services, and other essentials without a car (Figure 3); improve, expand, and connect networks of sidewalks, bike lanes, and other transit infrastructure to decrease car dependence; reduce the amount of parking required as a condition of residential development; and focus local and regional transportation planning on decreasing vehicle miles traveled in cars and trucks (1000 Friends of Oregon 2022, DLCD 2022a).

The Climate-Friendly and Equitable Communities rules require cities and some other urban areas within the seven MPOs that have not developed an integrated land-use and transportation scenario plan to reduce emissions from cars and light trucks, designate CFAs, and amend their local laws to remove existing regulatory barriers to denser, more walkable development in the CFAs. The rules define CFAs as urban areas that contain, or are planned to contain, a mix and supply of housing, jobs, businesses, and services. CFAs must be served, or plan to be served, by high-quality pedestrian, bicycle, and transit infrastructure. For example, the CFA rules require MPOs to allow taller

residential buildings and adopt minimum density standards to help ensure that public transit can serve the CFA. The rules support the ongoing implementation of the Portland metropolitan area's existing regional scenario plan, the 2040 Growth Concept.

The Climate-Friendly and Equitable Communities rules' implementation timelines do not align with the state's emissions reductions targets. The rules require the seven MPOs that have not yet developed scenario plans to do so by 31 December, 2027 (Eugene-Springfield and Salem-Keizer) or 31 December, 2029 (the remaining MPOs); these are the existing deadlines for the MPOs' major updates to their transportation system plans. The rules allow the MPOs to extend these deadlines by applying to the Department of Land Conservation and Development. MPOs may also apply to the Department of Land Conservation and Development for alternative deadlines to amend their commercial, land-use, and bicycle regulations and to implement their updated transportation system plans (Oregon Administrative Rules 660-012-0012). Because developed plans take years to implement, the new rules likely will not lead to stabilization or reduction of vehicle emissions from any of the state's MPOs (except Portland Metro, which is already implementing its scenario plan) until 2030 at the earliest, and probably not until years later.

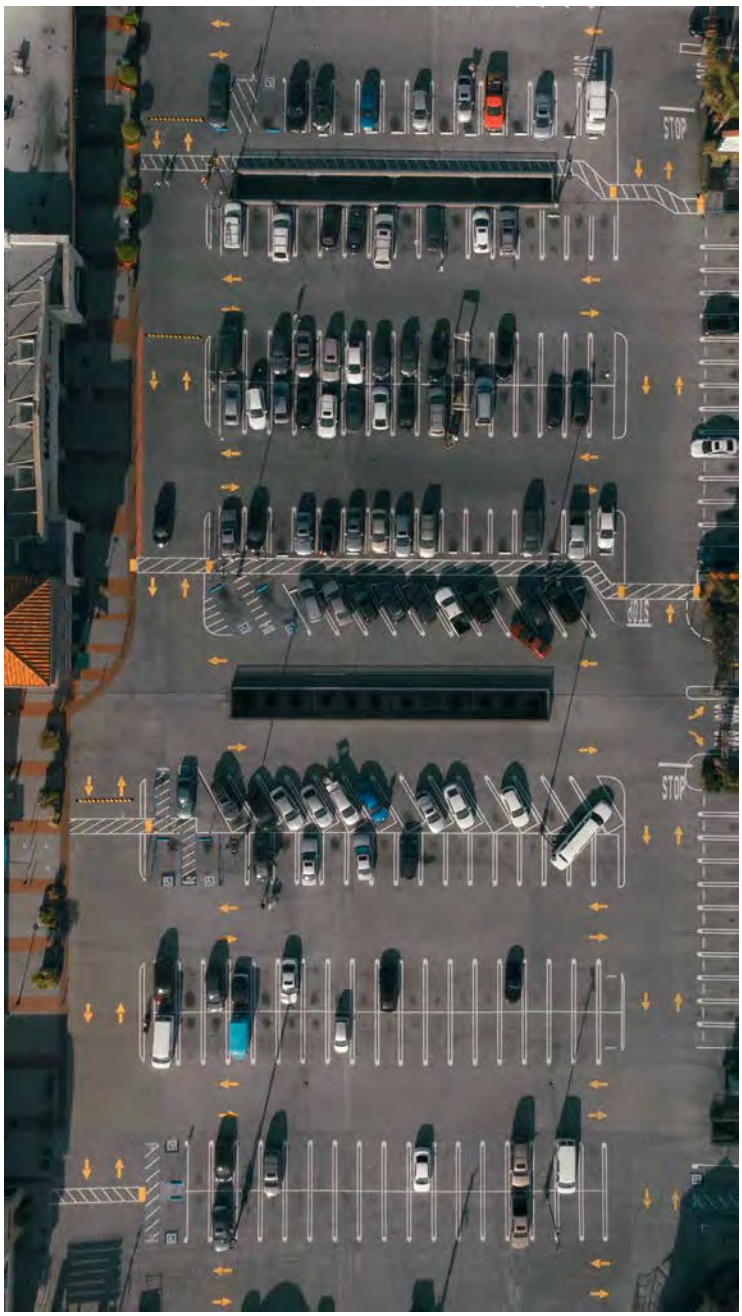

Figure 3. Climate-Friendly and Equitable Communities rules may help reduce Oregonians' reliance on vehicles to access jobs and services. Photograph by Hamza Erbay.

Therefore, although the new rules substantially improve the likelihood that local and regional integrated land-use and transportation regulations will help the state reduce emissions from the transportation sector (Boarnet and Handy 2014, American Association of State Highway and Transportation Officials 2021), the new rules will probably not support reduction of emissions to 45 percent below 1990 levels by 2035, a target that Executive Order 20-40 identified as necessary to meet the state's 2050 goal. Nor do the rules require local

or regional governments to specify how their planned transportation projects will allow the MPO to meet its share of the state's targets for emissions reductions by the transportation sector.

The land-use components of the Climate-Friendly and Equitable Communities rules are also unlikely to lead to significant reductions in emissions by 2035. The rules require local governments to study potential CFAs by the end of 2023 and designate CFAs by the end of 2024. The rules allow local governments to apply for extensions of the deadlines to designate and make comprehensive plan, zoning map, and code changes to implement the CFA rules. The latter actions necessarily precede changes in development patterns and practices. Local governments were required to begin applying the rules' reduced parking mandates to new development near frequent transit stops and certain other developments by 31 December, 2022. Local governments have until 30 June, 2023 to implement the other required parking reforms but may apply for an extension. All of the land-use components of the Climate-Friendly and Equitable Communities rules can be characterized as market-based strategies. Therefore, changes in land uses will only occur after local laws are amended, developers apply to build on land that the amended local laws regulate, and the new development is completed. Because the local law-amendment timelines allow for extensions and the emissions reductions will not occur until new development is completed, the land-use components of the Climate-Friendly and Equitable Communities rules are unlikely to result in reductions in emissions commensurate with the targets of 45 percent below 1990 levels by 2035.

Effects of Housing and Zoning Law Reforms

Prior to 2019, Oregon's land-use system did not constrain the use of single-unit residential zoning, a ubiquitous feature of zoning ordinances in U.S. cities, which is a major driver of urban sprawl (EPA 2018, Pendall 2021, Adams-Schoen and Sullivan 2022) (Figure 4). Typically, the single-unit residential zone limits residential development on each buildable lot within its boundary to a single dwelling structure that may be occupied by only one regulatorily defined family or household unit and that is surrounded by a yard with one or more paved parking spaces. Other residential structures, from duplexes to apartment buildings, are prohibited within the zone. As is the case in cities throughout the United States, cities in Oregon limited the vast majority of their residentially zoned land to detached single-unit homes. Because Oregon's land-use system authorizes cities to expand their urban growth boundaries when more land is needed to house growing populations, the local regulatory requirement that most residential land be dedicated to single-unit housing contributed to the expansion of urban areas and associated increases in emissions.

Oregon made history in 2019 when it passed House Bill 2001, which amended state law to require cities with populations of 10,000 or more to allow duplexes, and in the case of cities with populations of 25,000 or more, duplexes, triplexes, quadplexes, townhouses and cottage clusters, in areas that previously only allowed detached single unit homes (Adams-Schoen and Sullivan 2022). Oregon's statewide residential zoning reform, the first such statewide reform in the United States, was part of a series of amendments to the state's housing and land-use laws that included enactments in the 2017, 2019, and 2021 legislative sessions and the 2022 short session. Collectively, these laws require cities to utilize urban land more fully for needed housing (Sullivan 2020a).

In 2020, the Land Conservation and Development Commission adopted rules that filled in the details of House Bill 2001 and included model local codes to support cities in their implementation of the zoning reforms. The new rules include many standards intended to require cities to remove regulatory requirements that, individually or cumulatively, add "unreasonable cost or delay" to the

development of smaller, denser forms of housing in areas where only larger, detached single units had previously been allowed. For example, the rules limit the application of maximum density and lot coverage standards and minimum building and lot size standards. The rules also require cities to allow existing housing to be converted to multi-unit housing and place a cap on the amount of off-street parking that local zoning regulations can mandate for duplex, triplex, quadplex, townhouse, and cottage cluster developments. Maximum density and lot coverage standards, minimum building and lot size standards, and off-street parking mandates increase the amount of land used for housing and contribute to urban sprawl (LeDuc et al. 2000, Manville and Pinski 2020, Adams-Schoen and Sullivan 2022). Regulatory off-street parking mandates increase personal vehicle use and decrease use of mass transit and other lower-emissions forms of transportation (USDOT 2011, EPA 2018, DLCD 2020, LeDuc et al. 2000, Millard-Ball et al. 2022).

Figure 4. Single-use residential zoning is a major contributor to urban sprawl. Photograph by Porter Raab.

House Bill 2001 mandated prompt implementation by requiring cities to amend their comprehensive plans and land-use regulations to comply with the new law by 30 June, 2021, or 30 June, 2022, depending on the size of the city, and strictly limiting the bases for and scope of any extensions of the deadlines (Adams-Schoen and Sullivan 2022). Accordingly, in 2021 and 2022, cities throughout Oregon amended their local plans and regulations to conform to the new law. Ashland, Bend, Coos Bay, Eugene, Portland, Roseburg, St. Helens, and other cities exceeded one or more of the minimum requirements of the state regulations (Adams-Schoen and Sullivan 2022).

By requiring cities to utilize urban land more fully for needed housing and thereby decelerate the pace of urban growth boundary expansions, Oregon's housing and zoning law reforms will decrease the pace of urban sprawl and associated increased emissions and increase the energy efficiency of new housing units (LeDuc et al. 2020, Manville and Pinski 2020, Sullivan 2020a). Moreover, because the reforms included strict, legislatively mandated deadlines, local land-use decisions have been subject to the new laws since at least mid-2022. However, as is the case with other market-based strategies such as the land-use components of the Climate-Friendly and Equitable Communities Rules, changes in land uses and resulting emissions reductions will only occur after

developers apply to build on land that the amended local laws regulate, and the new development is completed. Accordingly, the housing and zoning law reforms may not result in sufficient changes in development patterns within the timeframe needed to support achievement of Oregon's 2035 targets. Additionally, the zoning law reforms did not invalidate pre-2021 private land-use restrictions that limit many lots to single-unit residential use. Both the validity and enforceability of these private restrictions under Oregon law and the extent to which they will impede residential densification and associated climate benefits remain unclear.

Carbon Sequestration

Compared to states without urban growth management laws, Oregon's land-use system has largely achieved its original purposes of preventing the conversion of farms and forests and limiting urban sprawl. Since the 1970s, western Oregon retained 89 percent of these lands and eastern Oregon retained 97 percent (Oregon Task Force on Land Use Planning 2009). The avoided conversion of natural lands attributable to implementation of the state's land-use planning system retained carbon storage in western Oregon equivalent to a reduction of 1.7 MMT of carbon dioxide per year (Cathcart et al. 2007).

However, research also suggested that Oregon could increase net sequestration in natural and working lands and waters by up to 9.8 ± 1.7 MMT of carbon dioxide emissions per year by 2050 (Graves et al. 2020). In response, the Oregon Global Warming Commission announced the goals of sequestering an additional 5 MMT per year in Oregon's natural and working lands and waters by 2030 and at least 9.5 MMT per year by 2050, relative to estimated net sequestration from 2010 through 2019 (OGWC 2021). These sequestration goals are in addition to Oregon's sector-based emissions reduction goals. The commission also recommended the development of community impact metrics to inform the development of sequestration strategies and to evaluate trade-offs of those strategies. The commission advised that the metrics include effects on jobs, local economies, public health, and access to programs (OGWC 2021).

The state's housing and land-use law reforms discussed above also will help the state protect natural and working lands from conversion to development. As discussed above, because Oregon's land-use system authorizes cities to expand their urban growth boundaries when more land is needed to house growing populations, pre-2019 local regulatory requirements that most residential land be dedicated to single-unit housing with one or more off-street parking space per housing unit contributed to the expansion of urban areas and conversion of natural and working lands (LeDuc et al. 2000, Manville and Pinski 2020). The Climate-Friendly and Equitable Communities rules discussed above also encourage and require cities in the state's eight metropolitan areas to adopt and enforce land-use plans and regulations that will limit conversion of natural and working lands by increasing density in existing urban areas and preventing sprawl.

Through these actions, Oregon remains a national leader in its use of state and local land-use laws to limit emissions and encourage carbon sequestration by preventing urban sprawl. However, as discussed above, the housing and land-use law reforms and Climate-Friendly and Equitable Communities rules are unlikely to result in sufficient changes in development patterns within the timeframe needed to support achievement of Oregon's 2035 targets. Additionally, incorporation of climate considerations into the statewide planning goals and their implementing regulations provides a significant but unrealized opportunity to better align Oregon land-use law and public and private land-use actions with the state's climate goals.

Reducing Community Vulnerability to Climate-Related Natural Hazards

Local zoning and other local lawmaking authorities provide powerful tools to increase community resilience to climate-related natural hazards (Adams-Schoen 2018, Sullivan 2020b). Oregon has partially utilized this potential. In 2021, Oregon released its updated Climate Change Adaptation Framework, which provides guidance to state agencies in implementing strategic, integrated, and equitable responses to climate change (DLCD 2021). The framework includes recommended strategic responses in six sectors: economy, natural world, built environment and infrastructure, public health, cultural heritage, and social systems. These strategies draw on a variety of state agency tools and legal authorities, and their implementation intentionally requires multiple agencies. Several strategies recognize the link between the state's land-use system and its capacity to respond and adapt to climate change.

The framework identifies two land-use strategies for creating equitable and livable communities. First, the framework suggests that state agencies develop guidance to support communities in integrating climate change and equity into land-use planning. Recommendations include supporting the integration of climate science; providing technical and funding capacity to support consideration of resilience, mitigation, and sequestration in plan adoption and amendment; developing decision-support tools that prioritize equity; and providing guidance on addressing urban heat islands with strategies that have multiple benefits, including increasing the number and size of green spaces and number of urban trees. The Department of Land Conservation and Development and the Department of Geology and Mineral Industries already provide some of these resources (DLCD 2012, 2019b; DLCD and DOGAMI 2019). Second, the framework recommends that the state evaluate the ability of the state land-use planning goals to address climate change and climate equity. DLCD and other state agencies will publish a status update on implementation of the framework in late 2022 or early 2023. The framework is not legally enforceable, however.

Oregon's new Climate-Friendly Area rules include a legally enforceable requirement that cities and certain other urbanized areas submit to the Department of Land Conservation and Development a report on potential climate-friendly areas within their jurisdiction (Oregon Administrative Rule 660-012-0315(4)(f)). The report must include plans to achieve fair and equitable housing outcomes within the potential climate-friendly areas and identify actions to mitigate or avoid potential involuntary displacement of current residents. The department assists local governments in analyzing spatial and housing equity and identifying mitigation strategies (DLCD 2022a).

Strategies to address the resilience of built infrastructure also draw on the land-use system. Land-use centered strategies include encouraging communities—through education and the development of model zoning ordinances and other decision-support tools—to avoid development in areas at high risk of natural hazards, supporting communities in adopting optional provisions in Oregon's model building code that mitigate wildfire risk in the wildland-urban interface, and developing options to relocate infrastructure in vulnerable areas. Although many of these strategies focus on protecting existing buildings and infrastructure from climate impacts, whether through building code requirements or bolstering insurance, strategies also include actions to move development out of high-risk areas. The framework includes other strategies that are not framed as land-use strategies but are closely linked to tools in the land-use system. Examples include promoting green infrastructure and preserving natural lands.

Although the framework provides guidance that may help communities increase their resilience to climate-related natural hazards, the state has not fully utilized existing land-use policies and laws to

facilitate robust climate adaptation. As hazard mitigation specialists and planners recognize, helping local governments counter the social, economic, and political pressure to develop in hazardous areas is essential to increasing resilience (Adams-Schoen 2018).

In Oregon, as in most states, local land-use laws related to hazard mitigation tend to focus on increasing the resilience of individual buildings. But development in hazardous areas increases community vulnerability even when the development incorporates building-level resilience strategies, such as those required by the National Flood Insurance Program's minimum floodplain management standards. Even when the structures are resilient, the risks of residing in hazardous areas are especially high for low-income and historically marginalized populations (Adams-Schoen 2023). For example, in communities participating in the National Flood Insurance Program, low-income and minority residents and renters continue to bear disproportionately high burdens post-disaster, including higher rates of job loss, displacement, and mortality and longer-term social and economic disruption (Adams-Schoen 2018, Rice Kinder Institute for Urban Research 2018). Local laws that focus on individual buildings do not promote land uses that increase or retain risk-mitigating features of undeveloped or less intensively developed land.

In summary, Oregon's land-use system, with its foundation of statewide land-use planning goals, provides a pathway to ensure that the state's land uses are responsive to climate change. Oregon has undertaken innovative land-use law reform that partially integrates the state's climate goals and land-use laws. Although Oregon is a national leader in many aspects of sustainable land use, full integration of climate science and equity considerations into state and local land-use plans and actions would better align Oregon's land-use system with the current and foreseeable effects of climate change.

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Public Health

Evidence steadily accrues that climate change has profound and compounded effects on human health and health care systems, and that these effects are not distributed equitably (Romanello et al. 2022). For example, as detailed in the fifth Oregon Climate Assessment (Ho et al. 2021) and in *Extreme Temperatures* (this volume), heat causes more deaths in the United States than any other weather-related source of mortality. Exposure of infants and children to high temperatures can be particularly insidious because it not only has direct physiological and mental consequences but increases the likelihood of economic disadvantage, malnourishment, and exposure to conflict, which can affect long-term physical health and exacerbate trauma and tendencies toward violence later in life (Miles-Novelo and Anderson 2019, Montes et al. 2021). Extreme temperatures, both hot and cold, were associated with excess deaths from cardiovascular causes, ischemic heart disease, stroke, and heart failure around the world (Alahmad et al. 2023). Furthermore, in the United States, extreme hot and cold were associated with increases in the number of tweets on Twitter, the social media platform, that contained hate speech (Stechemesser et al. 2022).

As demonstrated in *Wildfire* and *The Economic Implications of Climate Change for Oregon* (this volume), the physical and mental effects of wildfire smoke also are extensive and cascade to other sectors. The three contributions to this *Public Health* section focus on the effects of wildfire smoke on human health and the capacity of heath care systems. Across the western United States, the number of days on which wildfire smoke is present and the concentration of fine particulate matter ($PM_{2.5}$) on those days is increasing (Liu et al. 2016). As much as 50 percent of $PM_{2.5}$ emissions in some areas now comes from wildfire smoke (Burke et al. 2021). Even short-term exposure to elevated levels of concentrations of $PM_{2.5}$ can affect health, attention, and behavior (Cleland et al. 2022, Jones 2022).

Rohlman and colleagues begin this section by synthesizing recent research on the composition and toxicity of wildfire smoke and its effects on health of the general population. They also review new insights on the impacts of wildfire smoke on infant health.

As Kalashnikov explains in the second contribution to this section, as wildfire smoke becomes more prevalent, levels of $PM_{2.5}$ and surface ozone increasingly are high on the same days during summer. Concurrent exposure to multiple air pollutants can exacerbate effects on human health and behavior. For example, short-term exposure to $PM_{2.5}$ and surface-level ozone has been associated with an increase in violent crime in the United States (Burkhardt et al. 2019).

In the third part of this section, Chapman and colleagues report results of their research on the likelihood that a major wildfire season will increase respiratory hospitalizations in Oregon to the extent that a hospital has difficulty managing other patient needs. They highlight that wildfires may be creating a seasonal surge in health care demand analogous to traditional winter influenza seasons.

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Composition of Wildfire Smoke and Health Risks

Diana Rohlman, Samuel Attridge, Kelly O'Malley, and Kim A. Anderson

Introduction

In the western United States, the number of large wildfires (those that burn over 1000 acres [405 ha]) has been increasing since 2010. In 2020 alone, wildfires burned over six million acres (2.43 million ha) in California, Oregon, and Washington (NIFC 2018). These fires resulted in historically poor air quality as measured by the Air Quality Index (Figure 1), with many cities recording hazardous air quality levels (ODEQ 2021b). In Oregon, data from 2010 through 2020 show that smoke from wildfires has substantially affected air quality, with the number of days on which air quality is unhealthy for sensitive groups or worse (orange and above on the Air Quality Index; Figure 1) increasing 24-fold in Bend and nine-fold in Klamath Falls (ODEQ 2021b). In Portland, where air monitoring began in 1985, there never had been a day on which air quality was unhealthy for sensitive groups until 2015. However, during the next five years, Portland recorded an average of 4.6 days per year on which air quality was unhealthy for sensitive groups or worse (ODEQ 2021b). Given the recent trend towards a greater number of days with wildfire smoke, and the increasing size of wildfires (Kenward et al. 2016, ODEQ 2021b), the impact of wildfire smoke on human health is likely to increase.

Figure 1. The Air Now Air Quality Index (AQI). Source: www.airnow.gov/aqi/aqi-basics/.

There are decades of research on the health effects associated with exposure to particulate matter (PM), a main component of wildfire smoke. However, reduction of remaining uncertainties could better guide communication of information about wildfire-smoke exposure to protect public health. These uncertainties include the composition and toxicity of smoke, the health effects of repeated high exposures over many days, effects in subsequent years of prolonged exposure to smoke from a single wildfire, effects of repeated exposures to wildfire smoke over multiple fire seasons, and whether smoke from wildfires that burn through the wildland-urban interface (the area where the built and natural environment meet) and less-developed areas have different composition or toxicity and associated health hazards.

Here, we provide an overview of recent research on the composition and toxicity of wildfire smoke, and address effects on health of the general population. We also present a synopsis of emerging research on the impacts of wildfire smoke on infant health, with an emphasis on fires in the wildand-urban interface. Occupational risks, particularly to firefighters and other outdoor workers who experience greater smoke exposure, are substantial (Navarro 2020, Rice et al. 2021) but beyond our scope. For more information on populations potentially at risk of health effects from wildfire smoke, see EPA 2021.

Composition of Wildfire Smoke

Wildfire smoke is a complex mixture of particulates, carbon dioxide, water vapor, carbon monoxide, hydrocarbons and other organic chemicals, nitrogen oxides, and trace minerals. The composition of smoke changes on the basis of the fuel source (Samburova et al. 2016, Rager et al. 2021), fuel conditions, weather, heat of the fire, whether smoke is produced via flaming or smoldering combustion (Urbanski 2013, Seltenrich 2018, Sokolik et al. 2019, Rager et al. 2021), and age of the smoke itself (Liu et al. 2017, O'Dell et al. 2020). The amount of pollutants released following a fire can be estimated with emissions factors. For example, an emission factor can represent the amount of particulate matter released from each kilogram of coal burned (EPA 2022).

Comparing emissions from wildfires that burn under different meteorological and combustion conditions, and potentially in different fuels, means that emission factors differ among fires that burn different built or natural fuels, even in the same region (EPA 2021b). Urbanski et al. (2009) provide a comprehensive review of differences in wildfire emissions among fuel types. Although fuel source affects the composition of smoke (Rager et al. 2021), preliminary evidence from wildfires and controlled burn experiments indicates that fuel source is only one of several factors controlling differences in smoke composition (Urbanski et al. 2009, Hadley et al. 2021, Rager et al. 2021, Sparks and Wagner 2021).

The Smoke Emission Repository Application (SERA) database contains over 12,000 entries that catalogue emission factors from wildfires, prescribed fires, and fires that were ignited in a controlled laboratory setting. Particles less than 2.5 micrometers (μm) in diameter ($PM_{2.5}$) were the most abundant of the 274 pollutants in smoke as reflected in the database (Prichard et al. 2020). Of the hundreds of individual smoke components, $PM_{2.5}$ is the greatest concern to public health (EPA 2021a) because the fine particles can advance deep into the lungs, enter the blood, and affect other organs. Although a large body of knowledge on the health effects of particulate matter (PM) exists, gaps remain in understanding of smoke composition, toxicity, and associated health outcomes, especially in association with wildfires that occur in the wildland-urban interface (Reid et al. 2016, Black et al. 2017, Cascio 2018). Here, we addresses three components of wildfire smoke: particulate matter, volatile and semi-volatile compounds, and gases.

Particulate Matter

Wildfires were estimated to account for up to 25 percent of $PM_{2.5}$ emissions across the United States, and up to 50 percent of $PM_{2.5}$ emissions in the western United States, during the past decade (Burke et al. 2021). Research on wildfire smoke primarily has focused on $PM_{2.5}$ (G. Chen et al. 2021, Zhou et al. 2021) (Table 1), and current wildfire smoke recommendations in Oregon are based on reducing exposure to $PM_{2.5}$ (ODEQ 2021a). However, the breadth and type of materials that may burn, and therefore the composition of smoke, varies between wildland-urban interface fires and wildland fires. Particulate matter, metals, and polycyclic aromatic hydrocarbons (PAHs) have been found at different concentrations in smoke from wildland-urban interface fires relative to other sources (Samburova et al. 2016, Sparks and Wagner 2021). Particles from wildland-urban interface fires had elevated levels of metals and silicon (Sparks and Wagner 2021). Elevated zinc and nickel were associated with submicron particles ($<PM_1$), whereas manganese, tin, copper, and lead were associated with larger particulate matter ($PM_{10\text{-}2.5}$) (Sparks and Wagner 2021).

Polycyclic Aromatic Hydrocarbons

Wildfire smoke also contains volatile organic compounds, including PAHs and gases such as carbon monoxide and carbon dioxide (Liu et al. 2017, Messier et al. 2019, O'Dell et al. 2020, EPA 2021b, Hadley et al. 2021, Rager et al. 2021, Ghetu et al. 2022). The concentration of PAHs in both particle and vapor phases increases during wildfires relative to ambient (no wildfire) conditions (Samburova et al. 2016, Messier et al. 2019, Hadley et al. 2021, Rager et al. 2021, Ghetu et al. 2022). Although $PM_{2.5}$ is the main pollutant of concern, and best characterized in the literature, PAHs also are detected during wildfires. In samples collected during a 2008 wildfire in California, $PM_{2.5}$ contained nearly 50 times more PAHs than coarser particulate matter ($PM_{10-2.5}$), and concentrations of PAHs were greater in particulate matter from wildfire smoke than in particulate matter from ambient air (Wegesser et al. 2009).

Reference	Fire source	Pollutants measured			
		PM	PAHs	Gases	HAPs
Verma et al. 2009	Laboratory	+		+	
Wegesser et al. 2009	Wildfire	+			
Wegesser et al. 2010	Wildfire	+	+		
Franzi et al. 2011	Laboratory	+			
Nakayama Wong et al. 2011	Laboratory	+			
Samburova et al. 2016	Laboratory	+	+		
Liu et al. 2017	Wildfire			+	+
Kim et al. 2019	Laboratory	+		+	
Hadley et al. 2021	Wildfire	+		+	+
Rager et al. 2021	Laboratory	+	+		
Sparks et al. 2021	Wildfire	+			
Ghetu et al. 2022	Wildfire		+		

Table 1. Studies that evaluated wildfire smoke composition. PM, particulate matter; PAHs, polycyclic aromatic hydrocarbons; HAPs, hazardous air pollutants.

PAHs are formed via incomplete combustion and include over 1000 semi-volatile and volatile organic chemicals that each have a minimum of two benzene rings. PAHs include low and high molecular weight compounds in both particle and vapor phases; for example, concentrations of benzo[a]pyrene and naphthalene are highly correlated with that of $PM_{2.5}$ (Hadley et al. 2021). Emission factors of vapor-phase PAHs are higher than those of particle-phase PAHs (Samburova et al. 2016). In one study, per unit mass of consumed fuel, the total mass of PAHs emitted was skewed towards vapor-phase PAHs, mainly due to the release of low molecular weight PAHs such as naphthalene, acenaphthylene, acenaphthene, fluorine, phenanthrene, and anthracene (Samburova et al. 2016). Although prior studies detected lower levels of high molecular weight PAHs in the particle phase in woodsmoke, the emissions from vapor-phase PAHs were not assessed (Hadley et al. 2021). In a separate study, the average outdoor air concentrations of vapor-phase, high molecular weight PAHs were 86 times higher during wildfires than before or after (Ghetu et al. 2022). Twelve unique high molecular weight PAHs have been detected during wildfires (Ghetu et al. 2022). The majority were only detected when the Air Quality Index was greater than 140, irrespective of weather conditions or the primary fuel source (Ghetu et al. 2022).

Gases

In the western United States, over 80 trace gases were characterized during wildfire smoke events, and their concentrations were higher during fires than under ambient conditions (Liu et al. 2017). Gases often emitted from active wildfires include carbon monoxide, carbon dioxide, and formaldehyde (Verma et al. 2009, Liu et al. 2017, Prichard et al. 2020). The Smoke Emissions

Repository Application database includes records on specific gases, including greenhouse gases such as carbon dioxide (Prichard et al. 2020).

In California, levels of carbon monoxide significantly increased during wildfires ($p < 0.001$), although the average (± standard error) concentration during wildfires, 4.77 ± 0.22 ppm, remained below the 8-hour National Ambient Air Quality Standard of 9 ppm (Meo et al. 2021, EPA 2022). In laboratory experiments, wildfire smoke had lower levels of carbon monoxide than woodsmoke, which was attributed to the more efficient wildfire combustion process that emits carbon as carbon dioxide (Hadley et al. 2021). Despite this concentration difference, carbon monoxide emissions from wildfires remain a concern. Gas emissions in fresh smoke plumes (<20 min old) from wildfires were dominated by carbon dioxide, followed by carbon monoxide (Liu et al. 2017).

Other Components

Levels of acrolein, benzene, ammonium, nitrate, chloride, and sulfate were greater in wildfire smoke plumes than in ambient air, although the composition of wildfire smoke plumes shifted rapidly as the smoke aged (Liu et al. 2017, O'Dell et al. 2020). N-alkanes, methoxyphenols, levoglucosan, inorganic elements, metals, and ionic constituents were also detected in smoke generated during laboratory experiments (Rager et al. 2021).

Toxicity of Wildfire Smoke

In a laboratory, toxicity can be assessed via a variety of endpoints, and is used to better understand potential adverse impacts in biological systems outside the laboratory. In laboratory experiments, wildfire smoke samples from different fuel sources had different toxicity (Rager et al. 2021). Toxicity assays may not directly translate to human health. Regardless, however, they inform research on public health. We offer a brief overview of wildfire smoke-associated toxicity to clarify current research on toxicity of wildfire smoke mixtures.

In some cases, toxicity of smoke from different fuel types (e.g., peat versus pine) is associated with mixtures, suggesting potential interactions among chemicals that lead to toxicity, rather than with individual chemicals in isolation (Rager et al. 2021). For example, mixtures of inorganic and ionic constituents induced greater pulmonary toxicity than either set of constituents, yet mixtures with lower levels of methoxyphenols had greater toxicity than mixtures with high levels (Rager et al. 2021). The relative contributions of non-particulate constituents to wildfire smoke composition and overall toxicity are less well characterized (Black et al. 2017). As described below, toxicity varies among components of wildfire smoke.

Particulate Matter

Toxicity associated with particulate matter has been extensively documented (Anderson et al. 2012, EPA 2019). Although PM alone can predict toxicity, the type of PM can also inform toxicity predictions (Park et al. 2018). Additionally, the composition of wildfire smoke changes as it ages (Liu et al. 2017). Smoke from smoldering material has a higher concentration of PM than smoke from flaming material (Kim et al. 2019). Nevertheless, compositional changes may affect toxicity; despite its lower PM, smoke from flaming material had greater toxicity in a mouse lung model (Kim et al. 2019). Smoke from smoldering material induces a greater irritant response in vertebrates than smoke from flaming material (Martin et al. 2021).

Several laboratory studies have compared the toxicity of wildfire-associated PM and ambient PM. Mice treated with PM samples from a wildfire via intratracheal instillation had fewer macrophages and more neutrophils in bronchoalveolar lavage than control mice (Wegesser et al. 2009). The decrease in macrophages was more pronounced than in mice treated with the same dose of PM from ambient air. Similarly, coarse PM ($PM_{10-2.5}$) from wildfires was about four times more toxic to lung macrophages per unit weight basis than coarse PM from ambient air from the same region and season (Franzi et al. 2011). Additional experiments comparing wildfire-associated PM to ambient PM have identified differential gene expression patterns in human bronchial epithelial cells (Nakayama Wong et al. 2011). These studies indicate differences in toxicity between wildfire PM and PM from other sources, such as vehicle exhaust, woodsmoke, and dust (Wegesser et al. 2009; Franzi et al. 2011; Aguilera et al. 2021a, b; Liu et al. 2021).

Polycyclic Aromatic Hydrocarbons

Many particle-phase PAHs have been identified in wildfire smoke, although they are not restricted to wildfires. In laboratory studies of five common wildfire fuel sources, particle-phase benzo[a] pyrene was the major contributor to PAH-related toxicity (Samburova et al. 2016). A laboratory study evaluating 113 particle- and vapor-phase PAHs in wildfire smoke indicated that despite the higher emissions factor of vapor-phase PAHs, the carcinogenic potency of particle-phase PAHs was greater (Samburova et al. 2016).

Gases

Formaldehyde was detected at levels above California Environmental Protection Agency reference exposure levels in fresh smoke (<20 min old), and below reference levels as the smoke aged (O'Dell et al. 2020), leading to concerns that exposure to young smoke, for example by wildland firefighters, would be toxic (O'Dell et al. 2020). Although gas-phase hazardous air pollutants appeared to contribute less to overall health than PM, the contribution was detectable (O'Dell et al. 2020).

Wildfire Smoke and Human Health

Exposure to wildfire smoke can have health effects including mortality (G. Chen et al. 2021), adverse respiratory outcomes (emergency room visits, hospitalizations, asthma) (Kiser et al. 2020, Aguilera et al. 2021a, b), chronic obstructive pulmonary disease), and adverse cardiovascular outcomes (Reid et al. 2016, Black et al. 2017, Cascio 2018, EPA 2021a, b). Effects of wildfire smoke on human health have most often been assessed by modeling or measuring daily exposure to wildfire smoke and via impacts on the health care system, measured by emergency visits or hospitalizations for respiratory-associated symptoms and diseases (Black et al. 2017). Here, we evaluate new research characterizing health effects associated with wildfire smoke in the United States and Canada since 2019. We also focus on prenatal exposure to wildfire smoke and adverse infant health outcomes globally, which is an emerging area of concern.

The way in which exposure was measured (e.g. direct measurement of PM, wildfire-specific PM, wildfire smoke density, smoke plume data) differed among the studies cited below. No one metric has been identified as the most appropriate, yet results are largely consistent among exposure metrics and health outcomes. The use of different exposure metrics to characterize wildfire smoke exposure across epidemiological studies is further discussed in EPA 2021b.

Mortality

There is an established, causal relation between short-term exposure to $PM_{2.5}$ and mortality (EPA 2019). Several studies have identified a positive association between all-cause mortality and exposure to $PM_{2.5}$ from wildfire smoke (Table 2), with 0.62–1.3 percent increases in all-cause mortality following exposure (Doubleday et al. 2020, Matz et al. 2020, G. Chen et al. 2021, Liu et al. 2021). Increased rates of mortality were commonly associated with respiratory- and cardiovascular-associated mortality (Doubleday et al. 2020, Matz et al. 2020, G. Chen et al. 2021, Liu et al. 2021). Mortality was highest among those 65 or older (Doubleday et al. 2020). Furthermore, individuals with lower socioeconomic status had an increased risk of mortality following exposure to $PM_{2.5}$ from wildfire smoke (Doubleday et al. 2020, Liu et al. 2021). Exposure to wildfire smoke-associated $PM_{2.5}$ had a stronger effect on mortality than ambient $PM_{2.5}$ (G. Chen et al. 2021).

Reference	Mortality	Population studied		
		Children	Adults	Adults >65
Casey et al. 2020	null			
Doubleday et al. 2020	+		+	+
Matz et al. 2020	+			
G. Chen et al. 2021	+			
Liu et al. 2021a	+			

Table 2. Association of wildfire smoke exposure with mortality. +, positive association; null, null association.

Respiratory Health

The relation between short- and long-term $PM_{2.5}$ exposure and subsequent impacts on respiratory health likely is causal (Black et al. 2017, EPA 2019). Therefore, evaluations of exposure to wildfire smoke, in which the major component is $PM_{2.5}$, mainly have focused on respiratory-related effects (Table 3). Respiratory hospital admissions of the general population increase during wildfire events (DeFlorio-Barker et al. 2019, Casey et al. 2020, Liebel et al. 2020). Exposure to wildfire smoke is positively associated with exacerbation of asthma among children and adults (Lipner et al. 2019, Stowell et al. 2019, Kiser et al. 2020, Hahn et al. 2021) (Table 3). In a residential population exposed to wildfire smoke, lung function was significantly decreased one year following exposure, and remained low after several years (Orr et al. 2020).

Reference	Mortality	Population studied		
		Children	Adults	Adults >65
DeFlorio-Barker et al. 2019	+			+
Lipner et al. 2019	null	+		
Stowell et al. 2019	+	+	+	-
Casey et al. 2020	+			
Doubleday et al. 2020	+		+	+
Kiser et al. 2020	+			
Leibel et al. 2020	+	+		
Matz et al. 2020	+			
Orr et al. 2020	+		+	+
Yao et al. 2020	+			
Aguilera et al. 2021a	+	+		
Aguilera et al. 2021b	+			
G. Chen et al. 2021	+			
Hahn et al. 2021	+	+	+	+
Haikerwal et al. 2021	+		+	
Liu et al. 2021a	+			
Blando et al. 2022	+	+	+	

Table 3. Association of wildfire smoke exposure with respiratory health. +, positive association; null, null association.

In a time series study across 749 locations,

exposure to wildfire-related $PM_{2.5}$ was associated with increased relative risk of all-cause, cardiovascular, and respiratory mortality (G. Chen et al. 2021). The estimated risk was greater than expected relative to short-term exposure to ambient $PM_{2.5}$ (G. Chen et al. 2021). In Nevada, the association between asthma-related emergency department visits per 5 $\mu g\ m^{-3}$ increase in $PM_{2.5}$ was strongest during wildfire events (Kiser et al. 2020). Because Kiser et al. (2020) limited their analysis to the maximum $PM_{2.5}$ concentration on non-wildfire days, only wildfire days on which $PM_{2.5}$ was similar to non-wildfire days were analyzed. In California, for each 10 $\mu g\ m^{-3}$ increase in $PM_{2.5}$ associated with wildfire smoke, pediatric (0–19 years of age) respiratory hospitalizations increased by 1.3–10 percent (Aguilera et al. 2021b). By contrast, respiratory hospitalizations increased by 0.67–1.3 percent for each 10 $\mu g\ m^{-3}$ increase in ambient $PM_{2.5}$ (Aguilera et al. 2021b).

Influenza was associated positively with increasing $PM_{2.5}$ levels during wildfire season (Landguth et al. 2020) (Table 4). Additionally, several studies have reported initial evidence of associations between exposure to wildfire smoke and SARS-CoV-2 infections (Curtis et al. 2021, Leifer et al. 2021, Meo et al. 2021, Zhou et al. 2021, Schwarz et al. 2022) and deaths (Curtis 2021, Zhou et al. 2021). For a comprehensive review of the impact of wildfire smoke on respiratory health, refer to Grant et al. (2022).

Reference	Virus and effect			Population studied		
	COVID-19 infection	COVID-19 death	Influenza infection	Children	Adults	Adults >65
Landguth et al. 2020			+			
Leifer et al. 2021	+					
Meo et al. 2021	+	+				
Zhou et al. 2021	+	+				
Schwarz et al. 2022		+				

Table 4. Association of wildfire smoke exposure with viral infections. +, positive association.

Cardiovascular Health

A comprehensive review identified a causal relation between short-term and long-term exposure to $PM_{2.5}$ and cardiovascular effects (EPA 2019). The literature on cardiovascular health following exposure to wildfire smoke supports a positive relation (Table 5) (H. Chen et al. 2021). The impacts of wildfire smoke on cardiovascular health have most often been assessed as a function of ambulance dispatches (Yao et al. 2020), emergency department admissions (Casey et al. 2020, Hahn et al. 2021), hospitalizations (DeFlorio-Barker et al. 2019), and out-of-hospital cardiac events (Jones et al. 2020). Out-of-hospital cardiac arrests are typically excluded from analyses of emergency department and hospital admissions; 70 percent of these events are not admitted due to death occurring on arrival

Reference	Mortality	Population studied		
		Children	Adults	Adults >65
DeFlorio-Barker et al. 2019	+			+
Stowell et al. 2019	null	+	+	-
Casey et al. 2020	null			
Doubleday et al. 2020	+		+	+
Jones et al. 2020	+		+	+
Yao et al. 2020	+			
H. Chen et al. 2021	+			
Hahn et al. 2021	+	+	+	+

Table 5. Association of wildfire smoke exposure with cardiovascular health. +, positive association; -, negative association; null, null association.

or during transport via ambulance (Jones et al. 2020). Out-of-hospital cardiac events increased following exposure to wildfire smoke, and the effect was exacerbated among individuals with lower socioeconomic status (Jones et al. 2020). Asssessed by ambulance dispatches, as $PM_{2.5}$ increased during wildfire season, there was a concurrent increase in adverse cardiovascular outcomes (Yao et al. 2020). Similarly, as the density of wildfire smoke (and therefore the density of $PM_{2.5}$) increased, the risk of all-cause cardiovascular outcomes resulting in emergency department visits increased, with older adults at greater risk (Wettstein et al. 2018). In contrast, DeFlorio-Barker et al. (2019) found no increase in cardiovascular-associated hospitalizations: for each 10 $\mu g\ m^{-3}$ increase in either wildfire or ambient $PM_{2.5}$, the risk of cardiovascular hospitalization was the same.

Cancer

Exposure to wildfire smoke and incidence of cancer is not well studied, and relies solely on toxicological laboratory models and cancer risk assessments. Toxicological studies indicate a variety of mechanisms by which exposure to $PM_{2.5}$ may increase cancer risk (EPA 2019). $PM_{2.5}$ exposure has been linked with lung cancer mortality, and there appears to be a positive association between exposure to $PM_{2.5}$ and lung cancer incidence (EPA 2019). However, no studies have correlated exposure to $PM_{2.5}$ specifically from wildfire smoke and subsequent cancer risk.

Less is known about cancer risk following exposure to PAHs during wildfires, and PAHs infrequently are monitored during wildfires. Exposure to PAHs has been associated with cancer as assessed by cancer risk models (ATSDR 1995). Vapor-phase PAHs are estimated to contribute up to 86 percent of the carcinogenicity attributed to PAHs (Ramírez et al. 2011, Samburova et al. 2017). In a small study that used passive samplers to evaluate concentrations of vapor-phase PAHs in ambient indoor and outdoor air on each of seven days, PAH levels increased during periods of wildfire smoke that were mild as measured with the Hazard Mapping System (Messier et al. 2019). Cancer risk as indicated by concentrations of benzo[a]pyrene (a Group 1 carcinogen) was not significantly different on days with increased wildfire smoke and days with low outdoor smoke inundation (Messier et al. 2019). In a larger study across Washington, Oregon, California, and Idaho, indoor and outdoor exposure to wildfire smoke over seven days increased lifetime cancer risk, yet the estimated risk was below $1x10^{-6}$ at most locations (Ghetu et al. 2020). For reference, a risk of one in a million indicates that there may be one additional case of cancer over 70 years in a population of one million people.

Pregnancy and Birth Outcomes

The current evidence suggests, but is not sufficient to conclude, that ambient exposures to $PM_{2.5}$ affect pregnancy and birth outcomes (EPA 2019). Interpreting results across studies is difficult given the diverse ways in which exposure is assessed, the assessment of covariates related to birth outcomes (such as smoking and prenatal care), and the trimester evaluated (EPA 2019). Since 2019, new studies in the United States, Canada, and Brazil evaluated the association between prenatal exposure to wildfire smoke and adverse infant health outcomes, such as preterm birth (a live singleton birth that occurs before 37 weeks of pregnancy; WHO 2022a) and low birth weight (a singleton that weighs less than 5.5 lb [2,500 g]; WHO 2022b). Fetal development is a highly susceptible time period. Depending on the timing of exposure, prenatal exposure to $PM_{2.5}$—even short-term exposure, such as that during wildfires (Melody et al. 2019)—can be associated with preterm birth (Huynh et al. 2006, Ritz et al. 2007, Yuan et al. 2019) and low birth weight (Stieb et al. 2012, Yuan et al. 2019) (Table 6). The prenatal period also is sensitive given that the alveolar

ventilation rate increases during pregnancy (Hackley et al. 2007), resulting in a potentially larger dose. Individuals born preterm or with low birth weight are more susceptible to adverse respiratory health outcomes in early adulthood (Haikerwal et al. 2021).

We highlight the impact of wildfire smoke exposure in utero on preterm birth and low birth weight while recognizing the limitations within this field of study. A review of prenatal smoke exposure, preterm birth, and low birth weight globally found significant, positive associations (Amjad et al. 2021). Prenatal exposure to wildfire smoke was first characterized in 2012, when PM_{10} concentrations from wildfires were modeled across California (Holstius et al. 2012). The mean birth weight of infants exposed in utero during any trimester was 6.1 g lower than that of infants that were not exposed; the decrease was greatest when the fetus was exposed in the second trimester (Holstius et al. 2012). Subsequent studies also found positive associations between prenatal smoke exposure and low birth weight (Abdo et al. 2019, Mccoy and Zhao 2021, Requia et al. 2022a).

Reference	Infant health outcomes	
	Preterm birth	Low birth weight
Abdo et al. 2019	+	null
Heft-Neal et al. 2022	+	
Requia et al. 2022a	+	
Requia et al. 2022b		+

Table 6. Association of wildfire smoke exposure with infant (0-1 years of age) human health outcomes. +, positive association; null, null association.

Similarly, the timing of exposure to wildfire smoke is associated with the magnitude of incidence of preterm birth. Although wildfire smoke exposure at any time during pregnancy is associated with preterm birth, the risk was greatest when exposure occurred during the second trimester (Abdo et al. 2019, Heft-Neal et al. 2022, Requia et al. 2022b). Among more than three million births in California from 2006 through 2011, for each additional day of wildfire smoke over the course of the pregnancy, the risk of preterm birth increased by 0.49 percent (Heft-Neal et al. 2022). However, the effect was greatest when the smoke exposure occurred during the second trimester, and the model indicated that 3–4 percent of preterm births in California were attributable to wildfire smoke exposure (Heft-Neal et al. 2022). Additional adverse outcomes that require more research include associations between wildfire smoke exposure and the outcomes of small for gestational age and infant mortality (Amjad et al. 2021). Exposure to wildfire smoke also may be associated with gestational diabetes and gestational hypertension (Abdo et al. 2019, H. Chen et al. 2021).

Conclusions

As wildfire seasons in Oregon become longer, and large fires become more frequent (ODEQ 2021b), human exposure to wildfire smoke also becomes more frequent. Such exposure is anticipated to lead to a range of health effects including adverse respiratory health outcomes (Reid and Maestas 2019). Wildfire smoke is a complex mixture, and the concentrations of many of its chemical components are greater than in ambient air. The predominant pollutant emitted from wildfires is $PM_{2.5}$, with models indicating that emissions from wildfires account for up to 50 percent of $PM_{2.5}$ in the western United States (Burke et al. 2021). Exposure to particulate matter is associated with mortality, respiratory health, adverse birth outcomes, and cardiovascular health (Feng et al. 2016). Other smoke components, in either the particle or the vapor phase, may also contribute to adverse health effects, although their relative contributions are poorly characterized. A better understanding of the toxicity of all pollutants and their potential interactions in wildfire smoke may inform the management of fine particles beyond the current regulatory standard, which is based on PM mass alone.

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Compounded Health Effects of Fine Particulate Matter and Surface Ozone

Dmitri Kalashnikov

Exposure to fine particulate matter ($PM_{2.5}$) and surface ozone are associated with human health impacts including impaired cardiac and respiratory functions, and with increased chances of hospitalization and premature mortality (www.epa.gov/air-research/research-health-effects-air-pollution). High levels of $PM_{2.5}$ and surface ozone pollution are increasingly co-occurring on the same days during summer across many parts of Oregon (Figure 1a) (Kalashnikov et al. 2022).

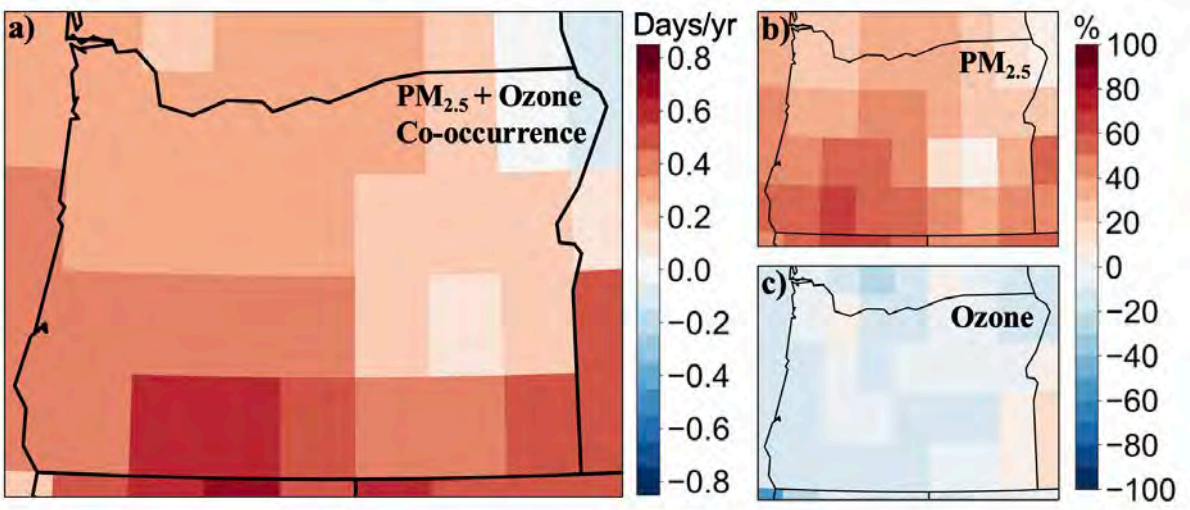

Figure 1. (a) 2001–2020 trends in the number of days per year (July, August, and September) with co-occurring high values of $PM_{2.5}$ and ozone. Co-occurrences are defined as values of both pollutants that exceed their local 90th percentile daily concentrations in the given year. Trends in the annual percentage of (b) $PM_{2.5}$ extremes and (c) ozone extremes occurring in each grid cell during July, August, and September relative to the rest of the year. Maps produced with air quality observations from the U.S. Environmental Protection Agency and adapted from Kalashnikov et al. 2022.

There is some indication that simultaneous exposure to multiple harmful air pollutants can have disproportionately higher impacts on human health than exposure to individual pollutants (Reid et al. 2019, Siddika et al. 2019).

The observed trends in co-occurrence of $PM_{2.5}$ and ozone can be linked to increasing prevalence of $PM_{2.5}$ from wildfire smoke across the region (Figure 1b), which coincides with ozone levels that are typically high during summer due to warm temperatures and abundant sunshine. Furthermore, wildfire smoke can lead to greater ozone concentrations when it mixes with urban pollution, and ozone levels are often elevated on smoky days during summer in cities in the western United States (Brey and Fischer 2016, Gong et al. 2017, Buysse et al. 2019). During the first decade of the twenty-first century, when large wildfires were less common, $PM_{2.5}$ concentrations in much of the western United States, including Oregon, were highest during the cool season, when stagnant air conditions and atmospheric inversions are prevalent (Figure 2a) (Hou and Wu 2016). The difference in timing of annual peak concentrations of $PM_{2.5}$ and ozone limited the chances of these two air pollutants co-occurring, at high concentrations, on the same days. Wildfires, therefore, are a mechanism of the observed shift in the timing of highest $PM_{2.5}$ concentrations toward summer rather than winter (Figure 2b), which increases the risk of co-occurring $PM_{2.5}$ and ozone and their adverse health impacts on Oregon's population.

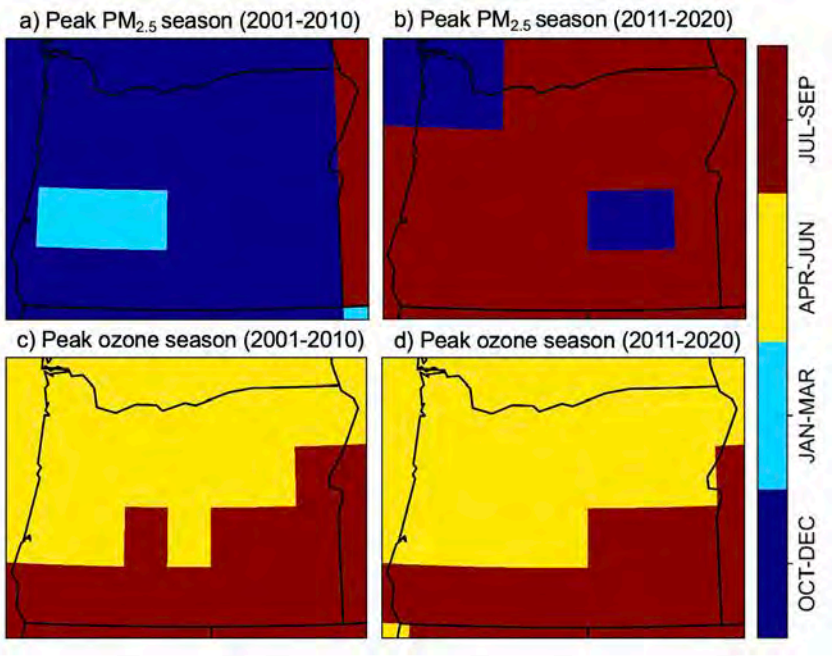

Figure 2. Seasons of peak average concentrations of PM2.5 (top) and ozone (bottom) from 2001–2010 (left) and 2011–2020 (right) in each grid cell. Maps produced with air quality observations from the U.S. Environmental Protection Agency and adapted from Kalashnikov et al. 2022.

As the projected risks of heatwaves and wildfires in Oregon and the rest of the western United States increase (Hicke et al. 2022), the risk of simultaneous exposure to multiple health hazards is also likely to increase. Certain populations, including children, pregnant women, elderly, and people with pre-existing heart or lung conditions, are likely to be more vulnerable to these climate-related health hazards (www.epa.gov/air-research/research-health-effects-air-pollution). Additional factors such as limited access to health care and disaster preparedness resources, and high baseline levels of pollution and other environmental risks faced by many low-income communities, indigenous peoples, and communities of color living in neighborhoods shaped by discriminatory housing policies, also contribute to higher vulnerability and lower adaptive capacity to climate-related health risks (Gamble et al. 2016).

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Fires, Respiratory Hospitalizations, and Capacity Issues

Kyle A. Chapman, Adelaide E. Clark, Kerry L. Farris, and Sarah Fitzpatrick

Wildfires and Climate Change

An estimated 6 million km^2 (2.3 million mi^2) worldwide, and 90,000 km^2 (34,750 mi^2) in the United States, burn annually due to wildfire (Mouillot and Field 2005, Koplitz et al. 2018, Ye et al. 2021). The total area burned in the western United States doubled from 1984 through 2015. In 2017, over 28,000 km^2 (10,800 mi^2) burned in the western United States (Abatzoglou and Williams 2016, Orr et al. 2020). Despite mitigation efforts that improved overall air quality across the United States, wildfires have increased emissions of numerous pollutants, including particulate matter (PM) (Black et al. 2017). $PM_{2.5}$ (PM less than 2.5 microns in aerodynamic diameter) is considered an essential component of wildfire smoke that degrades regional and local air quality during wildfires (Williamson et al. 2016, Lassman et al. 2017, Sheldon and Sankaran 2017, Alonso-Blanco et al. 2018, Larsen et al. 2018, McClure and Jaffe 2018, Requia et al. 2021, Ye et al. 2021). Fifty-two percent of annual $PM_{2.5}$ exceedances of the U.S. National Ambient Air Quality Standard occur in summer during wildfire season, and 26 percent of summer particulate matter in the western United States is attributed to wildfires (Kaulfus et al. 2017, Ridley et al. 2018). These emissions, including $PM_{2.5}$ concentrations, are expected to escalate due in part to climate change, especially in the western United States, where prevalence of wildfires will increase, wildfire seasons will become longer, and larger areas will burn (Flannigan et al. 2000, Kinney 2008, Abatzoglou and Williams 2016, Reid et al. 2016, Black et al. 2017, Cascio 2018). $PM_{2.5}$ exposures due to smoke are expected to increase 160 percent in the next 30–40 years (Liu et al. 2016), with the burned area in the Pacific Northwest expected to increase 80 percent by 2050 (Orr et al. 2020). Additionally, because particulates in wildfire smoke are mainly $PM_{2.5}$ (not larger particles), which settle out of the atmosphere slowly and therefore can disperse far from their sources, there is an increased chance of exposures to $PM_{2.5}$ downwind from wildfires (Makkonen et al. 2010, Urbanski 2013, Black et al. 2017, Ye et al. 2021).

Exposures to Wildfire Smoke

Exposure to wildfire-related emission sources increasingly has become a public health concern in the Pacific Northwest, not only because it presents direct human health effects but because it increases health care use (Makkonen et al. 2010, Dohrenwend et al. 2013, Urbanski 2013, Kochi et al. 2016, Cascio 2018, Hutchinson et al. 2018, Nelson 2020, Ye et al. 2021). Short-term exposures to high concentrations of $PM_{2.5}$ from wildfires can trigger adverse health outcomes including asthma, heart attacks, stroke, and decreased lung function; 339,000 premature deaths per year are attributed to these exposures (Kinney 2008, Reid et al. 2016, Borchers Arriagada et al. 2019, Stowell et al. 2019, Matz et al. 2020, Requia et al. 2021, Ye et al. 2021). Exposure to wildfire smoke may result in more-severe adverse health effects than exposure to similar levels of more-traditional sources of $PM_{2.5}$, such as diesel emission (Borchers Arriagada et al. 2019). As climate change exacerbates wildfire prevalence, an estimated tens of millions of people in the United States will be exposed to smoke at least once per 20 years by the middle to late twenty-first century (Mills et al. 2018).

Patients seeking treatment for a variety of respiratory diseases have a major impact on healthcare (including emergency room visits, hospital admissions, and outpatient visits) (Künzli et al. 2006, Viswanathan et al. 2006, Johnston et al. 2007, Delfino et al. 2009, Tham et al. 2009, Henderson et al. 2011, Dohrenwend et al. 2013, Dennekamp et al. 2015, Black et al. 2017, Liu et al. 2017, Reid et

al. 2019). Many of these studies focused on PM_{10} instead of $PM_{2.5}$. However, $PM_{2.5}$ is more strongly associated with human health effects, meaning previous links between $PM_{2.5}$ and respiratory diseases may have been underestimated (Black et al. 2017).

Health Care Systems and Surge Capacity

Smoke exposures pose substantial risks to both individuals and community services. Hospitals and public health organizations routinely plan to address medical surge capacity, or a system's ability to provide sufficient medical evaluation and care during periods of time that exceed the capabilities of the normal medical infrastructure of an affected community (PHE.gov). When health care organizations experience a marked increase in number of patients (a surge), there can be shortages of resources required for patient care. When a surge is due to a specific type of disease or complication, the ability of a health care organization to treat individuals with other conditions can be adversely affected. The COVID-19 pandemic surge exemplified this risk, with cancellation of surgeries, shifting of resources to triage, and increasing responsibilities of intensive care unit staff (Kerlin et al. 2021).

Such problems are compounded by increases in patient efficiency over the past decade. For example, hospitals today often operate at an average of 80 percent capacity and attempt to reduce the need for additional beds in an effort to save money and provide higher quality care (Litvak and Bisognano 2011). Hospitals in the western United States often plan for medical surges related to wildfires. However, those plans generally are limited to service of acute conditions resulting from direct exposure to wildfire, such as treatment of burns, immediate surgery, and life-sustaining ventilation.

Hospitals may also experience an increase in burden related to aggravation of chronic illness and less life-threatening respiratory conditions. Similar to the burdens on hospitals during COVID-19 waves, during wildfires and related smoke exposures, patients with less severe conditions may not receive needed care or hospitals may have lower capacity for proper care of those patients. Additionally, wildfires now require increased staff capacity and resource allocation during traditionally lower periods of demand. In the past, hospital systems prepared for increased usage and demand on respiratory care during winter. However, in summer, when rates of respiratory illness typically decrease, the risk of wildfires dramatically increases.

Research Aim

The relations between wildfires and health care systems' ability to handle such events are unknown, and must be better understood before action can be taken to improve health care systems' response to wildfires. We used data on $PM_{2.5}$ concentrations to predict the likelihood that a hospital will exceed capacity. We sought to determine the degree to which a major wildfire season, as occurred in 2018, is associated with respiratory hospitalizations that may compromise a hospital's ability to manage patient needs.

Data and Methods

We used air quality data from the Oregon Department of Environmental Quality (DEQ 2020) and electronic medical records from Asante Hospitals in southern Oregon. The study was reviewed by Asante's Southern Oregon Institutional Review Board (SO-IRB) and the Oregon Institute of Technology Institutional Review Board and deemed exempt.

Location and Air Quality Data Acquisition

We obtained data on $PM_{2.5}$ concentrations from the Oregon DEQ air monitoring network for criteria pollutants. The DEQ maintains over 40 $PM_{2.5}$ monitors in the state of Oregon, with six monitors located in the Rogue Valley (Figure 1). These stations are located in Medford (42.3315, -122.8803), Grants Pass (42.4342, -123.3485), Ashland (42.1941, -122.7086), Shady Cove (42.6625, -122.8095), Provolt Seed Orchard (in Grants Pass) (42.2886, -123.2308), and Cave Junction (42.1173, -123.6748). These monitors measure $PM_{2.5}$ continuously with R & P Partisol®-Plus 2025 PM-2.5 Seq. with VSCC™ nephelometers, meeting U.S. Environmental Protection Agency Method 145 (2020). Data are collected and reported by the DEQ as hourly averages. To estimate mean daily $PM_{2.5}$ concentrations, we averaged the 24 hourly values provided by the DEQ for each calendar day at each station.

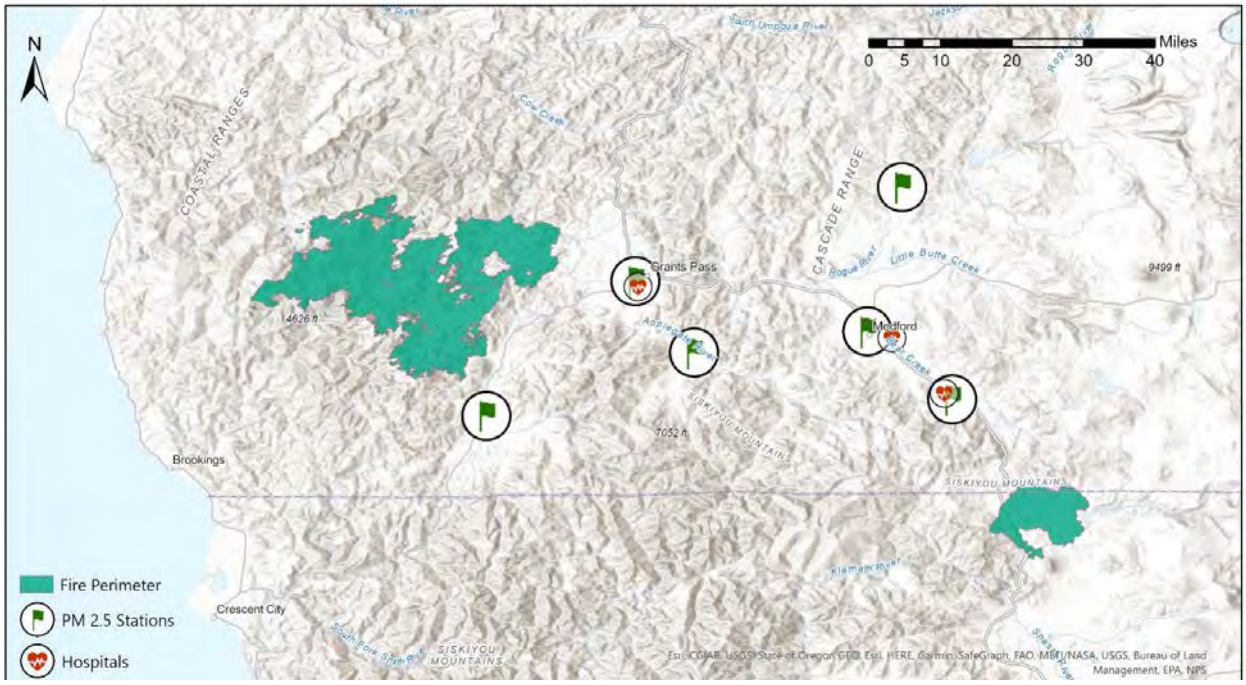

Figure 1. Six Oregon Department of Environmental Quality air monitor locations in the Rogue Valley (green flags); Asante Hospital locations in Medford, Ashland, and Grants Pass (red hearts); and perimeters of the Klondike, Taylor Creek, and Klamathon fires (green shading), which were the major sources of elevated $PM_{2.5}$ concentrations in 2018. Map created by Eleanor Kenyon, Oregon Institute of Technology.

Electronic Medical Records

We obtained patient data (n=354; 159 male, 195 female) through a partnership with Asante Hospitals and analyzed the data with previously published methods (Wettstein et al. 2018). All electronic medical records were de-identified by hospital staff before release to the research team. Medical records included hospital admittance location, admission date, discharge date, age, sex, residential zip code, diagnostic ICD 10 code, and insurance type. Our analysis included data from three Southern Oregon hospitals (Figure 1): Rogue Regional Medical Center (Medford; n=154), Three Rivers Medical Center (Grants Pass; n=167), and Asante Ashland Community Hospital (Ashland; n=33). Patients ranged from 1 to 98 years of age. Patients included in this study were admitted to one of the participating hospitals with a medical condition classified as one of 22 International Classification of Diseases (ICD)-10 codes (Table 1). Only those patients admitted

as in-patient, to the emergency department, or for observation were included. Patients listed as outpatients were excluded. Thirty-nine of the 354 patient encounters were readmits across the three hospitals and another four were treated at an affiliated facility within 90 days of their previous admission under one of the 22 ICD-10 codes (Table 1). The majority of patient encounters at all three hospitals (n=258) were in the emergency department.

Medical condition	Diagnostic code
Chronic obstructive pulmonary disease with acute exacerbation	J44.1
Chronic obstructive pulmonary disease with acute lower respiratory tract infection	J44.0
Asthma	J45.20-22, J45.30-32, J45.40-42, J45.50-52, J45.901, J45.902, J45.909
Emphysema	J43.0-2, J43.8-9

Table 1. Diagnostic codes (ICD-10) and related respiratory medical conditions used in this study.

Data Analysis

We estimated daily regional hospital burden (the dependent variable) by summing the number of respiratory patients admitted to each of the three hospitals from 1 July through 30 September, 2018. These dates corresponded to elevated $PM_{2.5}$ concentrations from wildfires. We considered the daily respiratory patient burden excessive if it surpassed the 80th percentile of the observed 92-day distribution. Excessive burden days were coded 1, whereas daily burdens below the 80th percentile were coded 0. We averaged daily $PM_{2.5}$ concentrations (the independent variable) across the three stations closest to each hospital (Ashland, Medford, and Provolt Seed Orchard). We then used a generalized linear model with a binomial error structure, implemented in program R (R Core Team 2020), to estimate the probability of exceeding respiratory hospital burden as a function of same-day and 3-, 5-, 7-, 9-, and 11-day $PM_{2.5}$ concentration averages.

Results

Effect of Fires on Regional Particulate Matter

In 2018, smoke from wildfires affected the Rogue Valley for approximately 92 days (Figure 2). Most of the smoke was generated by the Klondike, Taylor Creek, and Klamathon fires, which burned about 1046 km^2 (404 mi^2) combined (NIFC 2018). During this period, the average daily $PM_{2.5}$ concentration ranged from 29.6 μg m^{-3} (Grants Pass) to 54.6 μg m^{-3} (Medford) (Table 2). Maximum

2018 fire season (1 July – 30 September)							
Station	Average (μg m^{-3})	Median (μg m^{-3})	Max (μg m^{-3})	Smoke wave days	Unhealthy	Very unhealthy	Hazardous
Ashland	51.4	27.3	244.8	49	29	6	0
Medford	54.6	31.9	264.2	51	32	7	1
Provolt (in Grants Pass)	36.8	18.4	178.2	40	24	1	0
Grants Pass	29.6	11.6	201.2	34	17	1	0
Cave Junction	31.7	15.4	137.0	39	20	0	0
Shady Cove	45.4	23.7	217.7	49	30	2	0

Table 2. Average, median, and maximum daily $PM_{2.5}$ concentration and number of days with or exceeding unhealthy (Air Quality Index red), very unhealthy (Air Quality Index purple), and hazardous (Air Quality Index maroon) concentrations of $PM_{2.5}$.

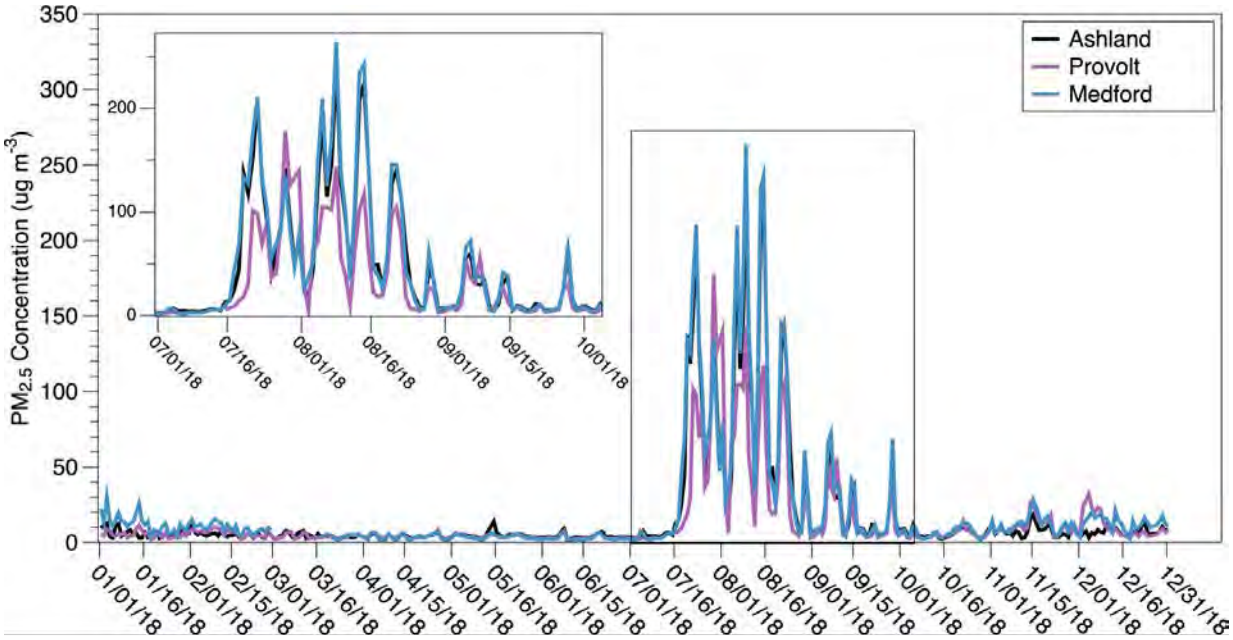

Figure 2. Time series of daily average $PM_{2.5}$ concentrations at Ashland (black), Provolt (purple), and Medford (blue) stations for the year 2018.

observed daily $PM_{2.5}$ concentrations were 137.0 to 264.2 μg m^{-3}. This resulted in 34–51 smoke wave days ($PM_{2.5}$ concentrations >20 μg m^{-3}) (Liu et al., 2017), or 45–67 percent of the 92-day season. Seventeen to 32 days (22–42 percent) of at least unhealthy air quality (U.S. Environmental Protection Agency Air Quality Index [AQI] red, or concentrations >55.5 μg m^{-3}) were observed in the region. One to seven days of very unhealthy air quality (AQI purple, or concentrations >150.5 μg m^{-3}) were also observed. Only one hazardous (AQI maroon, or concentrations >250.5 μg m^{-3}) daily average was observed. However, as many as 81 hazardous hourly averages occurred during this time period.

Effect of Air Quality on Hospitalizations

Peak hospital admissions occurred approximately 10 days after the peak in unhealthy $PM_{2.5}$ concentrations (Figure 3). This observation highlights the role of time and the accumulation of unhealthy $PM_{2.5}$ concentrations, which we further explored in the generalized linear model.

Between 1 July and 30 September, 2018, the daily hospital burden of respiratory patients ranged from a low of 3 to a high of 15. The 80th percentile for the 92-day distribution was eight patients. The $PM_{2.5}$ concentration significantly affected the probability of meeting or exceeding the 80th percentile threshold, regardless of duration (X^2 = 16.8 for same day to 23.7 for 11-day average; p = 0.00). The probability of exceeding patient burden increased with both increasing $PM_{2.5}$ and the duration of poor air quality (Table 3, Figure 4). For example, a single-day mean $PM_{2.5}$ concentration of 24 μg m^{-3} (midpoint of yellow or moderate) resulted in a 37% probability of exceeding hospital burden, but the probability jumped to 47 percent if the single-day $PM_{2.5}$ concentration was 201 (midpoint of purple or very unhealthy). Similarly, poor air quality that persisted beyond a single day increased the probability of exceeding burden (Figure 4). For example, a single-day mean $PM_{2.5}$ concentration of 103 μg m^{-3} (midpoint of the red or unhealthy category) resulted in a 41 percent probability of exceeding patient burden (Table 3), but a three-day to five-day mean concentration of 103 μg m^{-3} resulted in 46 percent and 47 percent probabilities of excessive burden, respectively

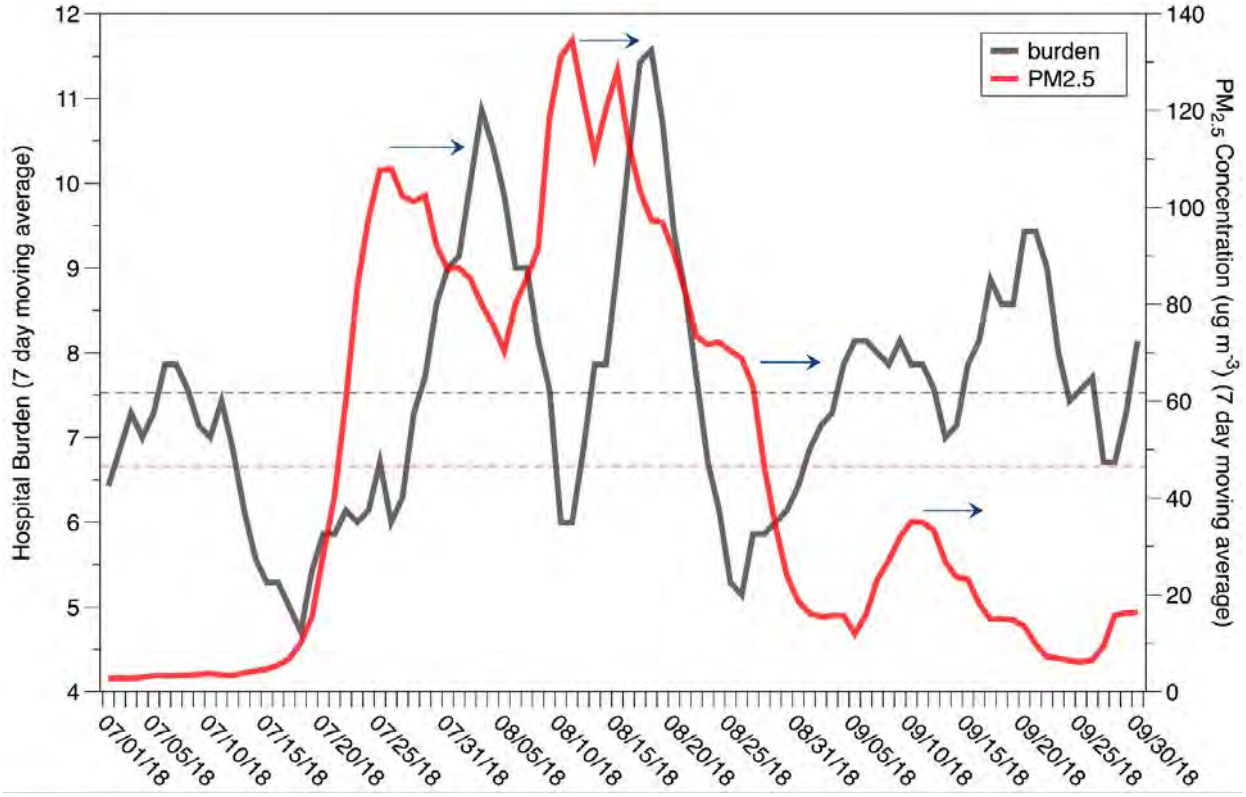

Figure 3. Relation between peaks in $PM_{2.5}$ concentrations (red) and respiratory hospital admissions (gray) from 1 July through 30 September, 2018. The dashed lines represent the mean 7-day moving averages for hospital burden (gray) and $PM_{2.5}$ concentrations (red).

(Table 3). Similarly, if these mean $PM_{2.5}$ concentrations persisted for 7, 9, or 11 days, the probability of excessive burden increased to 49, 52, and 53 percent, respectively (Table 3).

Discussion

The $PM_{2.5}$ concentrations measured during the 2018 wildfire season (Table 2) were similar to those reported during other wildfires. The EPA classifies $PM_{2.5}$ concentrations above 35.5 μg m^{-3} as unhealthy (Orr et al. 2020). Of the six stations in the Rogue Valley, only the stations in Grants Pass and Cave Junction reported a seasonal average below this threshold for the 92-day period that we defined as fire season. The seasonal average at every station exceeded the definition of a smoke wave (>20 μg m^{-3}) during this time (Liu et al. 2017). In wildfires in Victoria, Australia, that burned from late 2006 to 2007, the daily average was much lower (15.8 μg m^{-3}), but the maximum daily average was higher (295.0 μg m^{-3}) (Haikerwal et al. 2016). During the 2007 fires in San Diego County, a much higher daily average (89.1 μg m^{-3}) and daily maximum (803.1 μg m^{-3}) were reported (Hutchinson et al. 2018). The $PM_{2.5}$ concentrations in southern Oregon during 2018 were much lower than those observed during the Seeley Lake fire in Montana in 2017, where average daily $PM_{2.5}$ over 50 days was 220.9 μg m^{-3} and the reported maximum daily concentration was 638 μg m^{-3} (Orr et al. 2020). The Seeley Lake and San Diego fires were closer to their respective smoke-affected communities than the 2018 fires were to the Rogue Valley. The daily average $PM_{2.5}$ concentration in a community 50 miles (80 km) from the Seeley Lake fire during that 50-day period was 47 μg m^{-3}, which is similar to the concentrations over the 92-day period in the Rogue Valley, 20–40 miles (32–64 km) from the

2018 fire season (1 July – 30 September)						
Air Quality Index categories with associated $PM_{2.5}$ concentration midpoints	**Same-day**	**3-day**	**5-day**	**7-day**	**9-day**	**11-day**
Yellow (moderate) 24 μg m^{-3}	37% [27, 48]	34% [24, 46]	33% [23, 46]	33% [22, 46]	32% [21, 46]	33% [22, 47]
Orange (unhealthy for sensitive groups) 45 μg m^{-3}	38% [28, 48]	37% [28, 48]	37% [27, 48]	37% [27, 48]	37% [27, 49]	38% [28, 50]
Red (unhealthy) 103 μg m^{-3}	41% [28, 57]	46% [30, 62]	47% [31, 64]	49% [32, 66]	53% [35, 70]	53% [35, 70]
Purple (very unhealthy) 201 μg m^{-3}	47% [20, 77]	not observed	not observed	not observed	not observed	not observed

Table 3. Probabilities [95% confidence interval], expressed as percentages, of hospitals exceeding the respiratory patient threshold (80th percentile) given mean $PM_{2.5}$ concentrations representing medians of five U.S. Environmental Protection Agency Air Quality Index categories over various durations.

nearest fires. A study in Brazil used nationwide data from 2000–2015 and reported a much lower daily average $PM_{2.5}$ (2.19 μg m^{-3}), but a similar maximum daily average (164.18 μg m^{-3}) (Ye et al. 2021). During the Horse River Fire in 2016, sites in Alberta, Canada reported average daily $PM_{2.5}$ concentrations of 80–293 μg m^{-3}, with hourly maxima of 357–5229 μg m^{-3} (Landis et al. 2018). During the 2011 Richardson Fire in Alberta, Canada, the daily maximum $PM_{2.5}$ was 368 μg m^{-3}, whereas the daily averages were approximately 180 μg m^{-3} (Bytnerowicz et al. 2016).

Our results showed that the average daily $PM_{2.5}$ concentrations for the median moderate (AQI: yellow) were associated with a 37 percent probability of exceeding hospital burden on the same day. However, when air quality deteriorated to median unhealthy (AQI: red), the probability of exceeding hospital burden increased to 41 percent (same-day) and 53 percent (11-day). The maximum average $PM_{2.5}$ concentration for a single day (217 μg m^{-3}) resulted in a 48 percent probability of exceeding burden. At the observed maximum average $PM_{2.5}$ concentration sustained for 11 days (130 μg m^{-3}), the probability of exceeding burden was 60 percent. Additionally, as the mean daily $PM_{2.5}$ concentration increased from median moderate to median unhealthy, the same-day probability of excessive burden only rose 4 percent, whereas the probability of excessive burden rose more than 20 percent when these values persisted for nine days. In the 2006–2007 fire in Victoria, Australia, a same-day increase of $PM_{2.5}$ concentration by 8.6 μg m^{-3} was associated with an increase in emergency department visits for asthma of 1.96 percent; only the same-day association was statistically significant (Haikerwal et al. 2016). In San Diego in 2007, considerable increases in the number of visits for respiratory complaints also were reported, with increases of 3.2 visits per day increase for dyspnea and 1.5 visits per day for asthma in the one to three days after the elevated $PM_{2.5}$ concentrations were observed (Dohrenwend et al. 2013). In Brazil, an observed increase in probability of overall hospital admissions was also reported, but only in the first day of exposure, declining after a 1–3 day lag period. In the latter wildfire, for every 10 μg m^{-3} increase in $PM_{2.5}$ concentration, the probability of same-day hospitalization for respiratory illnesses increased by 5 percent (Ye et al. 2021). No immediate exposure effects were reported during the Seeley Lake, Montana, wildfire in 2017; however, residents exposed to elevated levels of $PM_{2.5}$ during the fire experienced decreased lung function one year after the fire (Orr et al. 2020).

Wildfires and widespread exposure to wildfire smoke pose risks to the infrastructures of hospitals by acting as surge events. Hospital systems invest substantial resources to manage surges in capacity.

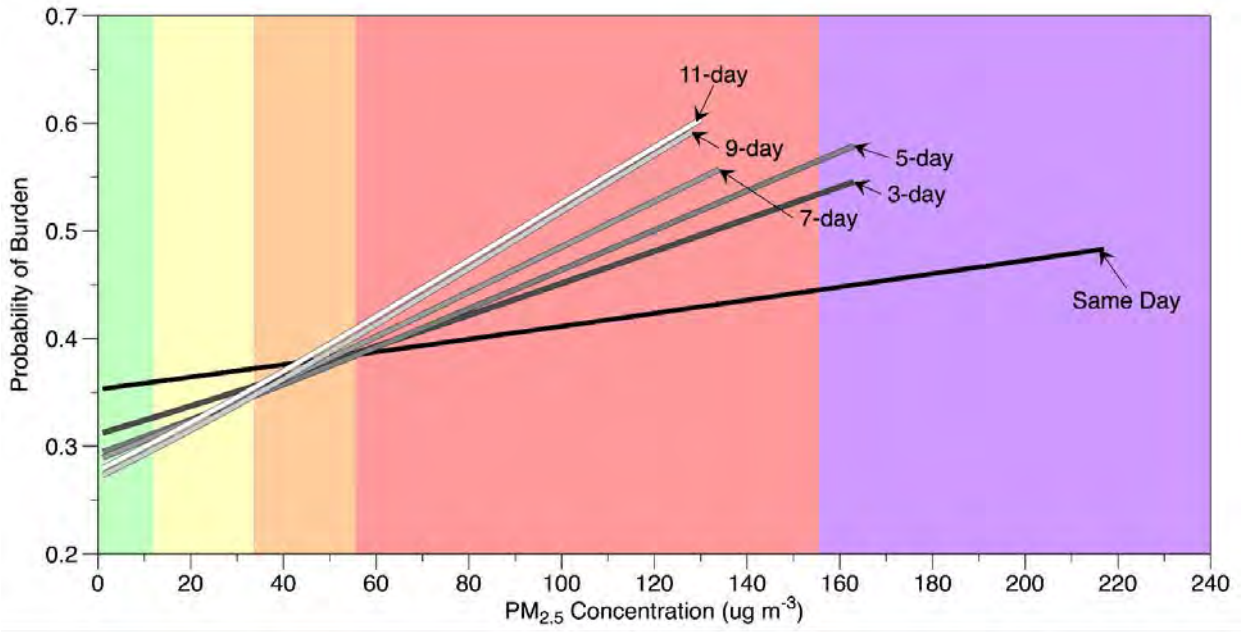

Figure 4. Probability of hospitals exceeding a respiratory patient threshold (80th percentile) given averaged lagged $PM_{2.5}$ concentrations over various durations. Colored regions indicate U.S. Environmental Protection Agency Air Quality Index categories (green = good; yellow = moderate; orange = unhealthy for sensitive groups; red = unhealthy; purple = very unhealthy).

The COVID-19 pandemic has placed a spotlight on the ability of health care systems to manage an influx of patients. However, wildfires and widespread exposure to smoke present a new type of problem. These events typically occur during summer (June–September). Historically, hospitals experienced seasonal burdens of patient flow from illnesses such as influenza, but these typically occur during winter (West et al. 2016). Some studies have indicated that the lowest burden occurs during summer (Walker et al. 2016). Over 25 years ago, Schmidt and Nelson (1996) suggested that a seasonal staffing model should be introduced for nursing units, and that health care organizations reallocate employee hours to match seasonal workload trends of their departments. Our study suggests that climate change, increased prevalence of wildfires, and associated smoke should be factored into the seasonal workload trends of health care organizations in regions that increasingly experience wildfires. We believe that as the occurrence of wildfires increases, health care organizations should consider the impact of a "fire flu" season.

We suggest three future avenues of research on relations between $PM_{2.5}$ exposures and hospital burdens. First, incorporate more years of air quality measures and hospitalization records to determine whether our results are generalizable to years in which smoke prevalence is lower. Additionally, expanding the timeframe may help explain the above-average hospital burden that we observed in months following fire season. Second, investigate the role of productivity in the hospital setting. Hospital productivity refers to the ratio between staff and requirements for patient acuity (intensity of care needed). The ratio of staff to patients depends on the hospital size, number of beds, and intensive care unit capacity. On average, the preferred ratio of intensive care unit beds to respiratory care practitioners is 9:1 (Matthews et al. 2006). Examining the relation between productivity and burden from respiratory conditions during periods of increased volume and acuity of respiratory conditions could further explain hospital burden when smoke is widespread. This type of analysis could also inform changes or procedures implemented by hospitals, such as expanding emergency preparedness plans to include widespread exposure to smoke. Third, evaluate

the transferability of our model in other regions within southern Oregon, such as the Klamath Basin, and expand the purview of hospital burden to other conditions exacerbated by prolonged exposure, such as cardiovascular conditions.

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Tribal Resilience to Climate Change

The effects of and resilience to climate change vary among populations. Marginalized populations, such as Oregon tribes, are more likely to be exposed to climate extremes and associated negative effects on physical and mental health. Accordingly, climate change places disproportionately high stresses on those communities. However, tribal adaptation to environmental and social change over millennia also can enable unusually high resilience. In this section, four early career tribal citizens discuss the ways in which they and their communities are responding to climate change via ceremony, political action, workforce development, environmental stewardship, and youth education and fellowship. The breadth and depth of the events, initiatives, and programs that they describe illustrate the myriad ways in which tribes are exercising self-determination and reclaiming sovereignty despite historic and contemporary inequities.

Salmon Recovery

Kieren Daley-Laursen

Many Northwestern tribes have deep cultural, spiritual, subsistence, and ancestral connections to salmon. The cultural heritage, traditional practices, and modern conservation efforts of tribes reflect the importance of these fishes to tribes that consider themselves to be Salmon People. For thousands of years, oral history has described the relationship of salmon to the people. The salmon gave their hearts and lives so the people could survive. In return, the people now speak for the salmon, who do not have a voice. Salmon was the first being to come forward and give its life to the people as food. Because all of the other animals then were willing to lay their lives down for the people, reciprocity is the law, and people have a responsibility to protect salmon and reciprocate the gift that salmon gave to them. Restoring salmon requires returning fishes to their historical homes, restoring river systems and oceans, and addressing climate change. Protecting and restoring salmon is integral to the cultural survival and economic well-being of Northwestern tribes.

Ceremonies and gatherings are among the ways in which tribes in Oregon and the Northwest honor salmon. Celilo Falls was a traditional salmon harvest and gathering site. Tribes traveled great distances seasonally to fish at Celilo Falls. They constructed villages nearby, creating a vibrant cultural hub (CRITFC 2022). Some tribes hold traditional ceremonies to return the head and tail of the first salmon caught at Celilo Falls back to the river (Woody 2014). These ceremonies honor salmon and contemplate how the lives of salmon support the lives of the community. The installation of The Dalles Dam inundated Celilo Falls in 1957. Tribal elders still remember fishing, feasting, gathering, playing games, and conducting ceremonies at the falls. The loss of this salmon fishery and community place is still felt in communities today (CRITFC 2022).

A recent event to honor the Wykanish [salmon] was attended by many tribes, including the Umatilla, Nez Perce, Jamestown S'klallam, Suquamish, and Yakama Nations (Figure 1). During this event, speakers drew parallels between the struggle of salmon swimming upstream and the efforts of Native Nations to protect salmon in the region. There are many ways in which this metaphor is accurate. For example, treaties in the 1800s between tribes and the U.S. government established trading in the Northwest and gave land rights to the U.S. government. As a result, native ways of life, including traditional salmon harvests, were targeted.

The metaphor also encompasses the dams that have altered traditional ways of life. Many tribes that live upstream from large dams that block fish passage have not been able to harvest from traditional fisheries for nearly a century, and their traditional ways of life have been significantly hindered. Dams have blocked passage to the habitat once available to salmonids and changed riverine conditions in ways that are harmful to salmonids, but dams are not the only cause of salmon population declines. One speaker at the Honor the Salmon event pointed out that salmon are dying of 1,000 wounds that need to be addressed systematically (Confederated Umatilla Journal 2022).

Climate change is one of these wounds. Tribes are acutely aware of the impacts of climate change on salmon, other threatened species, and other cultural resources. Increases in river temperatures directly affect the survival rates of juvenile and adult salmon by increasing the risks of disease, predation, loss of habitat, and death (UCUT et al. 2015). Increases in the frequency and severity of floods damage redds (salmon spawning beds). Extreme droughts reduce flows needed by salmon to migrate. Drought, increases in mean temperature, and heat waves are stressing forest trees and contributing to increases in the frequency, size, and severity of wildfires, causing die-offs and habitat

Figure 1. Salmon laying on a hand-woven tule mat in during a ceremony at the Honor the Salmon event. Photograph by Kieren Daley-Laursen.

loss. According to an assessment of the vulnerability of Pacific salmon and steelhead to climate change, the greatest climate threats to Pacific salmon are ocean acidification, increases in sea surface and stream temperatures, low summer flows, and, depending on the population and life stage, flooding or snowmelt loss (Crozier et al. 2019).

Tribes are experiencing these impacts firsthand. For instance, the McKinney and Yeti fires that occurred in the traditional homelands of the Yurok and Karuk Tribes along the Klamath River were followed by thunderstorms that transported large amounts of sediments to the river. The sedimentation caused decreases in the concentration of dissolved oxygen in the water, resulting in die-offs of salmon, sucker, lamprey, and many other species (Rodriguez 2022). Tribes are taking action to address climate change because its effects on terrestrial animals, fishes, and plants affect tribal cultural heritage and ways of life (ATNI 2022). Gathering and fishing sites and cultural practices specific to tribes are central to a tribe's sense of self, sovereignty, culture, identity, and well-being. The loss of traditional fishing at Celilo Falls is one example of how environmental changes can affect tribes profoundly.

Climate change and other environmental impacts have left many tribes with few or no salmon to harvest. The timing of natural events (phenology) has also been altered by climate change. Traditional knowledge holders are observing changes and experiencing impacts on food harvest due to drought, fire, shifting phenology, and extreme events. Climate change-driven changes in animal migration patterns affect cultural practices such as first salmon ceremonies. Some tribes in Oregon are unable to continue these ceremonies due to a lack of salmon, whereas others have had to alter the traditional timing or structure of these ceremonies to align with salmon runs. All of these factors adversely affect tribes' ability to fish, which in turn decreases the ability of communities to speak their language and sing songs of salmon and ceremonies, eat traditional foods with families and their community, and interact with the environment and sacred places.

Furthermore, declines in salmon populations can be a detriment to the health, economic well-being, and food sovereignty of native communities. A diet that includes fresh salmon decreases the risk of diabetes and heart disease, lowers poverty rates due to increased tribal health and subsistence, and lowers the mortality rates of tribal members (Meyer 1999). Salmon also provide economic benefits to tribal communities, including fishing-related jobs and trading opportunities that afford tribal governments greater economic sovereignty to pursue projects that support their communities. Food

sovereignty allows tribal people to determine their policies related to food and agriculture. The U.S. Food Sovereignty Alliance states, "Food sovereignty goes well beyond ensuring that people have enough food to meet their physical needs. It asserts that people must reclaim their power in the food system by rebuilding the relationships between people and the land, and between food providers and those who eat" (NICOA 2019). Ensuring that tribes throughout the Northwest have access to salmon and salmon fishing sites is an important step in strengthening these relationships among tribes, the land, and first foods.

Speakers at the Honor the Salmon event shared the sentiment that Northwestern tribes are tired of the divide-and-conquer approach to salmon recovery, which largely has been unsuccessful (Confederated Umatilla Journal 2022). Member tribes of the Affiliated Tribes of Northwest Indians (ATNI) have united to formally state their common values, policy goals, and desired outcomes for salmon recovery in the Pacific Northwest. In recognition of the need for collaboration to uphold their sacred cultural commitments to protect salmon (ATNI 2022), ATNI tribes co-produced a unanimous resolution, *We are all Salmon People* (ATNI Resolution 2022-25). Additional tribal organizations such as the Upper Snake River Tribes, Upper Columbia United Tribes, Columbia River Inter-Tribal Fisheries Commission, and Northwest Indian Fisheries Commission participated in the development of the resolution. The resolution aims to create a regional initiative while enabling tribes to pursue their distinct interests and projects related to salmon recovery (ATNI 2022).

The resolution covers themes such as the promotion of cultural welfare and values, sustainable harvest, climatic effects on salmon recovery, integration of best science practices and traditional knowledge, coordination among federal agencies, and adoption of a holistic approach that results in sustainable and resilient habitat for salmon. Parties to the resolution seek to protect and preserve treaty rights, develop partnerships with federal entities, and address the history of failed treaties.

Salmon recovery requires holistic approaches and collaboration among tribes, the federal government, state and local agencies, the public, and many industries in the Northwest, including agriculture, tourism, and energy. Holistic approaches recognize linkages among the land, First Foods, ways of life, physical and spiritual health, food sovereignty, and economic sovereignty. For example, the Coquille Tribe requested that they be recognized as co-managers of Chinook salmon (*Oncorhynchus tshawytscha*) with the Oregon Department of Fish and Wildlife and local governments. This action ideally ensures that the Coquille Tribe has decision-making power while providing further resources to the Oregon Department of Fish and Wildlife. The Cow Creek Band of the Umpqua Tribe of Indians has also requested greater coordination with other states, tribal, and federal governments (Aadland et al. 2022). Many believe such collaborations will benefit all Oregon residents while respecting tribal histories and sovereignty (Aadland et al. 2022).

The holistic approach may seem daunting, but it is feasible. A large wound contributing to the decline of salmon populations is the lack of habitat connectivity. Dams typically reduce habitat connectivity and quality for salmon by increasing water temperatures, reducing dissolved oxygen levels, and disrupting migration and other ecological processes. For decades, the Nez Perce Tribe in central Idaho has called for breaching the four lower Snake River dams to protect Snake River salmonids. In 2020, Idaho Congressman Mike Simpson initiated the Columbia Basin Initiative, which aims to breach the dams to conserve the state's salmon (simpson.house.gov/salmon) (Simpson 2022). Similarly, the Nez Perce Tribe launched the Salmon Orca Project (www.salmonorcaproject.com) to encourage the removal of the dams. In September 2022, NOAA released a report outlining the actions they believe will be necessary to recover salmon and steelhead in

the interior Columbia Basin. Among these actions are reducing direct and indirect mortality from mainstream dams, restoring the Lower Snake River through dam breaching, and restoring salmon passage through areas that currently are blocked (NOAA 2022).

The Nez Perce Tribe is taking proactive steps to mitigate and adapt to climate change and protect fishes by reducing their dependence on fossil fuels and hydropower. Since 2020, as part of an ambitious solar project focused on local energy production and storage, the Tribe has been installing solar arrays on government buildings and their casino, wastewater treatment plant, fish hatchery, and other facilities (Figure 2). In 2021, the Tribe installed the first Tesla PowerPack in Idaho. One goal of the Tribe's plan is to replace the power that the four lower Snake River dams generate (Nez Perce Tribe 2022). The Tribe calls this the 5311 plan because the Bonneville Power Administration reported that 5,311 megawatts are needed to replace the power generated by the four lower Snake River dams at peak capacity (Olson et al. 2022). Recognizing that they need not tackle this project alone, the Nez Perce Tribe created the Nimiipuu Energy Cooperative (www.nimiipuu.energy), which allows tribes to create, distribute, and share energy through a virtual power plant system. A virtual power plant is a network of power generators, such as solar panels or wind turbines, that are connected to users and energy storage through a centralized control system. A virtual power plant differs from traditional power plants by enabling independent ownership and maintenance of storage and generators while sharing or distributing energy as needed (Deign 2020). The Tribe recognizes that their early adoption in this area positions them as a resource to other tribes in the region that are interested in joining the cooperative and replacing energy produced by dams. The Nez Perce Tribe plans to produce 10 percent of the power needed, or 531 megawatts on the reservation, and to recruit other tribes. As other tribes join the cooperative, the collective potential to reach the 5,311-megawatt target increases (Nez Perce Tribe 2022).

Figure 2. Solar installation on Tribal lands. Courtesy of the Nez Perce Tribe.

Along with recovery projects led by organizations such as CRITFC and UCUT, the Nimiiupuu Energy Cooperative exemplifies the holistic approach called for by ATNI's *We are all Salmon People* resolution. As the rights of tribes in the Northwest to gather, hunt, and fish are deteriorating, collaboration becomes even more central to recovering the salmon that are the lifeblood of many ecosystems; recognizing, honoring, and incorporating tribal culture and values as integral to that recovery; and supporting historical, economic, and cultural practices of native cultures in perpetuity.

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Internships and Youth Programs Grow Climate Science Interest and Tribal Capacity

Lyndsi Lewis

My first job, at the age of 14, was facilitated by a summer youth program provided by my Tribe, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). As an employee in the Tribal Housing Department, I learned to answer telephones in a professional manner and assign tasks to employees in the shop. My summer job provided a foundation that would shape my work ethic and understanding of the employment services my Tribe offers to our people.

This past summer, my youngest son, who is in his junior year of high school, participated in the same summer youth program. Because climate change is high on his personal list of educational priorities, we requested that he be placed in the Department of Natural Resources. This request was met, and my son was employed by the Tribal Energy and Environmental Science Program, where he learned about the projects that CTUIR is evaluating to combat climate change and preserve our First Foods. It was inspiring to see how much the summer program has grown since I participated in it. In addition to the work experience, my son's cohort visited a nearby college campus to discuss higher education and a newly introduced scholarship program that is designated to benefit CTUIR members. They also learned about a program the college offers in which students spend three years learning biology or geology for a bachelor's degree and then transfer to an Ivy League school for a graduate program in forestry. This opportunity has sparked my teenager's determination and trajectory.

Figure 1. Frank Lake, Joe Hostler, Coral Avery, Brandon Tweig, and Margo Robbins (left to right) descend from a meadow to an oak woodland as they discuss the application of traditional knowledges and approaches to cultural burning to manage forests for culturally important uses. Photograph by Chas Jones.

Tribal governments have a unique opportunity to provide educational environments for tribal students. Not only the CTUIR but many other tribes have created youth programs that place students within departments of their interest, enabling them to gain experience and earn a wage during their summer breaks. The summer programs introduce tribal students to some of the basic policies of the tribal government and allow them to explore their professional interests. The programs also create relationships between students and mentors. Whether children are raised on a reservation or in an urban setting, tribal youth internships foster intergenerational cultural and spiritual connections to the landscape. Internships such as my son's allow for immersion

in traditional stories and management practices in a respectful and professional environment, encouraging tribal youth to continue the practice of their culture, which is founded in natural resources (Figure 1).

I am so pleased that my 16-year-old son had the opportunity to participate in CTUIR's summer internship program. He was introduced to pre-college and pre-employment perspectives while sparking his interest in science, technology, engineering, and mathematics. I have witnessed the inspiration that he gained by visiting a college campus and discussing his next steps after graduating from high school, and his newfound discipline and engagement in his current studies. His engagement with hands-on learning gave him an example of what his career could look like if he continues on the educational path he is currently pursuing. Inspiring youth at the earliest age stimulates their curiosity in climate and science and will help tribal communities adapt and become more resilient to climate change.

When I started community college, pursuing an associate degree in civil engineering, I became an intern with CTUIR's Department of Science and Engineering. The internship provided my first opportunity to observe my Tribe's work with the U.S. Department of Energy on environmental and climate issues, and I became passionate about making the environment sustainable for seven generations to come.

As a means of training individuals early in their careers to meet environmental and climate challenges, interns are provided with both education and real-world work experiences. Tribal internships engage and recruit potential employees while providing cultural understanding and perspective. Incorporating traditional values of CTUIR into the internship program connects potential employees to the foundation of the Tribal government and will ultimately support the Tribe in retaining employees and expanding its capacity.

After my recent graduation from Oregon State University, I wasn't sure if attending graduate school was what I wanted. I also wasn't sure if entering the workforce immediately would enable me to have the impact I hoped. As an intermediate step, I accepted a fellowship with the Affiliated Tribes of Northwest Indians. For ten months I am working with non-profit organizations, tribes, and state and federal entities and programs. This fellowship has given me time, experience, and the opportunity to seek mentorship. With time, I am weighing my options for continuing my education with a view of what is needed in the field and how climate change is being addressed on different levels. The experience I am gaining will help me make the best decision. The most important opportunity, in my opinion, is building a mentor-mentee relationship: connecting with individuals I admire and respect to gain personal insight into what will be a fulfilling and impactful career.

Land Stewardship, Food Sovereignty, and Mitigation of Climate Change Impacts

Kylie Avery

I was invited to join the Swinomish Tribe in building a piece of history on a day with one of the lowest tides of the year. After six years of waiting for permit approval, the Swinomish Indian Tribal Community was allowed by the U.S. Army Corps of Engineers to construct a clam garden on the shores of Kiket Island in Puget Sound, most of which is designated as Kukutali Preserve (Figure 1) and managed by the Washington State Parks and Recreation Commision and the Swinomish Tribe. Throughout the day, our introductions, conversations, and prayer were interrupted by loud military jets that flew overhead to nearby naval air stations. It served as a reminder of how a branch of the U.S. Department of Defense had jurisdiction over the tidal wetland and the power to give or deny the Swinomish permission to engage in land stewardship and tradition that has been practiced by the peoples of this region for millenia. But the day stood out as a great milestone for self-determination and tribal sovereignty, and for the Tribe's ability to mitigate the effects of climate change on coastal ecosystems.

Figure 1. Kukutali Preserve. Photograph by Kylie Avery.

Larry Campbell, a Swinomish elder, started the introductions by recognizing the western scientists who were present at the Tribe's invitation. He spoke about the importance of blending traditional knowledges and western science to alleviate the effects of climate change, and recognized that we had become a community. We now shared relations and family as we came together to give back to the First Foods, the land, and the Tribal community. A Swinomish council member told us that as Coast Salish peoples, their hearts were on the beach, and shared a common Coast Salish saying: "When the tide is out, the table is set." This proverb speaks to the significance of being able to practice one's culture and connect with a First Food that feeds both body and spirit. Alana Quintasket, a member of the Swinomish Tribal Senate, shared the story of a 4000-year-old clam garden that was abandoned when colonization began. Without the Indigenous people to turn over the clams through harvest and management, the garden died.

Clam gardens, which are constructed in intertidal zones, maximize productivity of these shellfish by building up the beach and providing a level surface on which the molluscs can grow. As described by the Swinomish Climate Change Initiative (2022), retaining layers of shells from clams and other species contributes to adaptation as the ocean becomes more acidic. When atmospheric concentrations of carbon dioxide increase, carbon dioxide enters the ocean and alters its chemistry,

reducing its pH and inhibiting shell formation in many species. The decomposition of shells from previous generations of clams in the gardens increases the local pH of the seawater. Clam gardens also increase local species richness by creating habitat for other native species, such as kelps and sea cucumbers (Swinomish Climate Change Initiative 2022).

Figure 2. The previous day's work on the clam garden wall was visible at low tide. Photograph by Kylie Avery.

When we arrived at the beach, the tide had dropped to its lowest level, allowing us to see the work completed the previous day by the Swinomish community (Figure 2). A substantial number of the people who contributed to building the garden were youth. We began to pick up the rocks that lay 25 meters from the edge of the clam garden wall. At first, we each picked up heavy rocks with our gloved hands and moved them toward the water, but we soon formed a human chain to pass rocks down the shore (Figure 3).

Figure 3. A view toward the clam garden from the picnic area. The chain of people passing rocks is on the left, and those gathering larger rocks with equipment are on the right. Photograph by Coral Avery.

As we carefully received and passed the rocks, we shared stories and backgrounds. I met people with whom I wouldn't otherwise have been able to connect: community members from the Malahat First Nation and Pauquachin First Nation who traveled from Canada to offer assistance, and invited researchers and reporters who captured the significance of the day. Others who weren't part of the chain moved the largest rocks with hand trucks and sturdy wagons. At the waterline, Swinomish community members shuffled the rocks to fill gaps in the walls. By the time the tide started to rise above the clam garden wall, our group had collectively moved about 20 tons of rock. We were part of something that will outlive us and hopefully will be present with the Swinomish people for the next millennium (Figure 4).

As I traveled home, tired and starting to feel sore, I reflected on everything that we had accomplished. My heart is still full from the

family of which I was a part. One of our group members said that everyone who needed to be there that day was there; that all of those who were there to share stories, lay their hearts on the beach, and stand witness and contribute to a great accomplishment were present. We built a wall not to separate people, but to connect them and to stand as strong as the hands and hearts that built the wall. I cannot express how honored and grateful I am to have been a part of reclaiming traditional knowledge, land stewardship, and culture in the face of colonization and climate change.

Figure 4. The clam garden wall at the end of the day, when the tide began to rise. Photograph by Kylie Avery.

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Including the Next Generations in the Climate Change Conversation

Kylie Avery and Zoe Roberts

In August 2022, the Upper Snake River Tribe (USRT) Foundation held their first Tribal Youth Climate Camp. Nineteen students from 12 to 17 years of age from three of the member tribes (Shoshone-Bannock, Shoshone-Paiute, and Fort McDermitt Paiute Shoshone) and who live on one of the member tribes' reservations came together for three days in Boise, Idaho, to learn about climate change. Accompanying the students were Zoe Roberts, Environmental Specialist with USRT and the camp's organizer; Kylie Avery, Affiliated Tribes of Northwest Indians Climate Intern and camp chaperone; and additional chaperones from the USRT member tribes. The camp was held in the Treasure Valley and along the Boise River (Figure 1). Prior to colonization, these were vital gathering areas for the nomadic tribes throughout the region. In late spring and early summer, tribes gathered along the Boise River to fish for salmon, perform ceremonies, and commune with one another.

Figure 1. The view from Bogus Basin Mountain Recreational Area. Photograph by Kylie Avery.

The main focus of the youth climate camp was water. Activities included rafting the Boise River, visiting the Boise WaterShed Environmental Education Center to learn about the urban water cycle and discuss water conservation, hiking in riparian and sagebrush shrubsteppe ecosystems and talking about their relations to water, and hiking around the Boise River Dam. Water and climate are key concerns for many of USRT's member tribes. Not only do hydroelectric dams, declining fish populations, temperature changes in and out of the water, and water legislation affect tribal life, but they may be confusing to children and teenagers. USRT hoped that by drawing connections between climate change and water, the students could begin to connect the practices and concerns of their tribes with the changing climate.

The camp occurred during a heat wave, and the Boise River was the best place to cool down. Observations while rafting illustrated the importance of the river for the surrounding plants and animals, and as a source of recreation. Many of the students had not previously visited or entered the Boise River, and both they and camp leaders were humbled and rewarded by the experience. The river is fed by snowmelt, and its water, like that of many other rivers in the Northwest, is preserved as a resource for people late into summer by a series of dams. One of the impacts of climate change in the region is a reduction in the percentage of precipitation falling as snow during the colder months, which contributes to an increase in the length and severity of drought.

Figure 2. Students wade through the Boise River to catch macroinvertebrates. Photograph by Kylie Avery.

At the Boise WaterShed, a learning center that hosts educational programs at the West Boise Water Renewal Facility, the group was shown that one of the ways in which Boise is conserving water is by thoroughly cleaning wastewater and releasing it back into the Boise River. The students enjoyed testing the quality of the recycled water by searching for macroinvertebrates that are sensitive to pollution (Figure 2). They placed tools such as kick nets and D-ring nets downstream to catch insects, snails, and worms that were displaced from rocks and sediment as the students waded through the river. Taxonomic orders and life stages such as mayflies and stonefly nymphs cannot tolerate poor water quality, and therefore their presence suggests that water quality is high (Figure 3). Additionally, the students were uplifted by talking about the effects of drought while being exposed to part of the solution.

After collecting macroinvertebrates, the students participated in a discussion of water management practices, water rights, and climate change. The students were asked to read quotations from historical water managers and select the quotation that resonated with them most strongly. Many students selected quotations stating that water shouldn't be over-consumed by private companies. Others selected quotations about water's service as a resource for every living thing or that noted that no one state, country, or private entity should have full control over water use. The educators posed the question, "In a perfect world, what would water management look like to you?" Many students said that water would be available to all and wouldn't be polluted by waste. The goals of this exercise were for the students to think critically about contemporary water management and to be empowered by visualizing their role in changing water management.

Figure 3. Students separate and identify macroinvertebrates caught in the Boise River. Photograph by Kylie Avery.

After visiting the Boise WaterShed, the group hiked in sagebrush shrubsteppe, which occurs throughout the Intermountain West (Figure

4). Many traditional foods and sacred medicines, including sagebrush (*Artemisia* spp.), grow in this ecosystem. The sagebrush shrubsteppe is threatened by drought and by non-native invasive species such as cheatgrass (*Bromus tectorum*), which in turn threatens food cultivation and harvest of medicine. Some of the discussions during the hike, echoing those about water conservation, emphasized the scarcity of resources. One of the chaperones spoke about food shortages in her community and the greenhouses the community is constructing to help supplement its food stores. Another chaperone explained that the reservation on which she lives is in a food desert, where grocery stores are scarce, expensive, and have few healthy options such as fresh produce. The effects of climate change directly affect food sovereignty and therefore the culture and health of Indigenous communities.

Figure 4. Youth hike through sagebrush shrubsteppe outside of Boise, Idaho. Cheatgrass, a highly flammable, non-native invasive species, is especially prevalent in this area. Photograph by Kylie Avery.

Figure 5. The Boise River Diversion Dam. Workers on the bridge are lowering boards to decrease the river's flow. Photograph by Kylie Avery.

Next, the students visited the Intermountain Bird Observatory, where scholars from Boise State University joined them to talk about the Boise River Diversion Dam (Figure 5) and some of the bird species that migrate through the region. The group saw that wooden boards are being added to the dam to reduce the flow of the river and increase water retention, and learned that similar boards have been used since the dam's construction in 1906. As one of the camp's chaperones explained, their Shoshone ancestors used a similar process to control the river flow for hundreds of years prior. They were stewards of the local land until they were displaced by colonization. Being reminded of that heritage by someone from the group was significant in changing the narrative to better reflect the history of land stewardship in the region.

Among the primary goals of the camp were to encourage students to be curious, ask questions, and draw connections among seemingly unrelated issues. The camp brought together students from three different reservations and allowed them

to talk about their experiences. Friendships grew between strangers within minutes. The students realized that their experiences may be similar, which can help them feel less overwhelmed or alone. A deep connection with another tribal student whose community is facing similar challenges due to climate change may be positive and last for years to come.

By the second day, many students felt comfortable enough to share their own experiences with climate change and other global events. One student explained that during the toilet paper shortage at the beginning of the COVID-19 pandemic, her community shared their supplies instead of hoarding. She anticipates that her community again will share if water or food shortages occur in the future. Many of the students had similar stories of members of their communities helping each other during hard times. Most of the students had sophisticated ideas about community and responding to climate threats. Some just needed a safe place where they could voice their thoughts, fears, and ideas. Sending students home with a head full of knowledge about climate is good, but sending students home with a head full of questions and ideas is far better.

The message surrounding climate change is urgent. But being able to start learning about climate change in a fun and lighthearted way is beneficial, especially for youth. Climate change is a heavy topic that can easily influence one's mental health. Occasionally reminding oneself of the progress being made is crucial. It's grounding to be surrounded by teens that just want to play in the river or enjoy scenic views with their friends. These students are the future of their communities and culture. If even one student returned home after the trip and asked their elders what they can do to protect against and adapt to the effects of climate change, the camp has enabled a leap toward progress.

Social Systems

According to the Yale Program on Climate Change Communication, which rigorously tracks public opinion and behavior related to climate change, about 74 percent of Oregonians recognize that global climate is changing (climatecommunication.yale.edu/visualizations-data/ycom-us). Sixty-six percent of Oregonians are worried about the effects of these changes, whether their focus is personal harm or harms to disadvantaged populations, future generations, or plants and animals. In this section, we focus on two ways in which residents of Oregon and other states and regions are responding to climate change: with visual art and with food systems. Visual artists are using their talents to bear witness to the ways in which human and natural systems are being affected by climate change. In the process, they are informing viewers, engaging their audience in conversation, and sparking cultural change. Meanwhile, those who raise food professionally or for themselves and their families are exploring how soils can be managed sustainably and, where necessary, restored. Scientific evidence suggests that the feasibility of the set of practices commonly referenced as *regenerative agriculture,* and the effects of those practices, vary among locations and as climate and other environmental conditions fluctuate. Charitable and potential federal investments in regenerative agriculture will provide greater clarity on the potential magnitude of benefits to food security, nutrition, livelihoods, and the natural environment.

Art and Climate Change

Dominique Bachelet

Visual artists have illustrated weather events, seasonality, and local climatic conditions through the ages. By doing so, they created a valuable record that provides information about past extreme events that affected societies and about climate variability. Many artists today have either witnessed or been affected personally by weather events that have been linked to ongoing climate change. Their reflections can be classified into three types of engagement: in art, where the medium is used to inform viewers about climate change; with art, where the medium engages the audience in conversation and information sharing; and through art, which can lead to cultural evolution and transformation (Bentz 2020).

Figure 1. *Climate Change* by Bart Walter on exhibit in Asheville, North Carolina, February 2020. Photograph by Dominique Bachelet.

In art, the most common use of art, bears witness to climate extremes and trends during the artist's lifetime. For example, Bart Walter's *Climate Change*, a sculpture of a polar bear, was included in the travelling exhibition *Environmental Impact II* (Figure 1). Roosen et al. (2017) commented, "Perceiving art demands attention, and processing art requires parts of the brain that are not normally accessed by typical communications about climate change." Bryan David Griffith's *Two Degrees of Impact* (Figure 2), part of his solo exhibition, *Rethinking Fire*, at the World Forestry Center in Portland, Oregon, referenced the research of Matthew Hurteau. This research suggested that protecting the large trees that can capture and store considerable amounts of carbon can help limit mean global temperature increases to less than 2°C (3.6°F) above pre-industrial levels.

Figure 2. David Griffith's *Two Degrees of Impact* on exhibit in Portland, Oregon, September 2022. Photograph by Dominique Bachelet.

Art is an effective means of science communication (Roosen et al. 2018) because it provides visual aids to introduce an issue and demonstrates the artist's personal reaction to events or the effects of events. As a result, events and their effects do not become abstractions that occur elsewhere or during other periods in time.

Daniela Noemi Molnar describes her work as a way to confront grief. Her series *New Earth* (www.danielamolnar.com/project/new-earth/new-earth-26/?cat=artwork#1) depicts the new shapes that glacier melt has revealed (Figure 3). Inspired by satellite imagery, she paints the reshaping of Earth by climate change.

Figure 3. *New Earth 26 (Alaska)* by Daniela Molnar.

Figure 4. Sabra Comins's *Fingers Crossed She Will Fly Unbound* on exhibit in Corvallis, Oregon, October 2021. Photograph by Dominique Bachelet.

Scientists' stories have inspired artists such as Sabra Comins. In her art that was included in the exhibition *What Will Nature Do?* at the Arts Center in Corvallis, Oregon, in autumn 2021 (Figure 4), Comins wanted to illustrate that although some species will likely become extinct as climate changes because their physiological thresholds will be exceeded, other species will escape those constraints and survive. She believe there is hope in the message from scientists that adaptation often is possible: "In [a scientific presentation], I heard nature is tough and people need to get out of the way . . . These butterflies are about to fly free of any constraints of our knowledge."

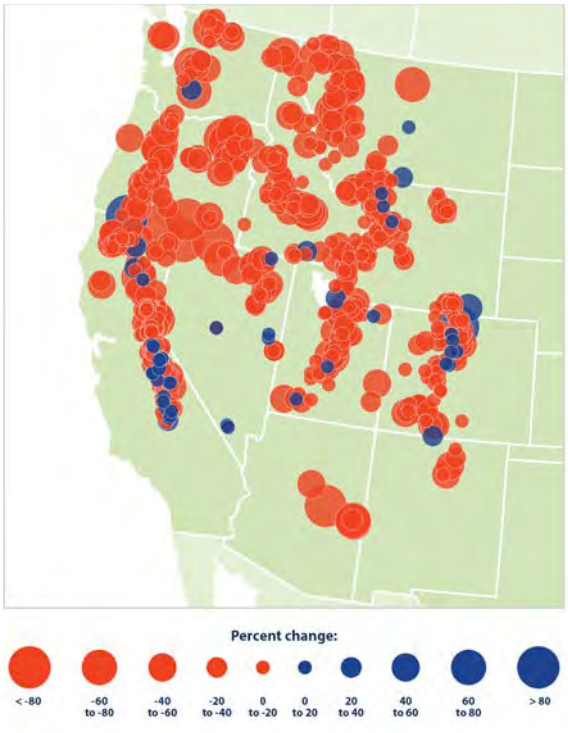

Figure 5. (Above) *Snowpack Trends in the Western US* by Alisa Singer. (Right) The data that inspired Singer's art (EPA 2016).

Alisa Singer painted an image that reflects a figure in the U.S. Environmental Protection Agency's guidance on snowpack as an indicator of climate change (EPA 2016). The image was derived from published data on changes in snowpack in the western United States (Mote and Sharp 2016) (Figure 5). Singer's series *Environmental Graphiti: The Art of Climate Change* (www.environmentalgraphiti.org) includes over 100 digital paintings, each of which is derived from a graph, map, word, or number relating to key facts or data about climate change. Her art has been featured on the covers of three recent reports of the Intergovernmental Panel on Climate Change (IPCC). The cover of the 2018

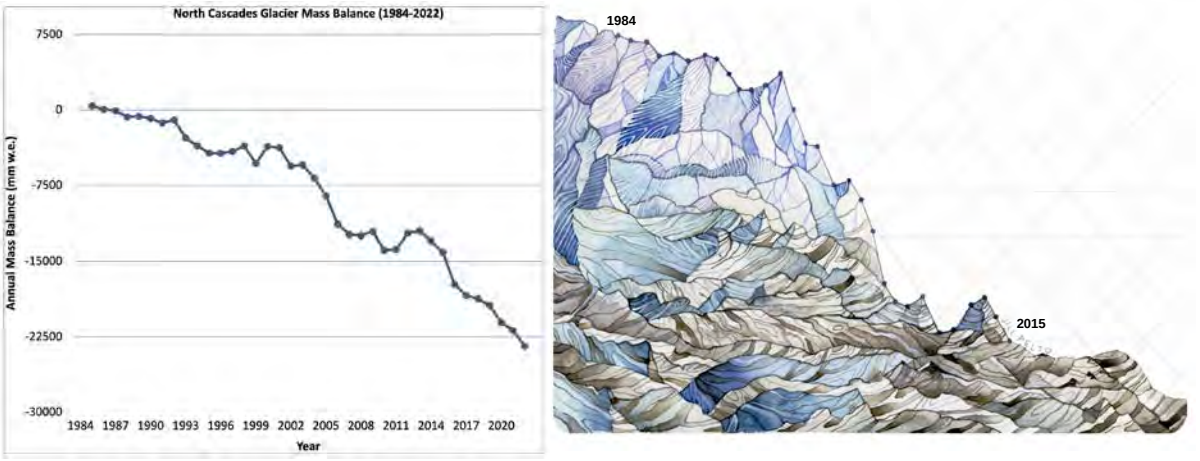

Figure 6. *Glacier Melt* by Jill Pelto.

report (Masson-Delmotte et al. 2018) was the first to feature art, a reflection of the scientific community's growing embrace of art as a powerful means of communicating the effects of climate change. Singer believes that "art makes the science more accessible and science makes the art more meaningful." Some artists who are also scientists, such as Jill Pelto, are using their scientific data as inspiration for an artistic expression of climate change (Figure 6).

Engagement **with art** aims to create opportunities for discussion that can bridge and integrate opposing interests and different forms of knowledge. Art and science projects can help develop a dialogue between artists and scientists and create a new, potentially more effective means of communicating scientific results to a general audience.

Because images can convey so much information, art can enable diverse viewers to understand the many facets of climate change (Bentz 2020). David Moyers's *Climate Change* (davidmoyers.com; Figure 7) demonstrates how flooding and wildfires are linked to emissions from trucks and cars and to elements

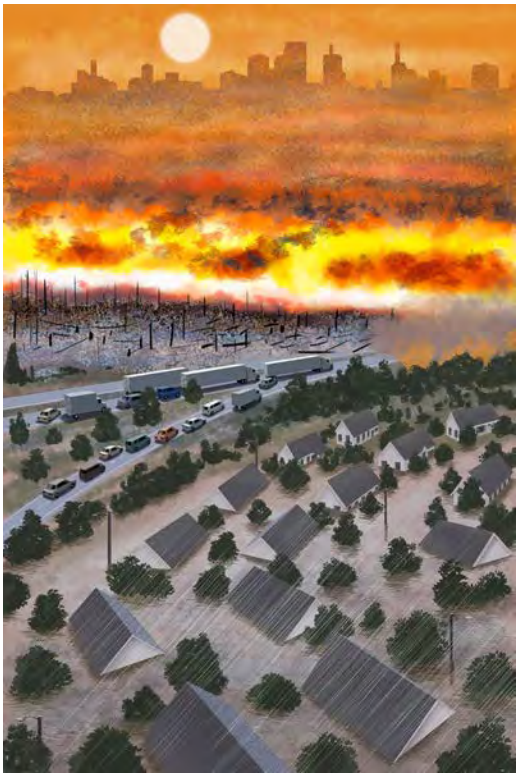

Figure 7. *Climate Change* by David Moyers.

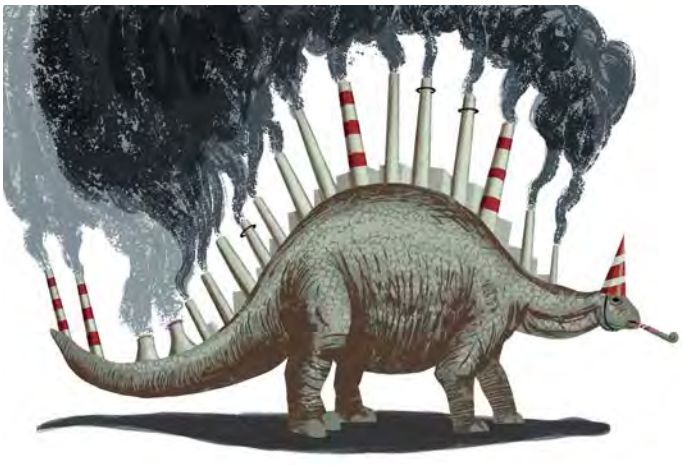

Figure 8. *Fossil Fuel Industry* by David Moyers.

of suburban lifestyles, such as daily commutes by motor vehicles. His art highlights the role of the oil industry in generating emissions of greenhouse gases (Figure 8).

Engagement **through art** intends to connect with its audience and ultimately motivate members of the audience to act differently. In this context, the role of art is to drive societal transformation in a changing climate. As the writer Zoë Lescaze (2022) commented, "The most effective protest art . . . does not confront us with evidence we've already proven perfectly willing to ignore. Instead, it broadens the narrow ways in which we tend to conceive of time and our position within larger ecologies, without necessarily mentioning climate change by name. The resulting works are not demands for immediate action but ones that expand our psychological capacity to act." Hannah Rothstein (www.hrothstein.com/#/national-parks-2050) calls her pieces a "call for action." She attempts to make the impacts of climate change feel more tangible by choosing places beloved by the American public and illustrating how those places will change unless decisions are made to

Figure 9. *National Parks 2050: Redwoods* by Hannah Rothstein.

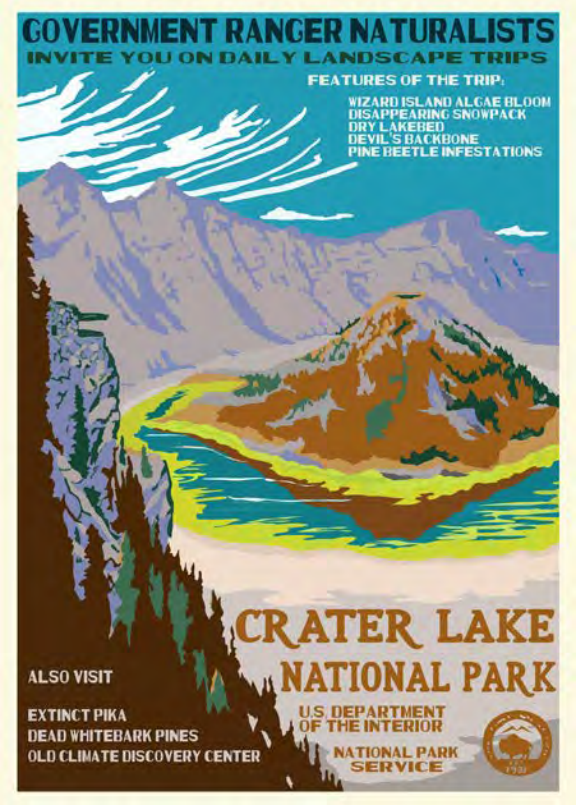

Figure 10. *National Parks 2050: Crater Lake* by Hannah Rothstein.

reduce emissions (Figures 9, 10). Art's power to evoke emotions can sensitize the public to climate change and its likely effects on Earth, including human societies.

Figure 11. *Not Yours, Not Mine, Is Ours* by Daniela Arenas. Photograph by Heather Moran / College of Charleston.

The desire for action is shared by numerous young people, who have created emotionally evocative paintings such as those included in the 2020 Student Art Expression of the Year program. Daniela Arenas, a student at the College of Charleston (South Carolina) who received one of three program's three awards, said, "I believe art speaks to people and it can influence how people feel and act. The message behind [my painting] *Not Yours, Not Mine, Is Ours*, is to show everyone the reality of what human-caused global warming is doing to our world and hopefully, make us take action . . . When viewers see this painting, my hope is that it prompts them to understand that it's in our own hands to change the world" (Figure 11). Similarly, Fiona Sieber, a high school student who painted an astronaut holding Earth between their hands, explained, "With my art I hope to show that the human race has the future of the earth in our hands." Sieber's painting was included in a virtual, community art space exhibition by students of Robert Bateman Secondary School's Art Activism class. The exhibition was presented in partnership with The Reach Gallery Museum in Abbotsford, British Columbia, in 2020.

Tom Christophersen, head of the Nature for Climate branch of the United Nations Environmental Programme, commented, "The main challenge is the lack of human imagination; our inability to see a different future because we're staring down this dystopian path of pandemic, climate change, biodiversity loss." Art may inspire younger generations to develop new policies and change attitudes and behaviors in ways that will eventually reduce global emissions of greenhouse gases.

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Regenerative Agriculture

Dominique Bachelet

Soil degradation generally is characterized by loss of organic matter, declining soil fertility and structural complexity, erosion, adverse changes in salinity or pH, or high levels of toxicants. Soils are degrading worldwide (Rekacewicz 2007), and over 40 percent of agricultural land is seriously degraded due to intensive human activities (Jie et al. 2022). The Dust Bowl in the United States during the 1930s exemplified how the interaction of drought and agricultural practices may cause extensive soil losses. In the United States, the volume of soil organic matter is currently about 50 percent of that present when forests and prairies were converted to agricultural land, primarily during the 1700s or 1800s (Baumhardt et al. 2015). Since World War II, farmers have used tillage and synthetic fertilizers to boost production. Tillage—aeration or turning of the soil, often by mechanical means, in advance of planting—increases emissions from decomposition and increases soil erodibility. Each year, 0.3 percent of global food-production capacity is lost to soil erosion and degradation (FAO and ITPS 2015). Regeneration of 25 mm (1 in) of topsoil requires approximately 500 years, and agricultural production generally requires a topsoil depth of 150 mm (5.9 in) (Pimentel 1998).

The ultimate goal of regenerative agriculture is to restore degraded soils and manage them sustainably (Lal 2020) (Figure 1). There is no consensus definition of regenerative agriculture (Newton et al. 2020) despite use of the term since the 1980s (Giller et al. 2021, O'Donoghue et al. 2022). Nevertheless, three principles generally characterize regenerative agriculture. First, minimize physical and chemical disturbance of the soil. Second, cover the soil to reduce erosion. Third, diversify crop rotations to manage pests and pathogens and provide diverse nutrients to the microbial community in the soil. Benefits of these practices include comparable yields from regenerative and conventional operations (Jordon et al. 2022) and minimal erosion as a result of extreme weather. As soil carbon content and water retention increase, so does the potential for higher farm revenues through reduced use of fertilizers, herbicides and pesticides, and fossil fuel-powered machinery. Furthermore, reduction of fertilizer applications tends to improve water quality by reducing runoff of nitrates into surface water or infiltration of nitrates into groundwater. Because synthetic and organic fertilizers increase the amount of nitrogen available to soil microbes, which turn nitrogen into nitrous oxide, a potent greenhouse gas, decreases in fertilizer use also mitigate emissions. The focus on soil aims to maximize long-term yields while minimizing application of chemicals (Lal 2020). By contrast, conventional agriculture often maximizes short-term yields with addition of synthetic fertilizers and pesticides.

The feasibility of adopting regenerative practices varies among locations. Conversion from conventional to regenerative agriculture also can incur substantial up-front equipment and labor costs. Because regenerative practices are based on maximizing soil condition and native species richness in agricultural lands, they have much in common with practices promoted for sustainable agriculture, climate-smart agriculture, organic farming, and agroecology. Which practices are applied will vary on the basis of soil conditions. The most common and accepted practices are no till, cover cropping, integrated nutrient and pest management, complex rotations, and integration of crops with trees and livestock.

No till, or minimum tillage with residue mulching, enhances the formation of soil aggregates, enriches organic matter in the soil, sequesters carbon, increases water infiltration into groundwater,

and increases soil water content. However, some soils develop hardpans that, left intact, can constrain root zones and thus reduce yields.

Cover cropping protects the soil surface with plants with the goal of reducing soil erosion; improving water retention; managing weeds, pests, and diseases; and increasing the species richness of soil microbes and insects that serve as pollinators. In Oregon, common cover crops include winter oats, cereal rye, crimson clover, Austrian field peas, and common vetch. Cover crops may be used for forage or, especially when they are legumes, as mulch to return nutrients to the soil. Use of cover crops generally increases soil organic matter and carbon sequestration. The benefits from cover cropping over time depend on initial soil conditions, type of cover crop, weather conditions, and timing of cover cropping.

Integrated nutrient and pest management minimizes chemical use and maximizes the efficiency of chemicals when they are used. Regular monitoring and knowledge are required to recognize signs of pest outbreaks. A diverse soil microbiota contributes to availability of nutrients and carbon to both plants and microbes. In the United States and Europe, it usually is feasible to reduce fertilizer use. However, use of fertilizers often is necessary to increase nutrient levels in eroded African soils.

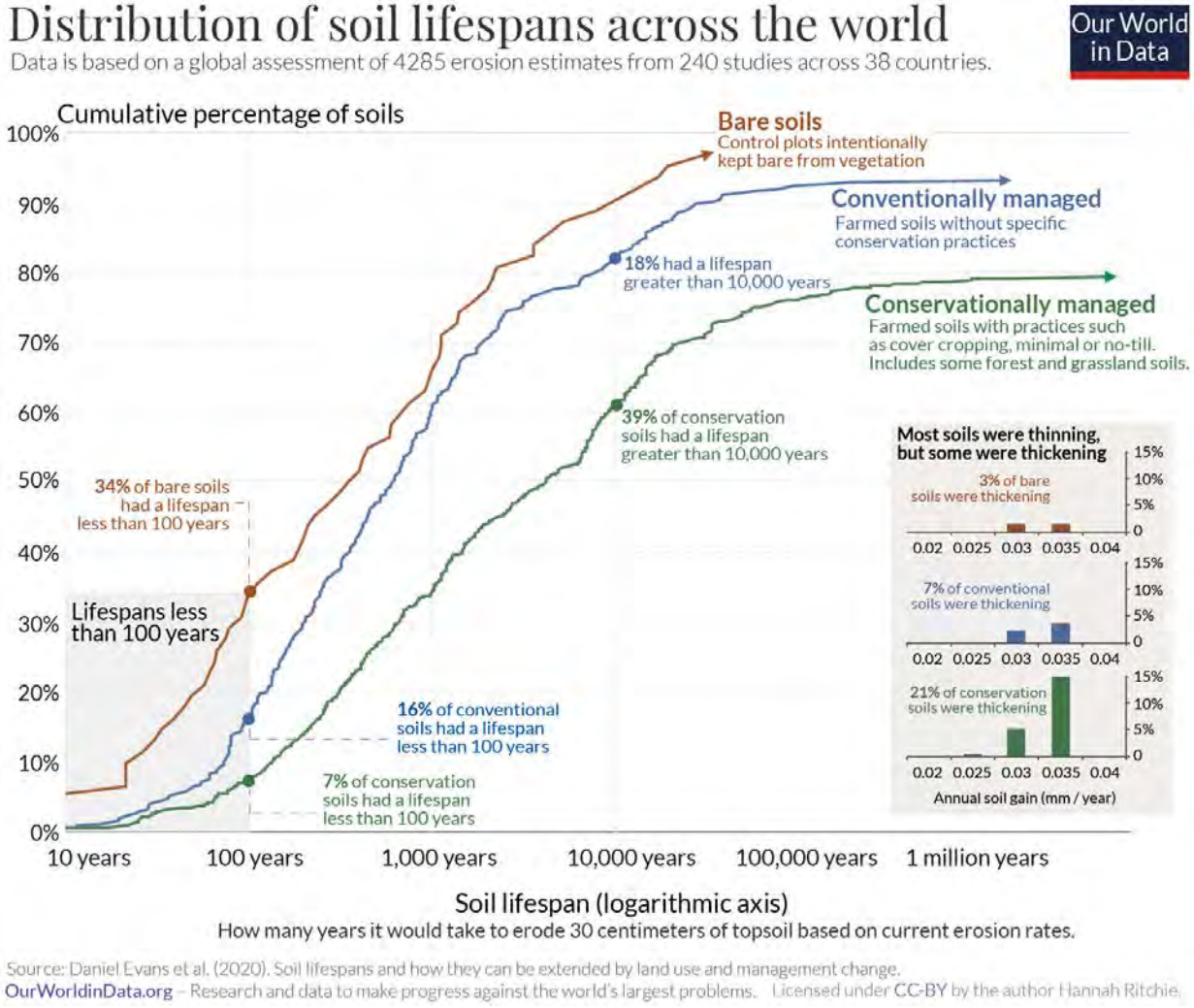

Figure 1. Distribution of soil lifespans worldwide. Source: ourworldindata.org/soil-lifespans.

Complex rotations can improve soil fertility by alternating a nitrogen-fixing with a nitrogen-hungry crop and increase native species richness by alternating crops that attract different types of insects that serve as pollinators. When complex rotations include cruciferous plants such as rapeseed or mustards, which contain glucosinolates and suppressing weed growth for weeks to months after mulching, the need for herbicides also is reduced.

Integration of crops with trees and livestock can reduce the volume of fertilizer and animal feed used and labor and machinery costs, thereby increasing farm revenues. Incorporation of fresh manure into soil by hooves can improve soil fertility, but the timing of grazing and crop rotation need to be monitored regularly to avoid exceeding grazing targets. Adding trees to pastures (silvopasture) increases soil carbon content and provides shade for livestock. Planting fruit trees and timber species can increase revenues from the operation; improve dairy yields by protecting animals from wind and extreme temperatures; decrease evaporation of soil moisture, which delays senescence of plants on which livestock feed; and attract a greater number of native species.

Biological and physical sciences indicate that regenerative practices can prevent erosion, retain soil moisture, and increase carbon sequestration (Paustian et al. 2020), but there are few quantitative data on the potential magnitude of these benefits. Furthermore, the amount of carbon sequestered per unit area varies among regions, crops, and producers; may not be permanent; and can be scientifically and logistically difficult to verify (Ranganathan et al. 2020). Adoption of regenerative practices requires an understanding of fundamental ecosystem processes and changes in human behavior and norms, and the process of learning to manage agricultural systems without using chemicals can be slow (Gosnell et al. 2022).

In Oregon, several organizations are promoting the expansion of regenerative practices across the state. For example, the Oregon Climate and Agriculture Network (ORCAN) is contributing to existing educational programs for farmers; strengthening networks with diverse stakeholders, from farmers to policy makers; advocating to improve soil conditions; advising the Oregon Global Warming Commission; and contributing to development of legislation. The Healthy Soils Healthy Climate Act (S.1356; www.congress.gov/bill/117th-congress/senate-bill/1356?s=1&r=45), introduced in April 2021 by Oregon senator Ron Wyden, would amend the Food Security Act of 1985 to create a permanent soil health program within the U.S. Department of Agriculture's Environmental Quality Incentives Program. Each year, $100 million would be allocated for incentive payments to producers who adopt practices designed to increase carbon levels in soil. Additionally, the bill would establish protocols for measuring soil organic carbon levels before and after implementation of such practices. The bill also would provide grants to land-grant colleges and universities to conduct research on soil health and carbon science and facilitate research on these topics at U.S. Department of Agriculture research stations.

The Agriculture Resilience Act (S.1337; www.congress.gov/bill/117th-congress/house-bill/2803/text) was introduced in April 2021 by Representative Chellie Pingree of Maine and Senator Martin Heinrich of New Mexico. The bill sets a goal of the U.S. agricultural sector achieving net zero emissions of greenhouse gases by the year 2040. It emphasizes increasing investments in agricultural research, improving soil health, supporting the transition to pasture-based livestock, ensuring farmland preservation and viability, promoting on-farm renewable energy, and reducing food waste.

Portland-based Sustainable Northwest, a 501(c)(3) nonprofit organization, recently received about half a million dollars from the M.J. Murdock Charitable Trust for a regenerative ranching program in Wallowa County in partnership with Country Natural Beef, a cooperative of more than 100 family

ranches that manages 26,000 km^2 (10,000 mi^2) in the western United States. Sustainable Northwest also received $10 million from the U.S. Department of Agriculture to invest in carbon sequestration, improvement of water quality, and protection of wildlife habitat at 120 beef operations across nine states. Emissions from each ranch will be monitored with the goal of reducing the net carbon emissions of beef production by 50–100 percent compared to convention operations.

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2022

PACIFIC NORTHWEST WATER YEAR

IMPACTS ASSESSMENT

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Supported by the NOAA National Drought Information System

ON THE COVER: The Skagit River delta near Mt. Vernon, Washington. Credit: Edmund Lowe

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EXECUTIVE SUMMARY

Regional Water Year Conditions at a Glance

- The 2022 water year (October 1, 2021 – September 30, 2022) in Idaho, Oregon, and Washington (the Pacific Northwest; PNW) tied as the 13th warmest and ranked as the 52nd wettest since records began in 1895. Compared to the 1991–2020 normal period, regional temperature averages and total precipitation were near-normal for the PNW as a whole, but there was substantial regional variability, particularly for precipitation.
- Compared to the start of the water year, drought conditions improved over nearly the entire PNW by the end of the water year. The exceptions were central Oregon, south-central Oregon, and the very southern portion of Idaho, where drought persisted.
- An extended period in late winter (January 10–March 31) with below normal precipitation stalled snowpack development. Typically 56% of the PNW snowpack accumulates from January through March, but the dry period caused snowpack to be below median by April 1 across most of the PNW.
- Spring was wetter and colder than normal in all three states. Across the PNW, April–June 2022 ranked as the 3rd wettest since records began in 1895, with 146% of the 1991–2020 normal precipitation. April through June tied as the 14th coldest on record (–2.8°F below the 1991–2020 normal), allowing snowpack to build in the mountains and reducing water demand enough for either drought concerns to ease completely or drought impacts to be less than anticipated, depending on the basin.
- The direction of the temperature and precipitation anomalies flipped again to close out the water year: July–September ranked as the warmest (+3.6°F above the 1991–2020 normal) and 5th driest (56% of the 1991–2020 normal) on record for the PNW.

Impacts at a Glance

- The agriculture, drinking water, forestry, fisheries, recreation, hydropower, and stormwater sectors were affected by abnormally dry conditions. Impacts included reduced surface water availability, tree mortality, reduced streamflow, reduced power generation, and the closure of recreational lands due to wildfire, among others.
- The agriculture, drinking water, forestry, fisheries, recreation, and stormwater sectors were affected by abnormally wet conditions. Impacts included reduced drinking water quality, delayed planting and harvest, limited access for forestry research and monitoring, limited access to recreation, flooding of fish spawning areas, and water contamination, among others.
- Extreme temperatures also affected various sectors. For example, colder than normal temperatures impacted fruit trees throughout Washington, and warmer than normal temperatures combined with below normal precipitation extended the fire season to the start of water year 2023.

Response Actions at a Glance

- State drought declarations were issued for many counties in Oregon and Idaho as early as November 17, 2021 and continuing through June 7, 2022. Washington initially extended its 2021 drought declaration for five watersheds in the eastern part of the state, but then rescinded the declaration in response to cool and wet spring conditions that increased streamflows. Oregon issued a state of emergency in response to the wet spring for six northeastern counties.
- Responses to the annual Pacific Northwest Water Year Impacts Survey suggested high operational flexibility during drought conditions: more respondents changed operations in response to dry conditions than wet conditions.

Forecast Verification at a Glance

- A qualitative examination of two separate seasonal forecasts from the NOAA Climate Prediction Center showed that the seasonal precipitation swings were not predicted well. From January–March 2022, the PNW was much drier than forecasted, and from April–June 2022, the region was much wetter than forecasted. On the other hand, the April–June below normal temperatures were predicted a month in advance for a majority of the PNW.

1 PURPOSE

The purpose of this third Pacific Northwest (PNW) Water Year Impacts Assessment is to summarize the water year[1] conditions and sector impacts as a resource for future management of drought and other climate extremes. We gathered the information presented in this assessment in two main ways. The first was through two separate but similar annual Water Year Recap and Outlook meetings, one for Washington and Oregon, and the other for Idaho. The meeting objectives are to summarize the climate during the previous water year and to review climate and weather-related impacts on various sectors, focusing on drought and other extremes. The second mechanism informing this report was the Annual Pacific Northwest Water Year Impacts Survey.

The purpose of this assessment is to summarize the water year conditions and sector impacts as a resource for future management of drought and other climate extremes.

The assessment primarily reflects the information from the meeting discussions, the survey, and authors' expertise. We focus on continued regional drought, flooding, a cool and wet spring, a warm and dry summer, and their associated impacts.

1 A water year is defined as the 12 months beginning on October 1 and ending on September 30 of the following year (e.g., water year 2022: October 1, 2021-September 30, 2022).

2 LESSONS LEARNED

1. Lessons Learned from the Water Year 2022 Conditions and Associated Impacts

Lesson 1.1: For the second year in a row, spring was critical in determining the magnitude and extent of drought. The record wet April–June in 2022 was the mirror image of the record dry April–June 2021. Above normal precipitation and below normal temperatures in April–June drastically changed the outlook for drought for the remainder of the water year. This demonstrates the limitations of April 1 conditions for predicting water shortages and impacts later in the water year. Additionally, two sequential, anomalous springs potentially undermined the confidence of the public and natural resource managers in seasonal forecasts.

Lesson 1.2: Summer is also a critical season and can rapidly change the drought outlook. Despite a colder and wetter than normal spring, July–September in the PNW was the warmest on record, and that rapid switch to warm conditions caused water shortages and high fire danger in many areas.

Lesson 1.3: The extreme precipitation events of water year 2022 underscored the need for forecasters to communicate the possibility of a low probability, but high-impact event, along with seasonal forecasts. Seasonal climate outlooks are valuable resources for planning operations and are often used during the season to adjust operations in multiple sectors in the PNW. However, in water year 2022, the extreme precipitation in mid-November and the exceptionally wet and cold period in spring served as a reminder of the importance to consider and plan for within season, short-term variability, and low probability but high impact events.

2. Lessons Learned from Water Year 2022 about Improving Regional Response to Weather and Climate Conditions

Lesson 2.1: The abrupt transition from abnormally dry (January–March) to abnormally wet (April–June) and back to abnormally dry (July–September) was a challenge for forecasting and operations planning in multiple sectors. The abrupt variability in conditions itself is potentially more difficult to manage than the impacts of abnormally dry or abnormally wet conditions alone. For at least one sector, agriculture, the timing of the transition between dry (March) and wet (April) was particularly challenging because it occurred when annual irrigation allotments were being considered.

Lesson 2.2: The colder than normal spring was perhaps a more unusual challenge than a warmer than normal season because we have become accustomed to long-term warming trends in the PNW. Colder springs are not consistent with climate change projections, and the magnitude of the anomalies in 2022 and the timing of a particular cold snap in mid-April had considerable effects on agriculture. This serves as a reminder that natural variability in both temperature and precipitation still needs to be considered as well as long-term temperature trends.

Lesson 2.3: It is best practice for state responses to have the flexibility to adjust to abrupt changes in conditions. In May 2022, on the basis of the best data available at the time, Washington extended its 2021 drought declaration for five watersheds in eastern Washington and issued a drought advisory for all of eastern Washington. In July, when it became apparent that drought metrics and sectors were responding to the cool and wet spring, and notably that streamflow forecasts were improving, Washington canceled both the drought advisory and drought declarations. Washington state statutes on drought include the flexibility to amend or extend orders, and water year 2022 demonstrated that there is a need for that discretion. Even though conditions changed again during the warm summer, effects on water supply were limited, and major irrigation projects (e.g., the Yakima Project) received full water deliveries. For impacts that were reported in Washington, such as low streamflows that affected fish late in summer and drying wells for some smaller water systems, a state-issued drought declaration would not have been beneficial.

Lesson 2.4: Seasonal transitions between abnormally wet/dry and abnormally cold/warm conditions underscore the need to improve resiliency. Although seasonal weather forecasts generally are skillful, the extended dry period in January–March 2022 and the extended wet period in April–June 2022, for example, were not well forecasted. Preparation for all types of weather conditions remains important to build resiliency for all sectors.

3 WATER YEAR EVOLUTION

WATER YEAR 2022 AT A GLANCE*

8th warmest (tied with 2014); +0.7°F

53rd driest; –1.09 inches (97% of normal)

25th warmest (tied with 1900, 1918, 2014); +0.1°F

29th wettest; +4.05 inches (109% of normal)

15th warmest (tied with 1918, 2013, 2018); +0.5°F

54th driest; –0.52 inches (98% of normal)

*Anomalies relative to 1991–2020 normal; records since 1895 (Source: NOAA NCEI 2022)

Water Year Summary

The PNW 2022 water year temperatures were near-normal, but still ranked among the warmest years in the historical record, while the regional precipitation average was near-normal.

Averaged across the PNW, the 2022 water year tied 6 years (1958, 1967, 1987, 2004, 2013, and 2014) as the 13th warmest (+0.4°F) and was the 52nd wettest (since 1895; NOAA NCEI) with 102% of normal. Also from an area-wide perspective, the 2022 water year was cooler than the 2021 water year, but warmer than the previous two water years (2019 and 2020).

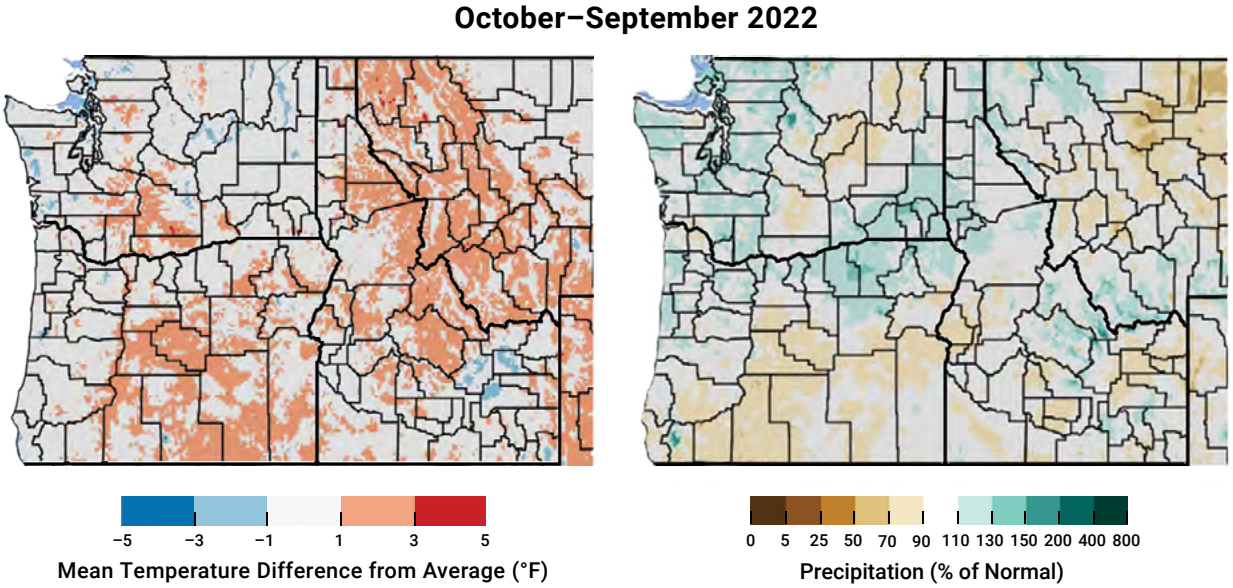
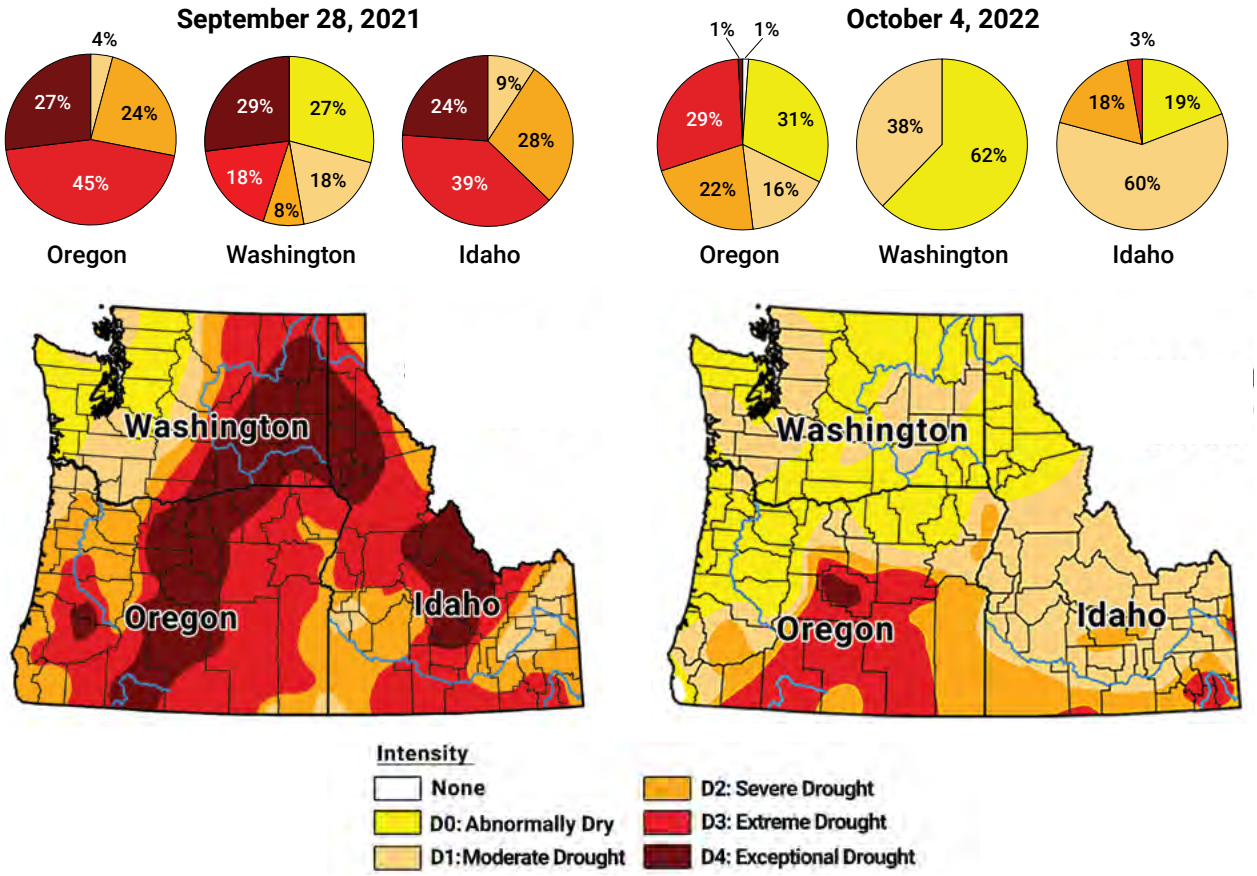


Figure 1: October 2021–September 2022 average temperature departures and precipitation percent of normal. The normal period is 1991–2020. Source: gridMET data through *Climate Engine*.

In addition, the 2022 water year was wetter than the last four water years (2018–2021), particularly 2020 and 2021, during which the regionally-averaged precipitation was 83 and 86% of normal, respectively. The period of 1991–2020 (*see page 11*) is used for the normal baselines throughout this assessment unless stated otherwise.

Water year temperature and precipitation anomalies were not spatially consistent throughout the PNW (*Figure 1*). Warmer than normal temperatures were more prevalent in Oregon and Idaho, as reflected in the state averages and rankings, while near-normal temperatures were more common in Washington. Spatial differences in water year precipitation within each state were more marked. Southern Idaho, southern and central Oregon, and central Washington had below normal precipitation, with water year totals between 70 and 90% of normal. Oregon was the driest of the three states relative to its normal. The remaining portions of the PNW had near-normal to above-normal water year precipitation, with totals between 90 and 130% of normal.

Overall, drought conditions improved over the course of the water year for most of the PNW. At the start of the 2022 water year, about 25% of each state's area was in exceptional drought, the most severe drought category recognized by the U.S. Drought Monitor (*Figure 2*). About 39% of Idaho, 45% of Oregon, and 18% of Washington were in extreme drought. The dire drought conditions at the start of the 2022 water year were due to a combination of factors. While some locations had low snowpack in 2021, even locations with normal snowpack that year were affected by a widespread, exceptionally dry spring, and a warm and dry summer, such that the 2021 water year ended with very dry conditions in some places. As a result, at the beginning of the 2022 water year, reservoir carryover was severely depleted across central and eastern Oregon and southern Idaho. By contrast, the



Yakima Basin in Washington began the water year with above average reservoir storage.

At the end of the 2022 water year, only a small area in central Oregon was in exceptional drought, and 29% of Oregon and 3% of Idaho were in extreme drought. While the area in severe drought was also less than at the start of the water year, a majority of the PNW was still experiencing either moderate drought or abnormally dry conditions. The weather conditions that led to drought reduction are described in more detail in the remainder of Section 3.

Figure 2: Pie charts and maps of drought conditions as characterized by the *U.S. Drought Monitor* on September 28, 2021 (*left*) and October 4, 2022 (*right*), the beginning and end of the 2022 water year, respectively.

Updated 30-Year Normals

Following the World Meteorological Organization (WMO) recommendation, long-term averages of temperature, precipitation, streamflow, and snowpack used to compare current conditions to average conditions, known as climate normals, have been updated. In previous *Water Year Impacts Assessments* (*2020*, *2021*), the 1981–2010 normals were used. The WMO requires that normals be updated every decade, and the 1991–2020 normals were released by NOAA in early 2021. The regional temperature, precipitation, snowpack, and streamflow summaries in this assessment compare the 2022 water year conditions to the 1991–2020 normals.

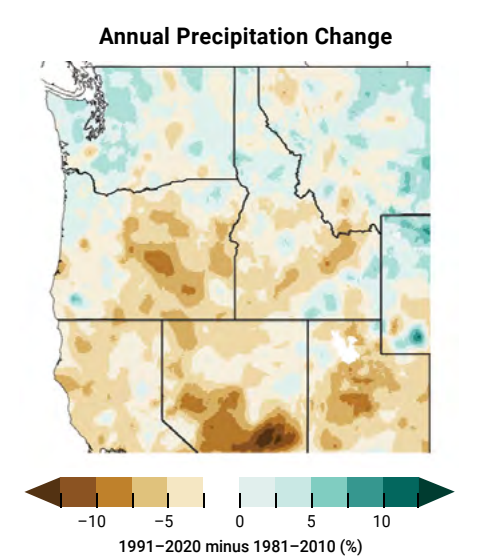


Figure 3: Annual (calendar year) precipitation change between the 1991–2020 normals and 1981–2010 normals (from *NOAA 2021a*).

How are the 1991–2020 normals different from the 1981–2010 normals? The 1991–2020 normals replaced the 1980s with the 2010s. Although normals are not intended to serve as indicators of climate change, and certainly are influenced by decadal variability, the updated annual temperature normals reflect warming over the PNW (*NOAA 2021a*, *b*). Averaged over the water year, normal statewide temperatures for Oregon, Idaho, and Washington increased by 0.5°F, 0.5°F, and 0.4°F, respectively. Because temperatures in each updated normal release generally are warmer, it is possible that a water year with near-normal temperatures still ranks as warm relative to the historical record. For example, Washington's 2022 water year ranking of 25th warmest despite near-normal temperatures is possible because the 1991–2020 normals are warmer than those of decades past.

There is more spatial variability in how the precipitation normals have shifted (*NOAA 2021a*). Average annual precipitation from 1991–2020 was higher throughout most of Washington, northwest Oregon, and northern Idaho but lower in central and eastern Oregon and southern Idaho (*Figure 3*). Averaged statewide, total water year precipitation was slightly less in Oregon (–0.40") and greater in Washington (+0.79"). Total water year precipitation across Idaho was essentially the same during both periods (1991–2020 was a mere 0.07" drier). Similar to these changes in the precipitation normals, the 1991–2020 natural runoff estimates from the National Weather Service Northwest River Forecast Center (NWRFC) also shifted. The 1991–2020 natural runoff generally remained the same or increased in Washington and northern Idaho, and stayed the same or decreased across Oregon and southern Idaho (*NWRFC 2021*).

The 30-year snowpack normals from the Natural Resources Conservation Service (NRCS) have also been updated to the 1991–2020 period. Many SNOTEL stations were installed in the mid-1980s. Therefore, the 1991–2020 snowpack normals were based on more complete data than the 1981–2010 normals. Changes in normals for individual stations can be viewed on the NRCS website (*NRCS 2022a*). The changes in snowpack normals are more difficult to generalize than changes in temperature and precipitation normals since the difference between the 1981–2010 and 1991–2020 snowpack normals are more sensitive to the individual station records. The methods used to calculate the normals have also changed (*NRCS 2022b*). We encourage readers to explore the changes to the normals for SNOTEL stations that are within the watersheds where they work.

Seasonal Progression

Water year 2022 had many swings between abnormally wet and abnormally dry conditions and abnormally cold and abnormally warm temperatures. As such, the seasonal progression of temperature and precipitation characterizes the water year more completely than water year averages and totals. Although the October–September total precipitation was close to the 30-year normal for each state, there was a noticeable spread between the months ranking among the wettest or the driest in the 127-year record (*Figure 4*). For each state, with only a few exceptions, October, April, May, and June were abnormally to severely wet while February and March were abnormally to severely dry. The rankings for the end of the water year were more extreme for Washington and Oregon than Idaho. August was moderately dry in Washington, and September was moderately to severely dry in Washington and Oregon. In Idaho, both August and September were neutral. Precipitation from November through January varied among the states, with Washington's moderately wet November and Idaho's moderately wet December the most anomalous months within that time frame.

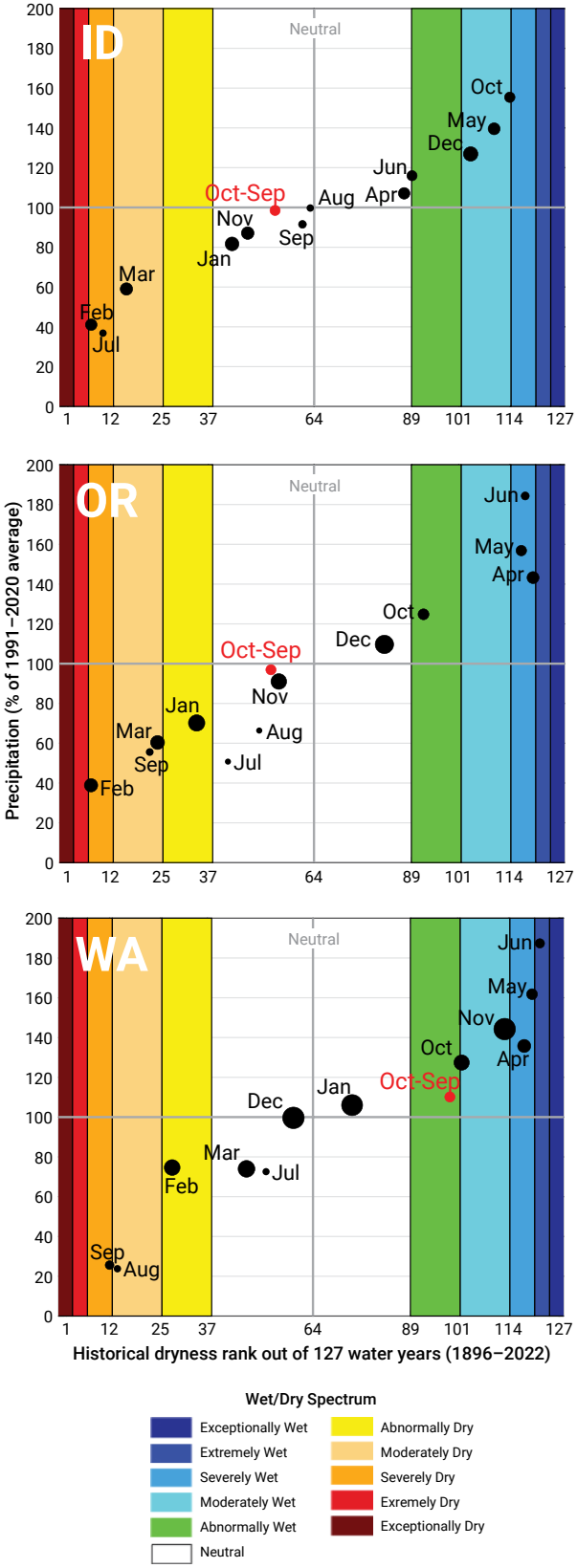


Figure 4: Monthly percent of normal (compared to 1991–2020 baseline) statewide precipitation as a function of the monthly precipitation rank during the last 127 water years for Idaho (*top*), Oregon (*middle*), and Washington (*bottom*). The red point illustrates the water year 2022 total. The colors corresponding to dry conditions are consistent with the U.S. Drought Monitor scale, and those corresponding to wet conditions with the *Climate Toolbox U.S. Water Watcher tool*. The sizes of the circles are scaled according to each month's relative average contribution to the water year total precipitation, from dry (*small*) to wet (*large*). NCEI nClimDiv data accessed on December 31, 2022.

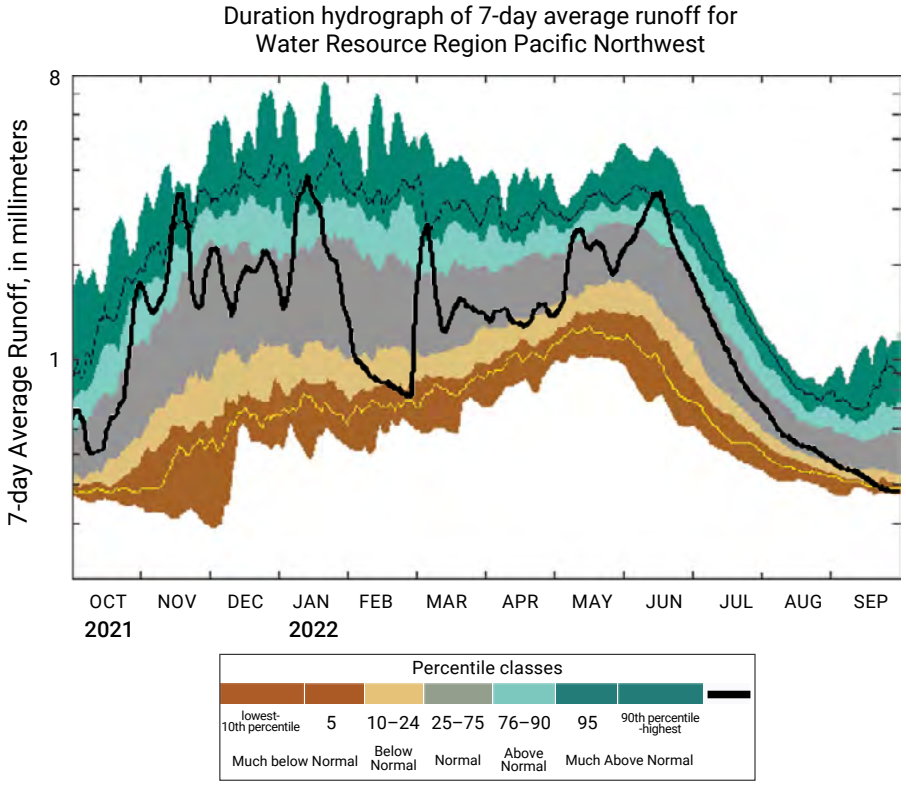


Figure 5: Seven-day average runoff over the PNW for water year 2022 and percentiles relative to the historical record. Source: *USGS*.

The relative wet and dry periods are also illustrated by the water year average streamflow across the PNW (*Figure 5*). Streamflow was above normal in mid-November and late December through early January, corresponding with wet periods of the water year. Streamflows in February and September were below normal, corresponding to dry periods of the water year.

Water year 2022 also had swings between abnormally warm and abnormally cold temperatures that went beyond typical seasonal changes. The most notable swing occurred from much colder than normal April–June temperatures to much warmer than normal July–September temperatures. Monthly and seasonal conditions are discussed in further detail in the next sections.

October–November 2021

Temperature

October–November 2021 temperature anomalies were largely positive and tended to be greater in the interior of the Pacific Northwest. Idaho was the warmest of the three states relative to its normal for the 2-month period (*Figure 6*). Eastern Washington and eastern Oregon also began the water year warmer than normal, while temperatures west of the Cascade Mountains in both states were near-normal. The regional differences were due to October conditions; Washington and Oregon were mostly colder than normal in October while Idaho was warmer than normal. The entire PNW was warmer than normal in November.

Precipitation

October–November 2021 precipitation was above normal in most of the PNW, except for a swath of near-normal to below normal

OCTOBER–NOVEMBER 2021 STATISTICS*

18th warmest (tied with 1927, 1932, 1933, 1958, 1963, 1976, 2020); +1.2°F

60th wettest (tied with 1906); +0.23", 103% of normal

31st warmest (tied with 1974, 1980, 2012); +0.9°F

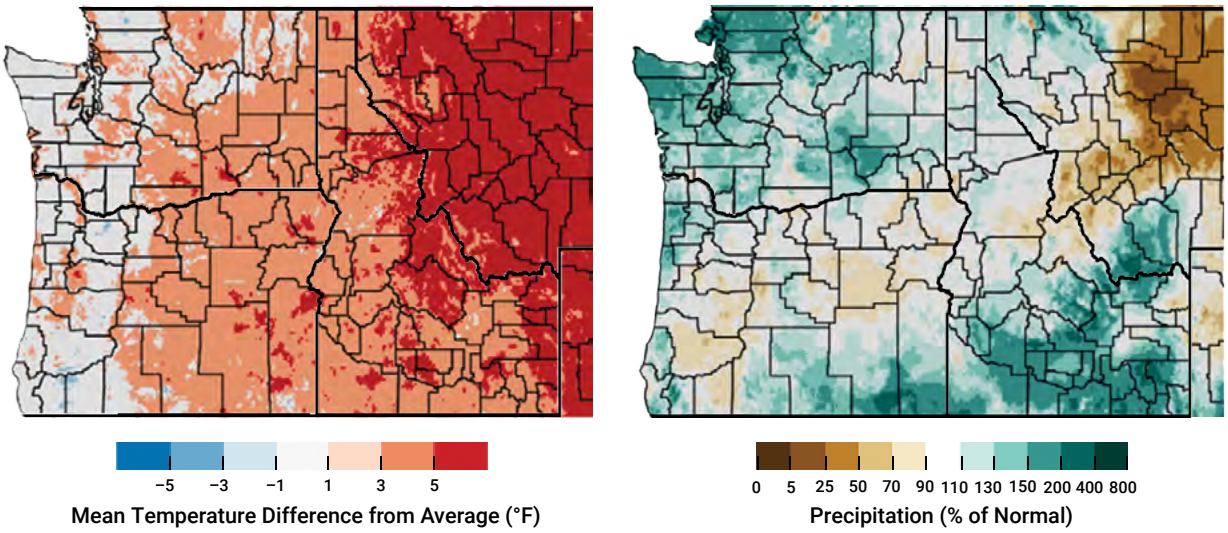
8th wettest; +3.95", 138% of normal

13th warmest; +2.5°F

42nd wettest (tied with 2012); +0.71", 116% of normal

*Anomalies relative to 1991–2020 normal; records since 1895. Source: NOAA NCEI 2022

October–November 2021



precipitation through central Oregon (*Figure 6*). Washington was the wettest of the three states relative to its normal, with above-normal precipitation totals in both months.

Five separate atmospheric rivers caused major flooding on the Nooksack and Skagit Rivers in northwest Washington

Figure 6: October–November 2021 average temperature departures and precipitation percent of normal. The normal period is 1991–2020. Source: gridMET data through *Climate Engine*.

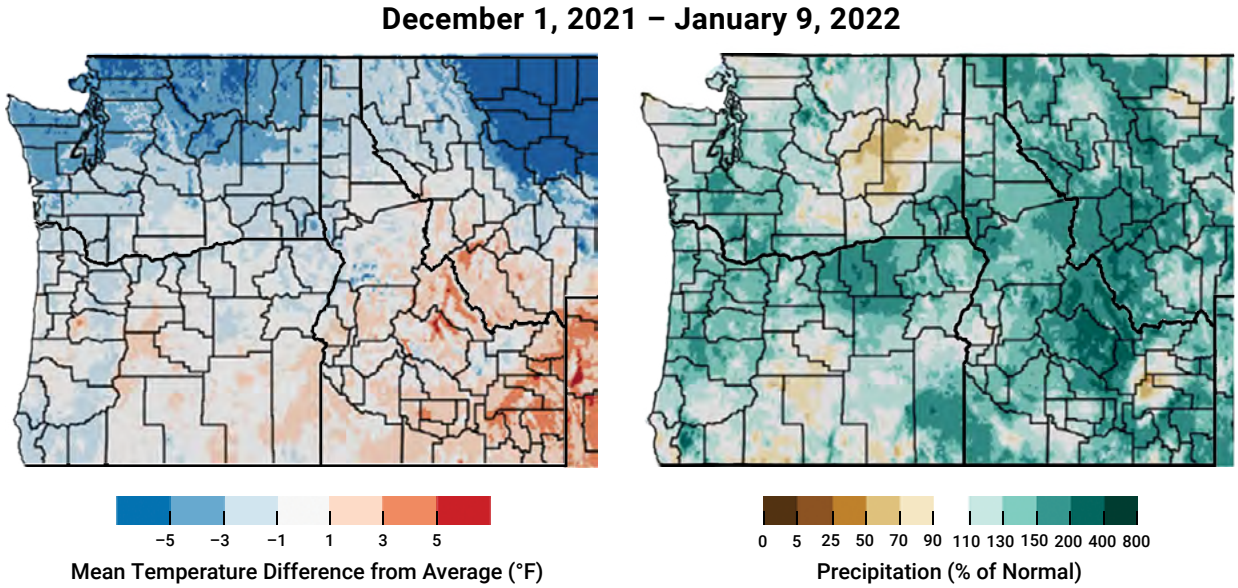


Figure 7: December 1, 2021 – January 9, 2022 average temperature departures and precipitation percent of normal. The normal period is 1991–2020. Source: gridMET data through *Climate Engine*.

during November. In addition to flooding, landslides and power outages were reported throughout northwest Washington. The warm temperatures meant that most of the precipitation during this period fell as rain rather than snow. During the mid-November atmospheric river that affected British Columbia, Canada, and Whatcom, Skagit, and San Juan counties in Washington, two-day precipitation totals corresponded to a 50- and a 100-year event across the region. Peak streamflow return periods ranged between a 50- and 100-year event in Washington and exceeded a 100-year event in British Columbia (Gillett et al. 2022). Although the above normal precipitation was the main cause of the flooding, the mild temperatures that melted existing snowpack and the saturated soils from earlier atmospheric rivers also contributed. Climate change made this event, which is now the costliest natural disaster on record for British Columbia (*Hakai Institute*), much more likely to occur (Gillett et al. 2022).

December 2021

Snowpack

PNW snowpack was well below normal at the start of December, but snowpack built substantially through December 2021 and early January 2022. December 1 through January 9 was an active period during which temperatures were below- to near-normal and precipitation was near- to above-normal across a majority of the PNW (*Figure 7*). Snowfall was especially frequent and heavy at the end of December and in early January. By January 9, snowpack was normal to above normal throughout the PNW.

DECEMBER 1, 2021 SNOW WATER EQUIVALENT*

20% of median

49% of median

47% of median North of the Salmon River

65% of median South of the Salmon River

JANUARY 9, 2022 SNOW WATER EQUIVALENT*

154% of median

135% of median

126% of median North of the Salmon River

131% of median South of the Salmon River

*Statewide, compared to 1991–2020 median. Source: National Resources Conservation Service

January–March 2022

Temperature

January through March 2022 temperatures varied throughout the PNW, but were mostly warmer than normal, especially at higher elevations. Excluding the cold and snowy first 10 days of January, most of the PNW had near-normal to above-normal temperatures (*Figure 8*). The Snake River Valley and southeastern Idaho were the exceptions. In these regions, temperatures were well below normal, resulting in Idaho statewide average

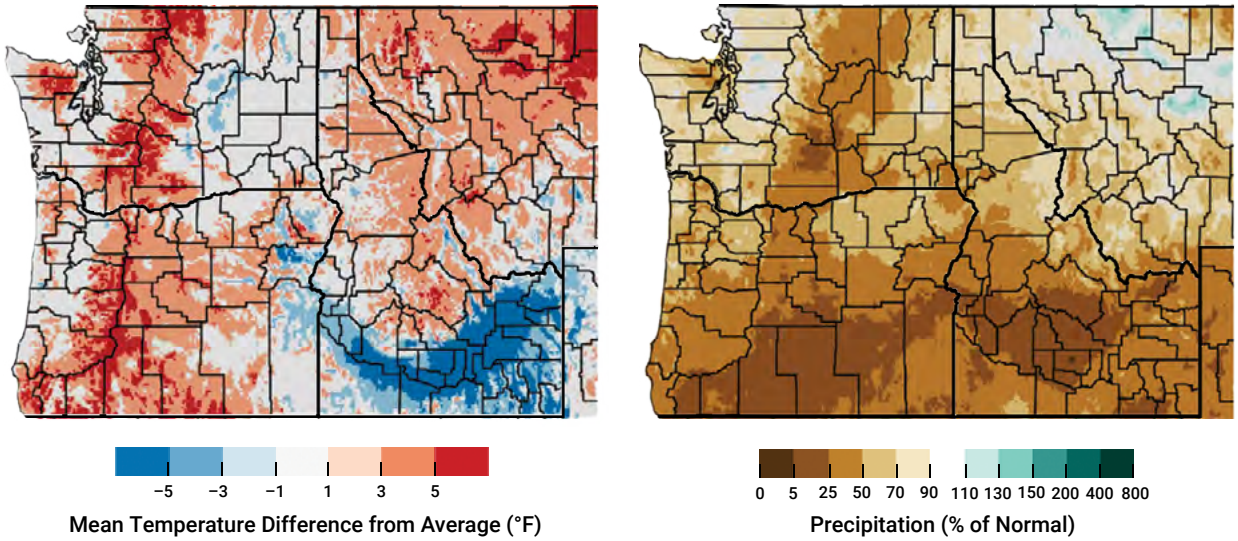
January–March temperatures that were below normal. Some areas of eastern Washington also had below normal temperatures. Temperatures in Oregon from January through March were the most spatially consistent and ranked as the 16th warmest on record.

Precipitation

January 10 – March 31 precipitation was below normal

Figure 8: January 10 – March 31, 2022 average temperature departures and precipitation percent of normal. January 1–9, 2022 was excluded because it was a colder and wetter period that was included in *Figure 7*. The normal period is 1991–2020. Source: gridMET data through *Climate Engine*.

January 10 – March 31, 2022



JANUARY–MARCH 2022 STATISTICS*

16th warmest (tied with 1961); +1.1°F

8th driest; −4.85”, 58% of normal

33rd warmest (tied with 1931 and 2018); +0.1°F

41st driest; −1.92”, 87% of normal

55th warmest; −1.3°F

5th driest; −2.81”, 62% of normal

*Anomalies relative to 1991–2020 normal; records since 1895. Source: NOAA NCEI 2022

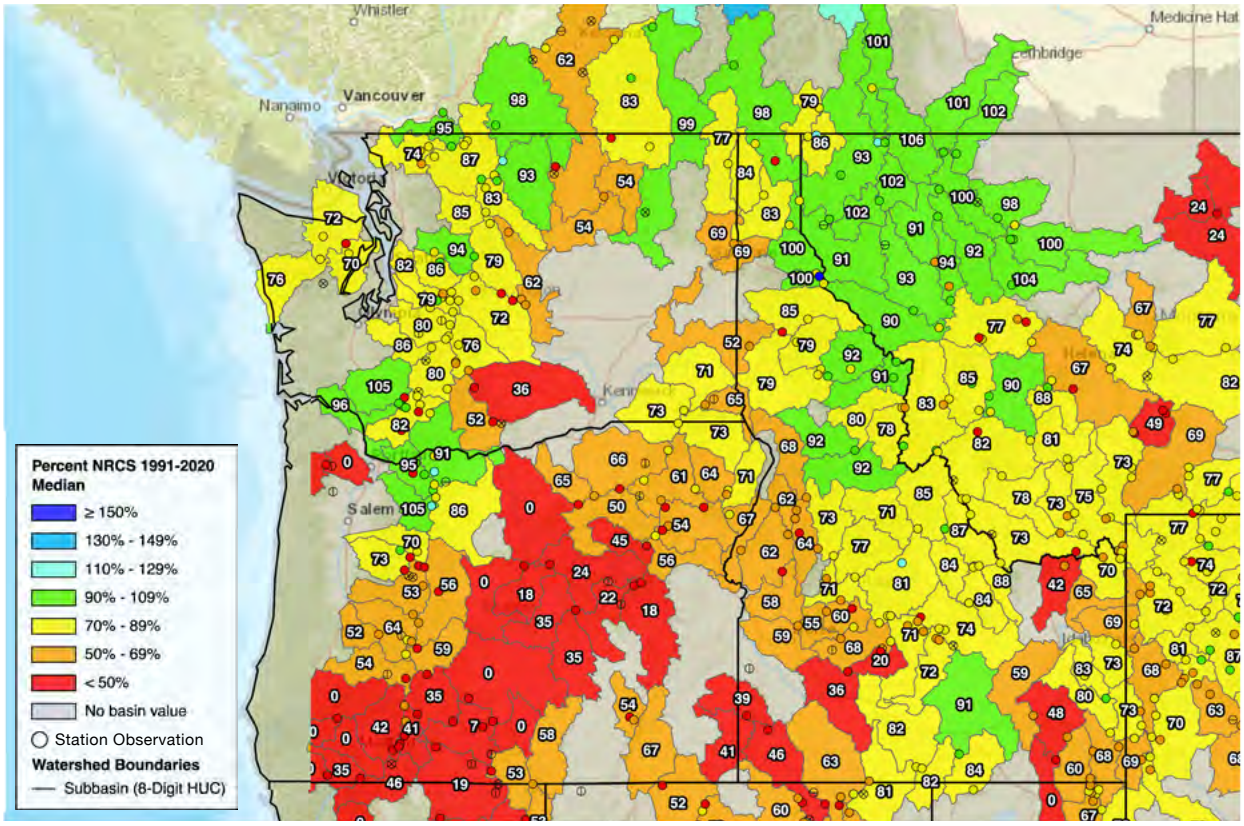


Figure 9: April 1, 2022 snow water equivalent (SWE) percent of 1991–2020 median. Station values may differ from the sub-basin average. Source: *NRCS*.

APRIL 1, 2022 SNOW WATER EQUIVALENT*

51% of median

80% of median

84% of median North of the Salmon River

69% of median South of the Salmon River

*Statewide, compared to 1991–2020 median. Source: National Resources Conservation Service

throughout the PNW, particularly in parts of southern Oregon, southern Idaho, and the Lower Columbia Basin, where 5–25% of normal precipitation fell during that period. Of the three states, Oregon had the largest precipitation deficit for January–March, receiving 58% of normal precipitation. Numbers were marginally higher for Washington, mainly because of a wet period at the end of February in the central Puget Sound region.

Snowpack

According to the Natural Resources Conservation Service (NRCS), 56% of the PNW snowpack is typically accumulated from January through March. By April 1, which is near the usual date of peak snowpack, snowpack was below median throughout most of the sub-basins in the PNW (*Figure 9*). Statewide average snow water equivalent (SWE) was highest relative to normal north of the Salmon River in Idaho, at 84% of median. The lowest SWE was in Oregon, at 54% of median.

April–June 2022

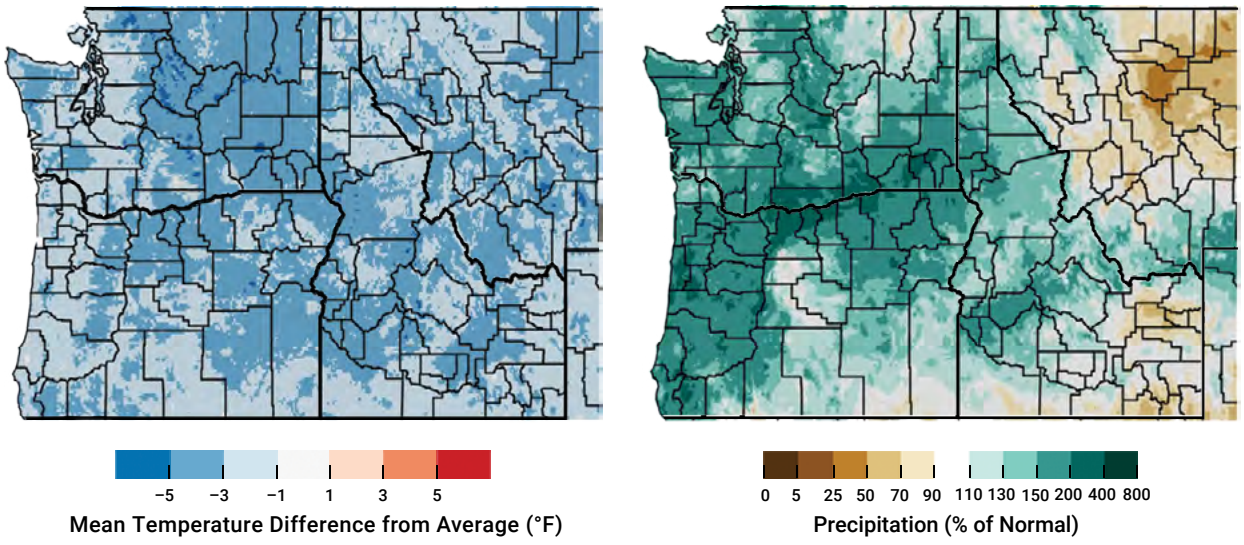
Temperature

April–June 2022 temperatures were below normal throughout the PNW, with temperatures between 3 and 5°F below normal in much of the areas of all three states (*Figure 10*). Washington was the coldest relative to its normal of the three states. Averaged statewide, April–June temperatures in Washington, Idaho, and Oregon tied as the 6th, 9th, and 17th coldest on record, respectively. This represented a shift from the warmer than normal temperatures observed in the previous three months over much of the PNW. Within this cold spring, there were some notable cold snaps, particularly one in mid-April during which minimum temperatures were below freezing and snow fell throughout the PNW at most elevations.

Precipitation

In a marked swing from the below normal January–March precipitation, April–June precipitation was above normal for most of the region, with large areas receiving between 150 and

Figure 10: April–June 2022 average temperature departures and precipitation percent of normal. The normal period is 1991–2020. Source: gridMET data through *Climate Engine*.



APRIL–JUNE 2022 STATISTICS*

17th coldest (tied with 1902 and 1929); –2.8°F

2nd wettest; +3.83", 157% of normal

6th coldest (tied with 1984); –3.2°F

3rd wettest; +4.39", 157% of normal

9th coldest (tied with 1899, 1916, 1964, and 1984); –3.0°F

19th wettest; +1.35", 121% of normal

*Anomalies relative to 1991–2020 normal; records since 1895. Source: NOAA NCEI 2022

200% of normal precipitation. Above normal precipitation was more spatially consistent in Oregon and Washington than in Idaho. The April–June precipitation in Oregon and Washington ranked as the 2nd and 3rd highest on record, respectively. Parts of southern and southeastern Idaho were the exceptions, receiving between 70 and 90% of normal precipitation.

Snowpack

The below normal temperatures and above normal precipitation benefited mountain snowpack throughout the region. Statewide percentages of median snowpack were above normal in Oregon and Washington and near-normal in Idaho by May 1, 2022, representing actual growth in SWE in many locations. There were notable exceptions, however. The snowpack did not recover as well in southern Oregon, where there was a below normal snowpack on May 1 (*Figure 11*). Snowmelt begins in most basins in the PNW before May 1, so SWE can be above normal on May 1, but still below peak SWE earlier in the season, and can be misleading from a water supply perspective. Nevertheless, the snowpack recovery was beneficial for many basins throughout the PNW, and SWE in many basins reached its typical peak, just later in the season than normal. The Willamette Basin in Oregon is one example (*Figure 12*); the above median April 21 peak SWE was equivalent to the peak SWE that usually occurs on March 28. SWE in that basin recovered to the median, and snowmelt was later than usual.

Many other basins in the PNW gained SWE in April, but still ended the season with SWE below the median peak. For example, SWE in the Rogue-Umpqua basin in southern Oregon initially peaked in early January and then gradually declined until snowmelt began in late March (*Figure 12*). The colder and wetter than normal April arrested the snowmelt and allowed for a second peak, on April 23, at 70% of the median peak SWE

MAY 1, 2022 SNOW WATER EQUIVALENT*

117% of median

114% of median

108% of median North of the Salmon River

95% of median South of the Salmon River

*Statewide, compared to 1991–2020 median. Source: National Resources Conservation Service

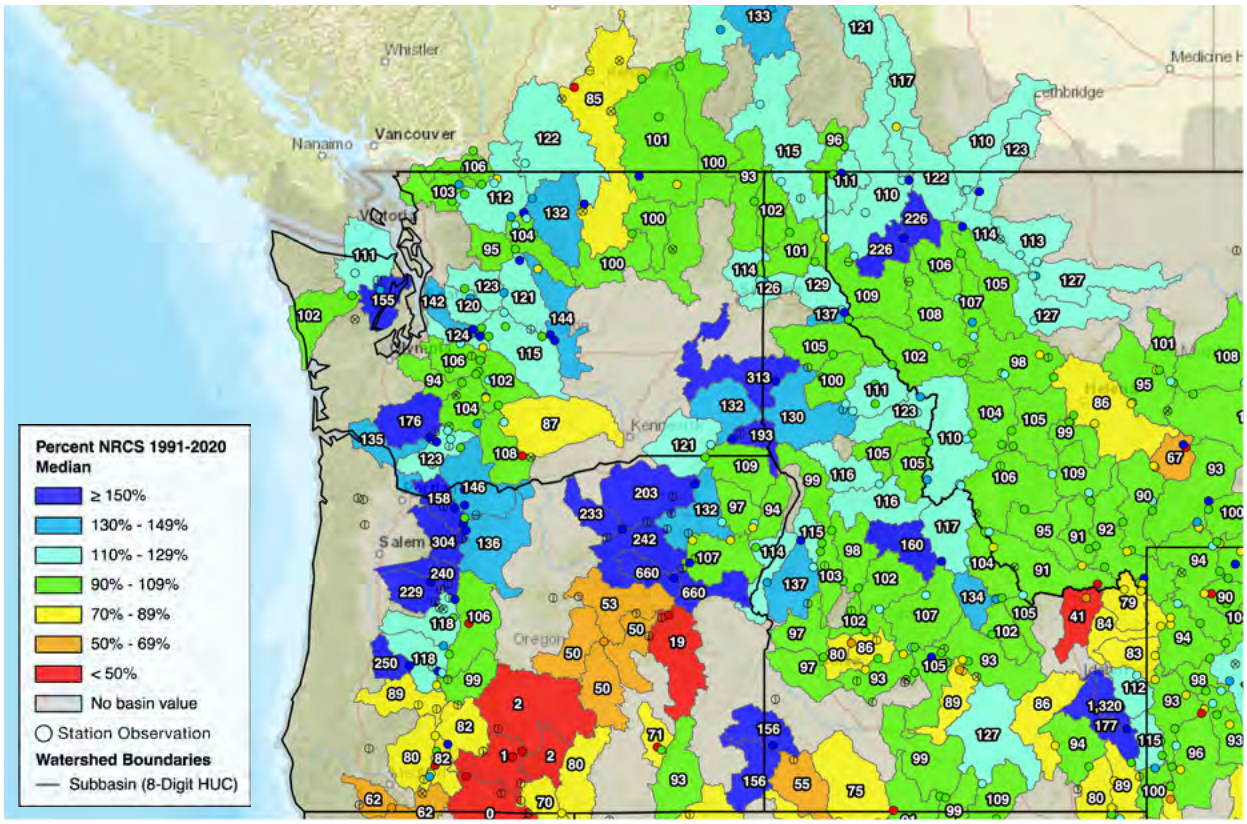


Figure 11: May 1, 2022 snow water equivalent (SWE) percent of 1991–2020 median. Source: *NRCS*.

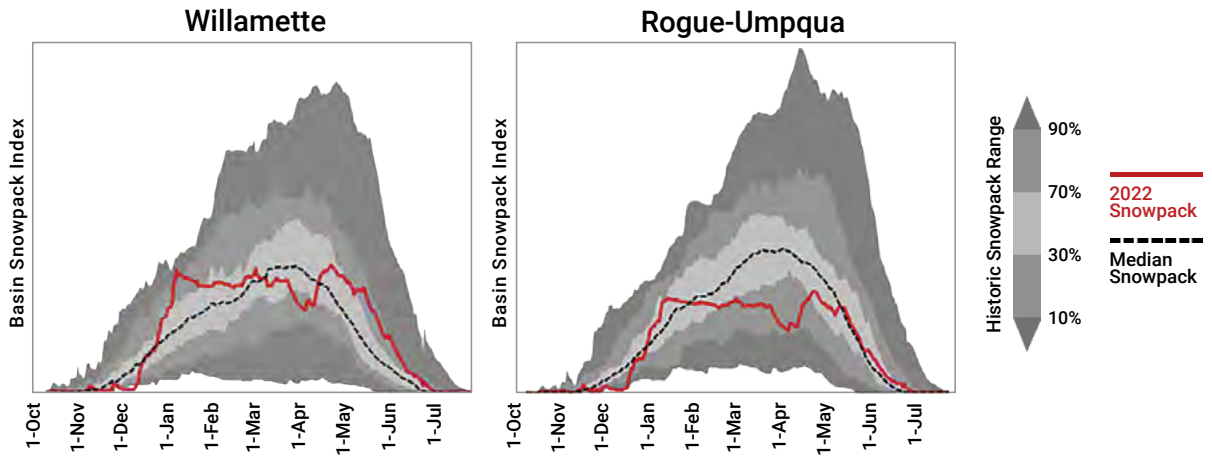


Figure 12: The Willamette and Rogue-Umpqua, Oregon, water year 2022 snowpack traces (*red line*) compared to normal (*dashed line*). Growth in snowpack during April resulted in near-normal peak SWE for the Willamette basin, whereas April SWE in the Rogue-Umpqua basin was below normal despite the growth. Source: Matt Warbritton USDA-NRCS.

(usually seen in early April). This secondary peak was critical in allowing the subsequent snowmelt to follow the usual timeline. The refreezing of the snowpack in April, due to the exceptionally cold temperatures, delayed snowmelt and eased drought in southern Idaho in particular. Overall, and in contrast to water year 2021, the timing of the snowmelt across most of the PNW was near normal or later than usual.

July–September 2022

Temperature

In contrast to April–June, average temperatures for July–September were 3–5˚F above normal throughout most of the PNW. July–September ranked as the record warmest for each state and for the PNW region. Dewpoint temperatures in July and August were above normal throughout most of the PNW, particularly in western Washington, western Oregon, and throughout Idaho (*Figure 13*).

July–August 2022 Dewpoint Temperature Anomaly

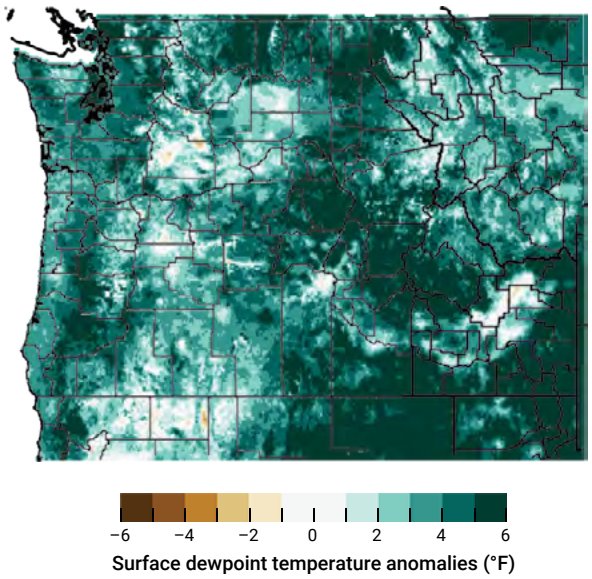


Figure 13: July–August 2022 surface dewpoint temperature anomalies from the PRISM provisional monthly climate dataset. Anomalies are relative to 1991–2020.

The higher humidity than usual in those locations reduced evaporative demand.

Precipitation

Summers in the PNW usually are dry. This was especially the case during the past water year with below normal July–September precipitation for most of the region, particularly in western Washington and northwest Oregon, where less than 5%

JULY–SEPTEMBER 2022 STATISTICS*

RECORD warmest; +3.7°F

9th driest (tied with 1934); –0.83", 57% of normal

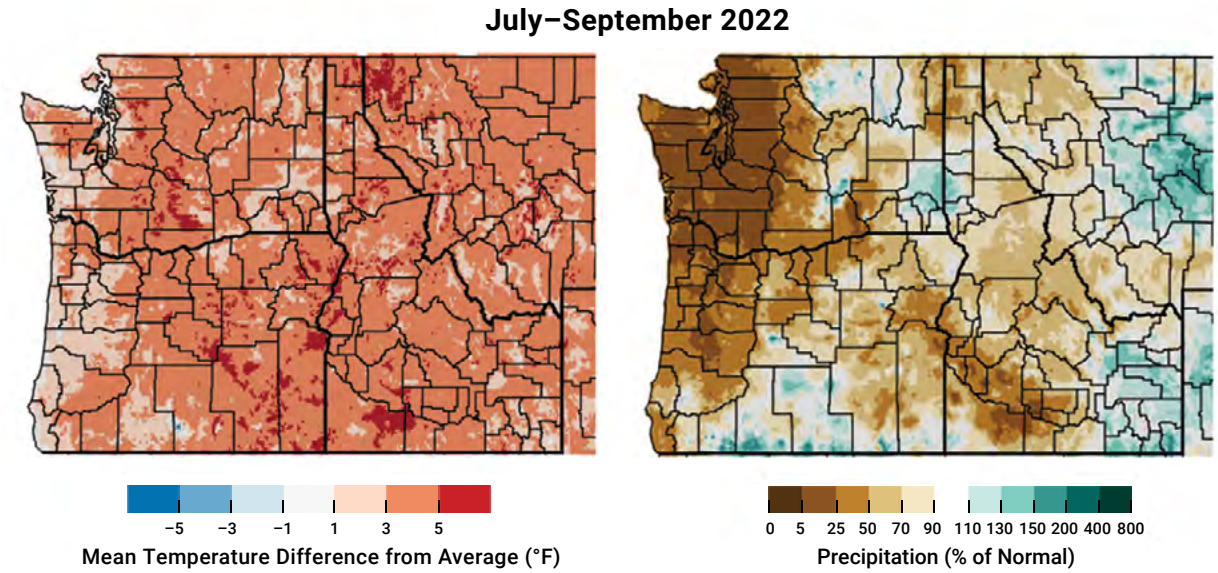
RECORD warmest; +3.5°F

2nd driest; –2.20", 36% of normal

RECORD warmest; +3.8°F

31st driest; –0.56", 78% of normal

*Anomalies relative to 1991–2020 normal; records since 1895. Source: NOAA NCEI 2022



of normal precipitation fell (*Figure 14*). The relatively high humidity reduced evaporative demand and helped to offset the extreme summer dryness to some extent. Some locations in north central Washington, southeast Washington, south central Oregon, and southeast Idaho received above normal precipitation, in part as a result of summer monsoonal moisture. Still, statewide July–September precipitation was among the lowest on record, with Washington and Oregon ranking as 2nd and 9th driest, respectively.

Figure 14: July–September 2022 average temperature departures and precipitation percent of normal. The normal period is 1991–2020. Source: gridMET data through *Climate Engine*.

Multi-year drought

The weather and seasonal climate conditions for water year 2022 are reviewed above, but there are longer-term precipitation deficits across much of the PNW from the *2020* and *2021 water years*. The current drought cycle in much of the PNW began in fall 2019, at the start of the 2020 water year. Eighty-two percent of the PNW experienced a precipitation deficit over the last three water years (*Figure 15*). During this period, 5% of the PNW was short the equivalent of one full year of normal precipitation and 18% was short 80%. The greatest precipitation deficits were in central Washington, central Oregon, parts of southern Idaho, and southwest Oregon. These precipitation deficits are a major factor in the region's drought severity and persistence. Only 13% of the PNW experienced a precipitation surplus over the last three water years. These surpluses were mostly in western Washington and northeast Oregon, and the amounts were mostly less than 40% of the annual average.

The 36-month Standardized Precipitation Evapotranspiration Index (SPEI) ending September 2022 indicated drought throughout the PNW, with values less than –2.0 east of the Cascade Mountains in Oregon and Washington and in isolated locations in Idaho (*Figure 16*). The SPEI has both a precipitation and temperature component; indices less than –1.0 typically signify the beginning of drought, and drought severity increases as the index becomes more negative. The severity of long-term drought decreased during the 2022 water year, as measured by the SPEI, in western Washington, most of western Oregon, and southeastern Idaho. Long-term dryness persisted elsewhere in the PNW, and all short-term precipitation anomalies should be viewed through the lens of these long-term precipitation deficits.

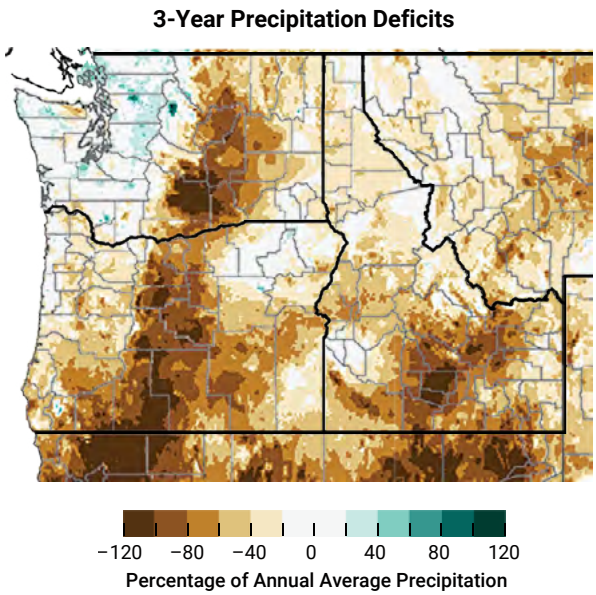


Figure 15: Precipitation deficit for the 3-year period from October 2019 – September 2022 as a percentage of annual average precipitation from the PRISM climate dataset. Values of –100% are equivalent to one complete year's worth of missing precipitation, values of 0% correspond to average precipitation over the 3-year period, and values of 100% indicate one full year's worth of surplus precipitation. The annual average precipitation values use 1991–2020 PRISM climatology.

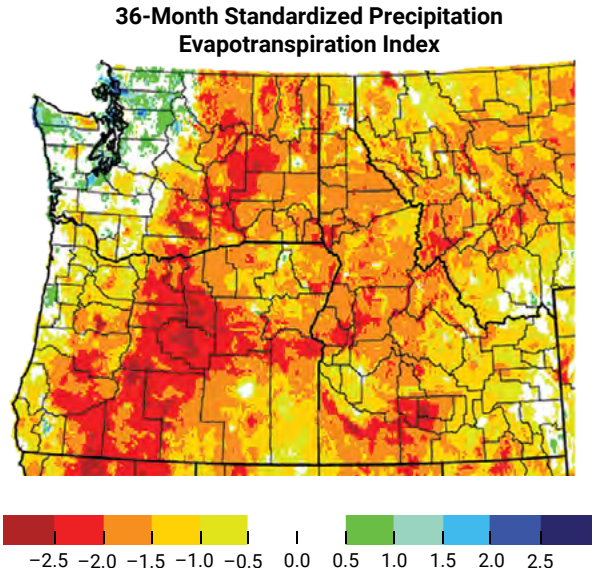


Figure 16: Three-year (36-month) Standardized Precipitation Evapotranspiration Index (SPEI) for the period ending September 30, 2022. Source: *West-Wide Drought Tracker*, using provisional PRISM data.

Two Contrasting Springs: Boise Basin, Idaho Recovery

Drought continued from 2021 through 2022 in most of southern Idaho, but the Boise basin was an exception. Snowpack in both years was below median—88% of median peak in 2021 and 71% of median peak in 2022—but similar to other areas of the PNW, the spring climates were drastically different between the two years.

In 2021, Idaho experienced an exceptional spring drought with precipitation ranking as the lowest since 1924. April–June Boise basin precipitation was 40% of normal and average temperatures in Boise County, representing the upper portion of the Boise basin, were 3.2°F above normal. These warm and dry conditions resulted in extremely low runoff. April–September runoff was estimated at 51% of normal, or 744,911 acre-feet (ac-ft). The Boise Reservoir system started with 454,000 ac-ft of carryover at the beginning of the 2021 water year and ended with 325,000 ac-ft of carryover.

In 2022, despite an even lower snowpack that peaked at 71% of the median, April–June was extremely cool (3.5°F below normal in Boise County) and wet (153% of normal for the Boise basin). April–September runoff was 73% of normal, or 1,070,816 ac-ft. The cool and wet conditions reduced agricultural demand and also delayed runoff long enough for the reservoir system to fill. Carryover at the end of the season was substantially above normal at 485,000 ac-ft. The recovery from drought and addition of 160,000 ac-ft to the reservoir system despite 71% of median snowpack was very unusual.

The comparison of 2021 and 2022 runoff in the Boise basin underscores the importance of spring conditions, as emphasized in the *2021 Water Year Impacts Assessment*. Runoff in 2022 was relatively high when compared to a handful of years with comparable low April 1 SWE ranging between 50–80% of median (*Figure 17*). Conversely, runoff in 2021 was much lower compared to another handful of years with comparable April 1 SWE (*Figure 17*).

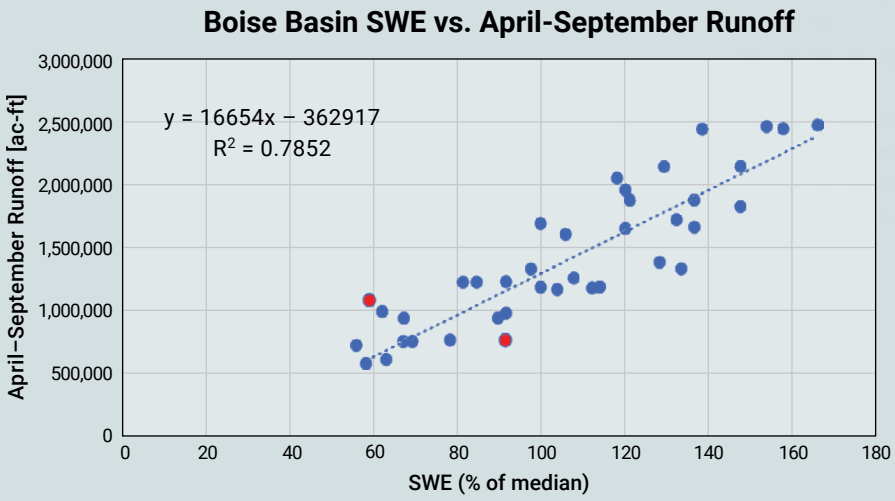


Figure 17: A comparison of April 1 SWE, measured as the percentage of median April–September runoff, in the Boise River basin. The two red dots represent 2021 (April 1 SWE: 93% of median; runoff: 744,911 ac-ft) and 2022 (April 1 SWE: 61% of median; runoff: 1,070,816 ac-ft). Source: *NRCS Interactive Map*.

4 WATER YEAR IMPACTS

Here we summarize impacts on multiple sectors in Oregon, Idaho, and Washington on the basis of three sources:

- The national Condition Monitoring Observer Reports (CMOR)
- The Annual Pacific Northwest Water Year Impacts Survey
- Presentations and discussions from the 2022 water year meetings

Information on drought and other climate conditions is critical to connect those conditions to their effects on local resources, people, and economies.

CMOR, established in 2018, allows members of the public to submit drought impact reports for their specific location at any time of year. The Annual Pacific Northwest Water Year Impacts Survey is distributed at the end of the water year to natural resource managers, agency staff, and all registrants for the water year meetings. Information from presentations and discussions at the 2022 water year meetings detailed here highlights particularly compelling climate impacts and responses within the region. Neither these sources nor the impacts presented in this assessment are exhaustive.

2022 Condition Monitoring Observer Reports

The Condition Monitoring Observer Reports on Drought (CMOR), provided by the National Drought Mitigation Center (NDMC) and the National Integrated Drought Information System (NIDIS), collects local observations of drought impacts to aid in drought monitoring and research. Observations inform the U.S. Drought Monitor and agencies that make drought-related decisions. For the 2022 water year, observers submitted 35 reports, mostly from Oregon, with a few from Washington and Idaho. Reports depict two themes:

Persistence of dry conditions in fall 2021: Observations of dry conditions from counties in eastern and western Washington indicated that the drought persisted from the 2021 water year into October of the 2022 water year. Observers described dry soils and a lack of water despite some initial fall rain. Local observations from fall 2021 also described tree and plant damage related to heat and moisture stress in northwestern counties in Oregon.

Extended dry period in winter 2022 that wasn't completely relieved by the wet and cool spring: Early winter 2022 was dry in much of Oregon, negatively affecting agriculture. Observations from counties in southern and eastern Oregon described dry conditions in January through March that reduced the growth of forage and other plants. Observations indicated that dry soils led to loss of topsoil, production of dust, poor quality and reduced production of hay, and reduced emergence and growth of native plants. Conditions were described as severely dry throughout much of the region.

Precipitation in May and June brought some relief to Oregon but was insufficient for crops to recover from the dry winter. Observers in southern and eastern Oregon who reported a dry winter also reported some relief from rain in spring and early summer, but indicated that the relief was short-lived and insufficient for recovery of some forage and other vegetation.

Wheat field in eastern Washington. Credit: Edmund Lowe

Yakima River, WA.
Credit: Ian Dewar

Annual Pacific Northwest Water Year Impacts Survey

The PNW Water Year Impacts Survey collects information on impacts of abnormally dry or wet conditions on the drinking water, agriculture, forestry, fisheries, hydropower, recreation, and stormwater sectors. The survey is distributed at the end of the water year. Characterization of abnormally dry or wet conditions is made by the survey respondents. Respondents may select impacts from a list or specify other impacts.

We distributed the 2022 water year survey in October 2022 via listservs of NIDIS, Office of the Washington State Climatologist (OWSC), Climate Impacts Group (CIG), PNW Tribal Climate Change Network, and Agriculture Climate Network; sent the survey to all registrants of the Oregon/Washington Water Year Meeting and the Idaho Water Year Meeting; and featured it in the OWSC monthly newsletter and the USDA Northwest Climate Hub newsletter. Sixty-eight people responded; 64% were employees of local, state, and federal agencies, and others were affiliated with Tribes, non-profit organizations, universities, irrigation districts, and power and water utilities. We include responses from agencies, resource managers, and producers, and in some cases responses may describe the same impacts. Impacts of abnormally wet conditions during the 2022 water year were reported by most sectors. By contrast, no impacts from abnormally wet conditions during the 2021 water year were reported.

SECTOR-SPECIFIC WATER YEAR IMPACTS

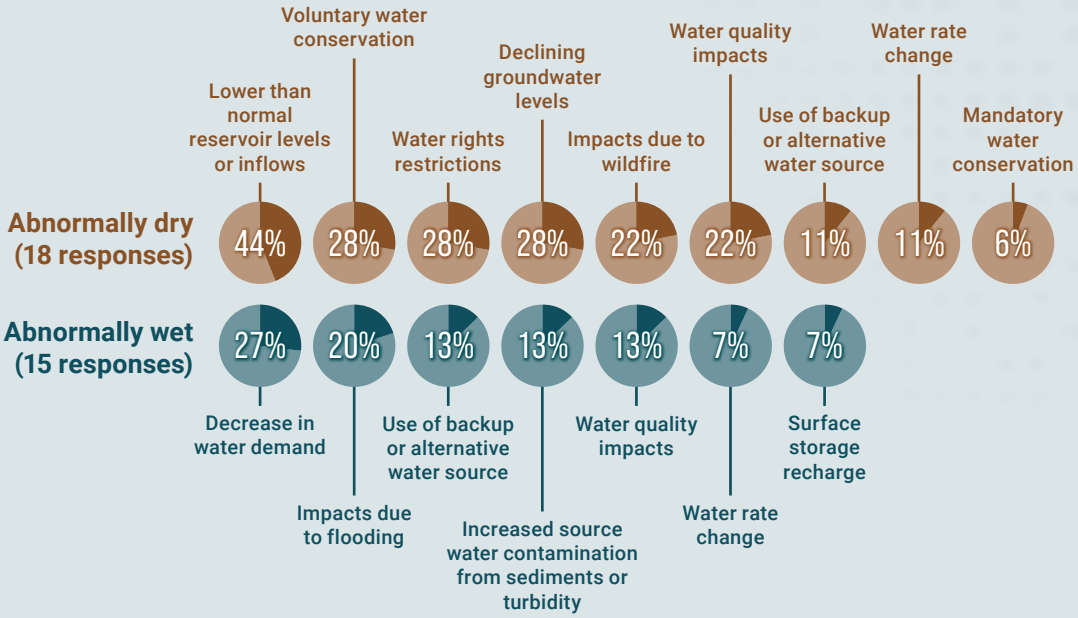
Water tower in Quincy, WA, April 7, 2022. Credit: Ian Dewar

Drinking water

Impacts on the drinking water sector were reported from watersheds across the Pacific Northwest, but primarily from counties and watersheds in southern Oregon. Of the 22 respondents, 18 (82%) reported impacts due to abnormally dry conditions and 15 (68%) reported impacts due to abnormally wet conditions. Lower than normal reservoir levels was the most common impact of dry conditions.

During the Oregon/Washington Water Year Meeting, participants described a greater need to truck water to small, rural communities, particularly in Oregon, and to use alternative water sources in general. Flood damage and lower water demand were the most commonly reported impacts of abnormally wet conditions.

DRINKING WATER IMPACTS SURVEY



2022 Effects of Anomalous Weather and Climate on Tree Fruit in Washington

Washington is the largest producer of apples and cherries in the United States. According to Washington State University's tree fruit specialist, Bernardita Sallato, both of those crops were adversely impacted by spring cold, early summer rain, and late summer heat during the 2022 water year.

The colder than normal temperatures beginning in April, along with strong winds, frost, and snow in mid-April, were especially impactful for cherries. Cherry trees bloom earlier than apple and pear trees, and are therefore more susceptible to frost damage. By April 12, cherry growers in Washington were already reporting about a 10% crop loss. Apples were also affected by frost damage (*Figure 18*). In addition to these direct impacts, the colder than usual spring, which coincided with bloom, reduced pollination and ultimately fruit yields. Washington's fruit trees rely heavily on honeybees as pollinators, and honeybees are less active in temperatures below 55°F, rain, snow, or wind.

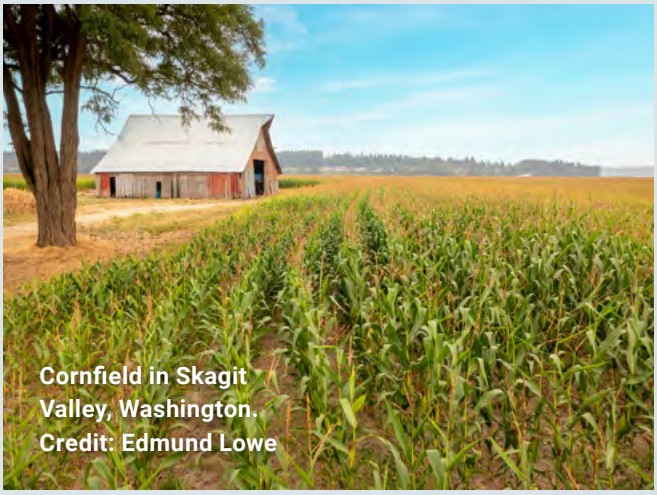
Precipitation in June and early July caused cherries to crack right before harvest. Overall, Washington lost about 43% of its cherry crop in 2022. Because of these losses, the cherries that were harvested sold for about double their usual price. Although these high prices did not fully compensate for the loss of production, high prices were a silver lining for some growers in a year that was ultimately poor for cherry production.

Summer heat also affected both apples and cherries. Although the warmer than normal temperatures began after the cherry harvest, they affected buds for next year's crop and tree growth. Summer heat caused sunburn on apples and reduced fruit quality. At the time of this writing, total apple losses are unknown, but early indications are that the spring frost damage, summer sunburn, and effects of heat on fruit quality and storability caused a 50% loss in the Washington apple crop.

Figure 18. Apples with defects associated with 2022 weather conditions. Apples a. deformed due to reduced pollination, b. with calix end cracking due to early frost, and c. with sunburn immediately before harvest. Photo credit: B. Sallato.

Agriculture

Of the 23 respondents, 21 (91%) reported impacts due to abnormally dry conditions and 9 (39%) reported impacts due to abnormally wet conditions. Similar to reported impacts on drinking water, impacts on agriculture were reported across the PNW and especially in southeast Oregon. Most respondents that noted impacts from abnormally dry conditions reported reduced surface water availability, water right restrictions, or less surface water and streamflow available.

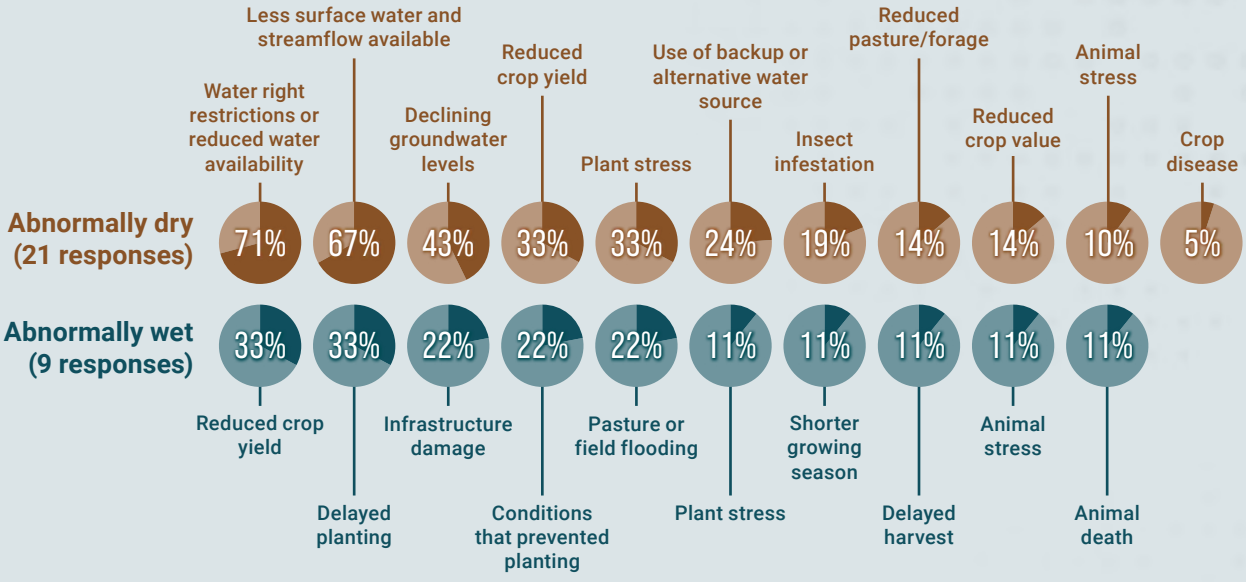


Cornfield in Skagit Valley, Washington. Credit: Edmund Lowe

During the Oregon/Washington Water Year Meeting, participants described water shortages, which primarily affected irrigation districts and irrigation reservoirs, and greater conflict over water for agriculture, municipal uses, and fisheries. Water shortages caused water right curtailments and loss of agriculture production, and were regarded by some in the agriculture sector as isolated events rather than a trend. Drinking water systems that are small or dependent on shallow wells were affected by multi-year water shortages and gradual reductions in ground water. Lack of water also affected water quality.

Delayed planting and reduced crop yield were the most commonly reported impacts of abnormally wet conditions.

AGRICULTURE IMPACTS SURVEY



Snake River, Idaho. Credit: Purelight Photos

Idaho Fall Water Supply Meeting

In response to severely depleted reservoir levels at the start of spring 2022, snowmelt beginning in March, and low snowpack on April 1, the governor of Idaho took the extraordinary measure of declaring drought for all counties south of the Salmon River on April 29. Were it not for the extremely cool April and May in southern Idaho, 2022 could have been one of the worst droughts on record. At the Idaho Water Supply Meeting, NRCS Snow Survey staff indicated that they had not previously seen snowmelt initiate, then stop due to cold temperatures and rebuild, as occurred from March through May.

Total 2022 irrigation year (November 1, 2021 – October 31, 2022) water supply for the Upper Snake River Basin (*Figure 19*) was among the lowest since the early 2000s drought. Canal companies and irrigation districts that rely on senior natural flow rights generally fared better than those who rely on storage contracts that are filled by more junior water rights. April–June precipitation in the mountains of central Idaho, at the headwaters of the Boise and Payette basins, was in the top 30th percentile. This precipitation and cooler than normal temperatures allowed these basins to recover from drought and end the year with above normal reservoir carryover. The rest of southern Idaho, which received near-normal April–June precipitation, also benefited from the unusually cool weather, although water shortages were substantial. Storage space under Palisades Reservoir water rights only partially filled in 2022 and Palisades is the second largest reservoir in the Upper Snake Basin. Natural flow (the amount of water that can be delivered to water right holders) fell steadily from 90% to 74% of normal through the irrigation year (*Figure 20*).

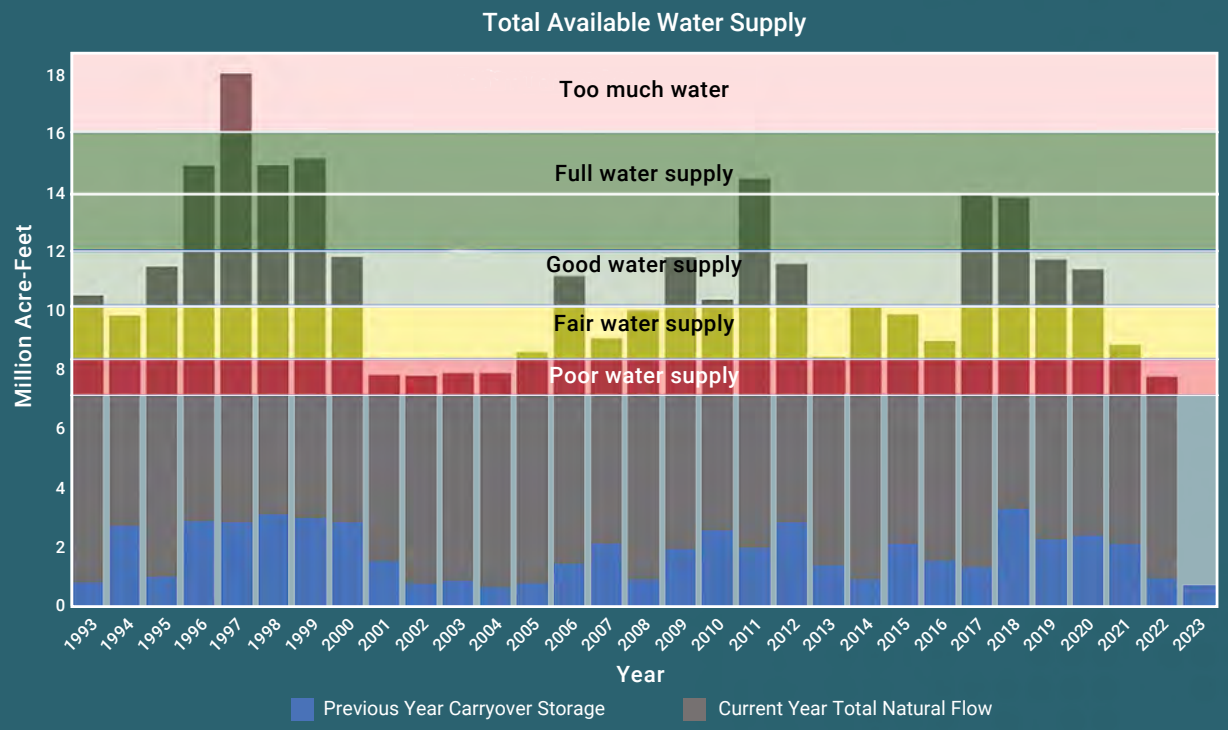


Figure 19: Total water supply in the Upper Snake River Basin, Idaho, for each irrigation year (November 1 to October 31). The blue bars are the total reservoir storage (Jackson Lake, Palisades, Henry Lake, Island Park, Grassy Lake, Ririe, American Falls, Lake Walcott, and Lake Milner reservoirs) at the start of each irrigation year and the gray bars are the estimates of natural flow on November 1 through October 31, ending on the year listed on the x-axis. The data for 2022 are preliminary. Source: Tony Olenichak, Water District 1 Watermaster.

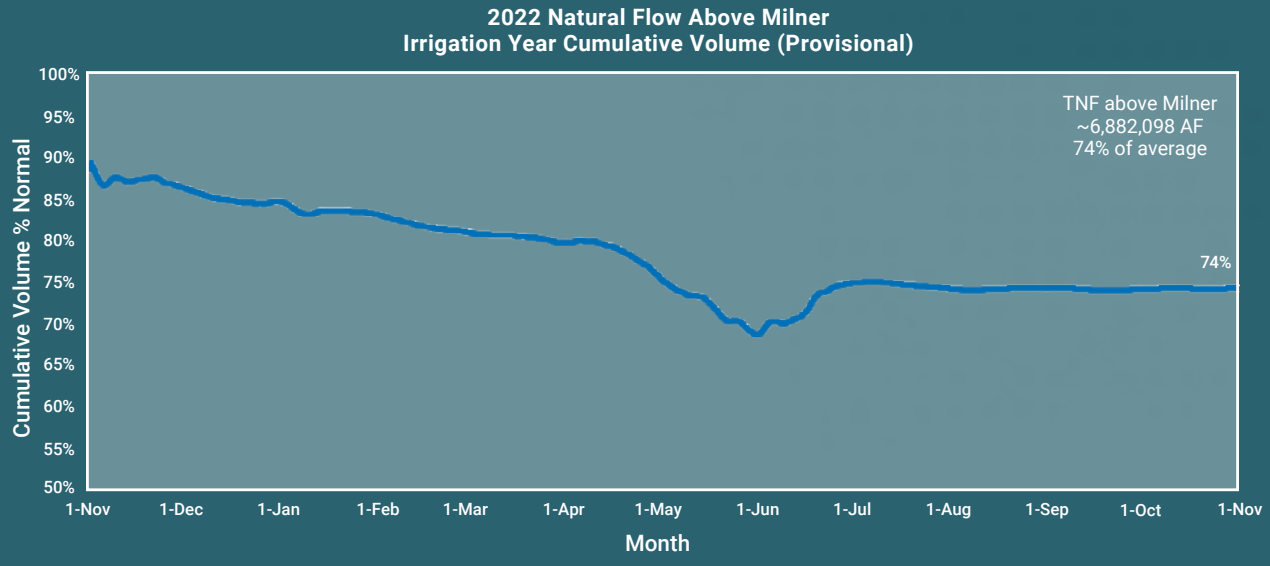


Figure 20: Natural flow of the Upper Snake River Basin for the 2022 irrigation year (November 1, 2021 to October 31, 2022) as a percent of normal. Source: Jeremy Dalling, USBR.

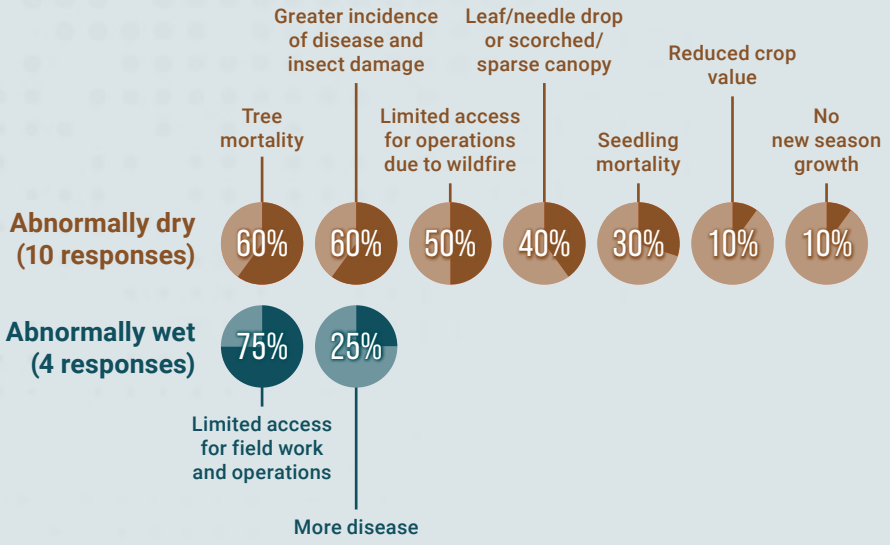
Forestry

Ten survey respondents reported impacts on forestry, all of which reported effects of abnormally dry conditions, and four respondents (40%) also reported effects of abnormally wet conditions. Impacts were reported across the PNW, especially the Umpqua basin. The most commonly reported impacts of dry conditions were tree mortality, insect and disease damage, loss of trees, and operational impacts due to wildfire. The most commonly reported impacts of wet conditions were limited access for fieldwork and tree disease.

Nooksack River along Mt. Baker Highway, Washington, with maple and alder trees showing fall colors. Credit: Edmund Lowe

During the Oregon/Washington Water Year Meeting, participants commented that the wet spring delayed the onset of the wildfire season, but effects of long-term drought on trees persisted and the wildfire season continued later than normal. By the end of the water year, wildfire risk was high across the region despite the wet spring, and the fire season extended into fall and water year 2023. Western Washington had some notable wildfires at the start of water year 2023, including one that closed a major transportation route and was close to critical watersheds for drinking water. According to the Bureau of Land Management Idaho Wildfire Information statistics, almost 500,000 acres burned in Idaho in the 2022 calendar year compared to an average of 370,000 acres per year for 2009–2018. Water Year Meeting participants also noted that large swings between wet and dry conditions have made it more difficult to use prescribed fires to reintroduce fire to particular landscapes.

FORESTRY IMPACTS SURVEY



Central and Southern Oregon 2022 Fir Tree Mortality

According to annual aerial survey data collected by the U.S. Forest Service, Oregon Department of Forestry, and Washington State Department of Natural Resources, there was significant fir tree mortality in 2022. High mortality of fir trees was surveyed across 1.1 million acres in Oregon and 66,000 acres in Washington (*Figure 21*). The ultimate cause of the fir tree mortality is believed to be drought, which weakens the trees and makes them more susceptible to insects and disease. Central and southern Oregon, where drought has occurred for multiple years, were particularly hit hard, with upwards of 50% mortality in some areas within the region. The area of fir tree mortality in Oregon ranks as the highest since the surveys began in 1952. This information was provided by Danny Depinte, the Pacific Northwest Region's Aerial Survey Program Manager, at the Oregon/Washington Water Year meeting; final numbers are now available at the *U.S. Forest Service website*. The U.S. Forest Service Northern Region and Intermountain Region covers Idaho, and 2022 aerial surveys by those groups identified approximately 30,000 acres of low severity fir tree mortality.

Figure 21: Fir mortality in the Fremont-Winema National Forests observed during the 2022 forest health aerial survey. Photo Credit: Daniel DePinte.

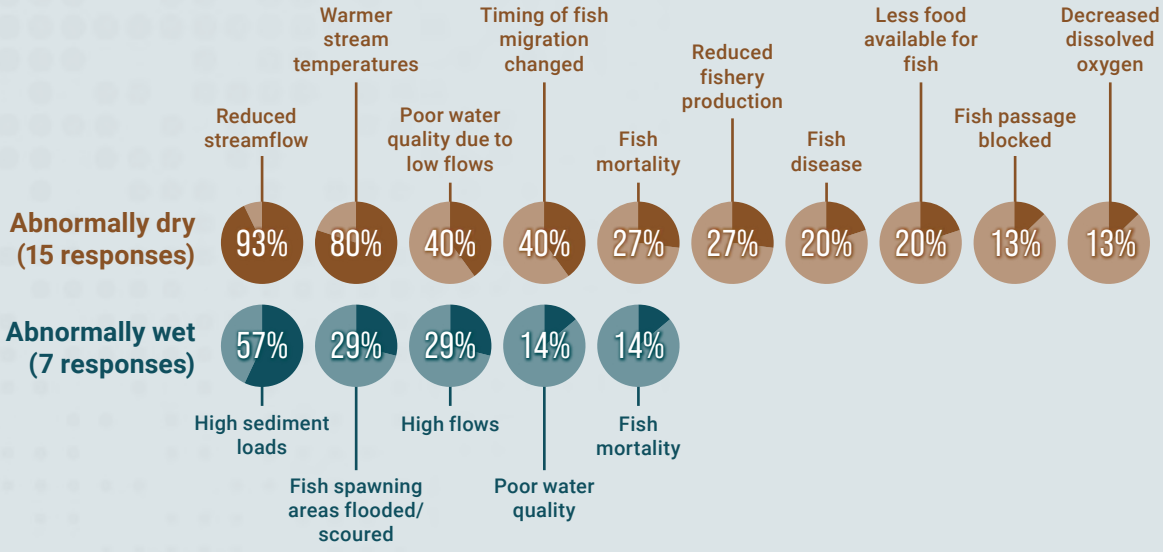
Fisheries

Fifteen survey respondents reported fisheries impacts; all reported impacts due to abnormally dry conditions, and seven (47%) also reported impacts due to abnormally wet conditions. Most impacts were reported for the Lemhi, Big Wood, Salmon, and Boise rivers in Idaho, the Willamette River in Oregon, and the Nooksack River in Washington. Almost all respondents reported reduced streamflows and warmer temperatures.

Sockeye salmon spawn in a shallow stream. Credit: Stefan Shug

During the Oregon/Washington Water Year Meeting, participants described that many fisheries across the region were greatly affected by low streamflows. Fisheries on the Olympic Peninsula were impacted at the end of the water year. Fish mortality in Whatcom County, Washington, was high due to low streamflows, warm water temperatures, and associated increases in diseases.

FISHERIES IMPACTS SURVEY



2022 Stressors on Chinook Salmon in the Nooksack Basin

The extreme precipitation swings during the 2022 water year affected spring run Chinook salmon in the Nooksack Basin, as reported by the Nooksack Indian Tribe's geomorphologist, Michael Maudlin, at the Oregon/Washington Water Year Meeting. The full extent of the impacts has not yet been determined, and it may be years until it is completely known due to the time it takes for the spawning and juvenile fish present in the basin in 2022 to return as adults.

The flooding on the Nooksack River in November 2021, estimated to have a return interval of 50 to 100 years or between a 1 and 2% chance of occurring in any given year (Gillett et al. 2022; *USGS StreamStats* using Nooksack at Ferndale: 12213100), caused significant and costly impacts to humans, including infrastructure damage. Flooding coincided with the spring run Chinook's incubation and rearing life stages, affecting salmon at a vulnerable time. There are primarily three ways Chinook could be affected by a flood of this magnitude during fall: 1) the scouring of eggs causing loss of incubating salmon, 2) loss of juveniles that were flushed down the river and unable to survive in saltwater, and 3) stranding of fish in floodplain areas from which they were unable to swim to the main river. Human actions to manage and repair infrastructure damage from floods can also negatively impact fish. For example, temporary roads built over rivers may not allow for fish passage and bank production projects can reduce the quality of habitat for fish. Although sediment removal can reduce future flooding in some cases, it can also negatively impact spawning habitat. Based on the low number of out-migrating juvenile salmon estimated in spring 2022, salmon co-managers believe that the flood had a considerable impact on the spring run Chinook population, but won't know the complete extent of the impacts until adults start returning to the watershed in three or four years.

In addition, preliminary numbers for 2022 indicate that hundreds of spring run Chinook died pre-spawning due to low flow conditions in summer. Summer streamflows are relevant to all stages of the spring run Chinook life cycle, and spawning in particular can be negatively impacted because the fish come into the Nooksack basin during that time of year. Lower flows allow the water temperatures to warm more quickly, and during late summer 2022, there were several instances of water temperatures above the lethal migration temperature (21°C). For example, the South Fork of the Nooksack exceeded that threshold in late July and approached it again in mid-August (*Figure 22*). Not only can the warm temperatures kill the fish, but warmer temperatures, even those that are below the lethal migration threshold, allow disease to spread.

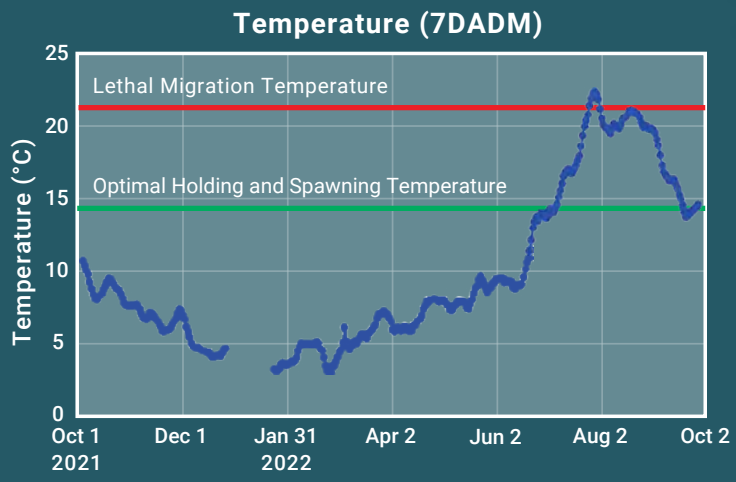


Figure 22: Water year 2022 7-day average maximum water temperature from the South Fork of the Nooksack River at Saxon Bridge, Washington (U.S. Geological Survey gauge 12210000). The lethal migration temperature (21°C) and optimal holding and spawning temperature (<14.5°C) for Chinook are plotted for reference. Source: Michael Maudlin, Nooksack Indian Tribe.

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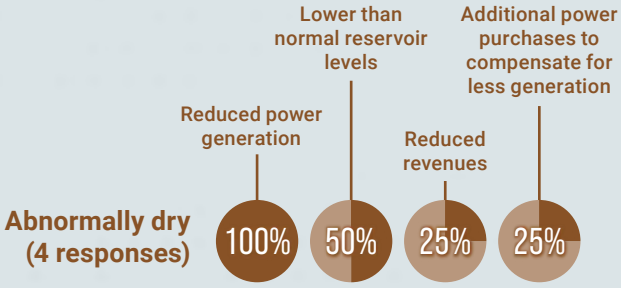
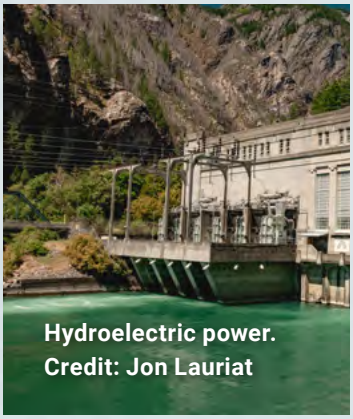
HYDROPOWER IMPACTS SURVEY




Hydroelectric power.
Credit: Jon Lauriat

Mount Rainier.
Credit: Bill Vanan

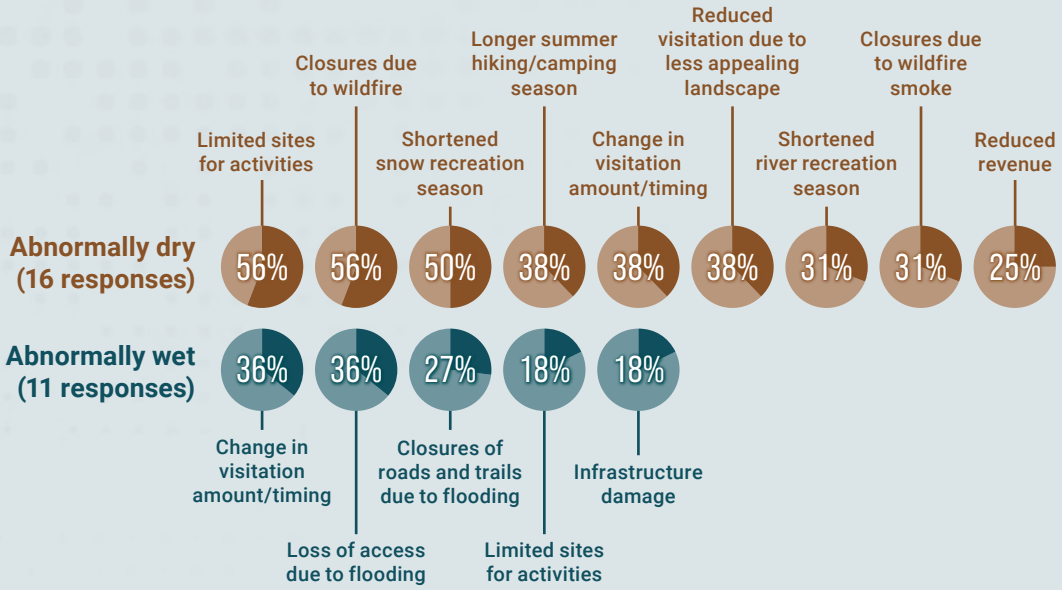
Hydropower

Four respondents reported impacts on hydropower; all reported impacts due to abnormally dry conditions, and one also reported impacts due to abnormally wet conditions. The primary impacts on hydropower associated with abnormally dry conditions were reduced hydropower generation and low reservoir levels. Impacts were reported for southern Idaho and eastern Washington.

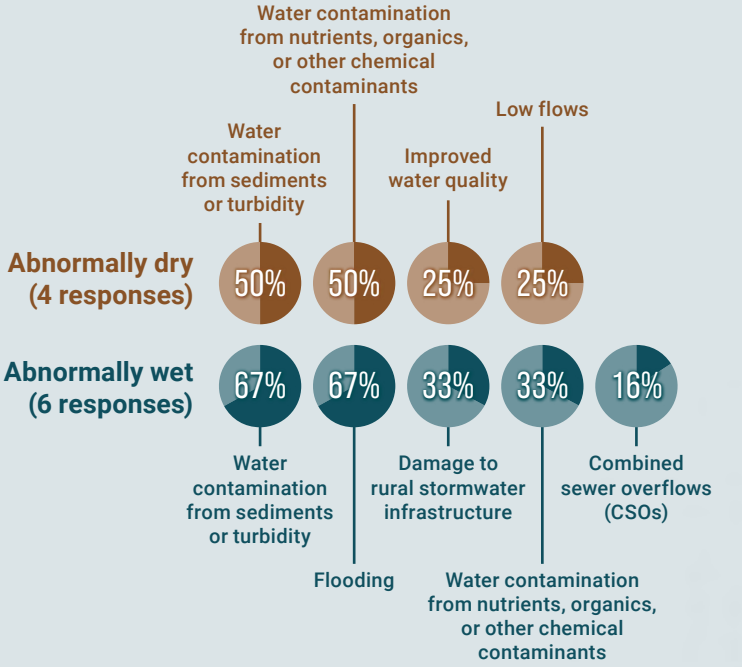
Recreation

Seventeen respondents reported impacts on recreation. Of these, sixteen (94%) reported impacts associated with abnormally dry conditions and 11 (64%) reported impacts associated with abnormally wet conditions. Impacts on recreation were reported across the PNW, with the Mt. Hood area and Deschutes basin highlighted.

RECREATION IMPACTS SURVEY



STORMWATER IMPACTS SURVEY



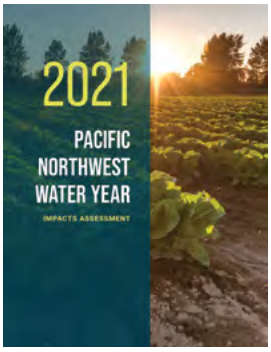
Stormwater

Seven respondents reported impacts on stormwater. Of these, four (57%) reported impacts associated with abnormally dry conditions and six (87%) reported impacts associated with abnormally wet conditions. Stormwater was the only sector for which a greater number of respondents reported impacts of wet rather than of dry conditions. The primary reported impact of both wet and dry conditions was water contamination. Impacts associated with wet conditions were reported for northwest Washington and for specific areas in Idaho, including Canyon County and the Clearwater, Grande Ronde and Lower Snake basins.

Flooded road in Snoqualmie Valley, Washington. Credit: Ian Dewar

New 2021 Water Year Reports

One advantage of our PNW Water Year Assessments is that they are available shortly after the end of the water year. Accordingly, much of the information included in the assessments is preliminary. Several summaries and reports on the 2021 water year (October 1, 2020 – September 30, 2021) or the 2021 and 2022 calendar years have been made available since our *2021 PNW Water Year Impacts Assessment* was released in February 2022.



***2021 Pacific Northwest Water Year Impacts Assessment*. Credit: NOAA NIDIS**

The *2021–2022 California Current Ecosystem Status Report*, released in March 2022, focused on the marine ecosystem along the west coast with the goal of informing fisheries management (*NOAA CCIEA 2022*). A brief summary can be found *here*, and a report focused on the 2022 water year will be released in spring 2023. A more localized marine perspective can be found in the annual *Puget Sound Marine Waters Report*, which summarizes the oceanic, atmospheric, and terrestrial influences on the Puget Sound for the calendar year (*PSEMP 2020*; *PSEMP 2021*).

Many scientific studies of the PNW June 2021 heat wave have been released since our last assessment. Consistent with the 2021 water year assessment, they show that while a warming climate was a contributor to this extreme heat event, the specific atmospheric pattern was the main driver of the heat wave. McKinnon and Simpson (2022), for example, concluded that the probability of an event of this magnitude is very low in climate model simulations and that it likely occurred by chance, or a "bad deal of the cards." Schumacher et al. (2022) further teased apart the influences and found that dry soils (i.e., pre-existing drought conditions) played a role in the extreme temperatures over the PNW during the 2021 heat wave, although the specific weather pattern was the greatest factor. They estimated that the atmospheric circulation explained 82% of the temperature anomalies over the warmest 5-day period, low soil moisture 10%, and ocean anomalies 1%, and gave a conservative estimate of the contribution of background warming from climate change of 6%. While the climate change contribution to the magnitude of the extreme temperatures was relatively small, its contribution to the likelihood of the event occurring was much larger, as it is estimated that the event was 150 times more likely to occur in our warming climate (Philip et al. 2022).

Regardless of the mechanisms, the event had wide-ranging consequences, and a number of new studies quantified those impacts. For example, Raymond et al. (2022) surveyed heat wave damage to PNW intertidal shellfish and found widespread negative outcomes that may continue to impact ecosystems and fisheries for many years to come. Heat damage to vegetation and tree seedling mortality were mentioned in the *2021 PNW Water Year Impacts Assessment*, and we now have estimates of the area of heat scorch observed through aerial surveys (by U.S. Forest Service, Oregon Department of Forestry, and Washington Department of Natural Resources) in western Oregon and western Washington. The June 2021 heat wave caused distinctly scorched foliage on the south and west sides of trees, and directly damaged tree crowns. The surveys mapped a total of 229,000 acres of heat damage across western Washington and western Oregon. Because most of southwest Oregon was obscured by smoke during the aerial surveys, that area was not examined (*WA DNR, 2022*; *ODF and USFS, 2022*).

5 STATE LEVEL & SECTOR-SPECIFIC RESPONSES

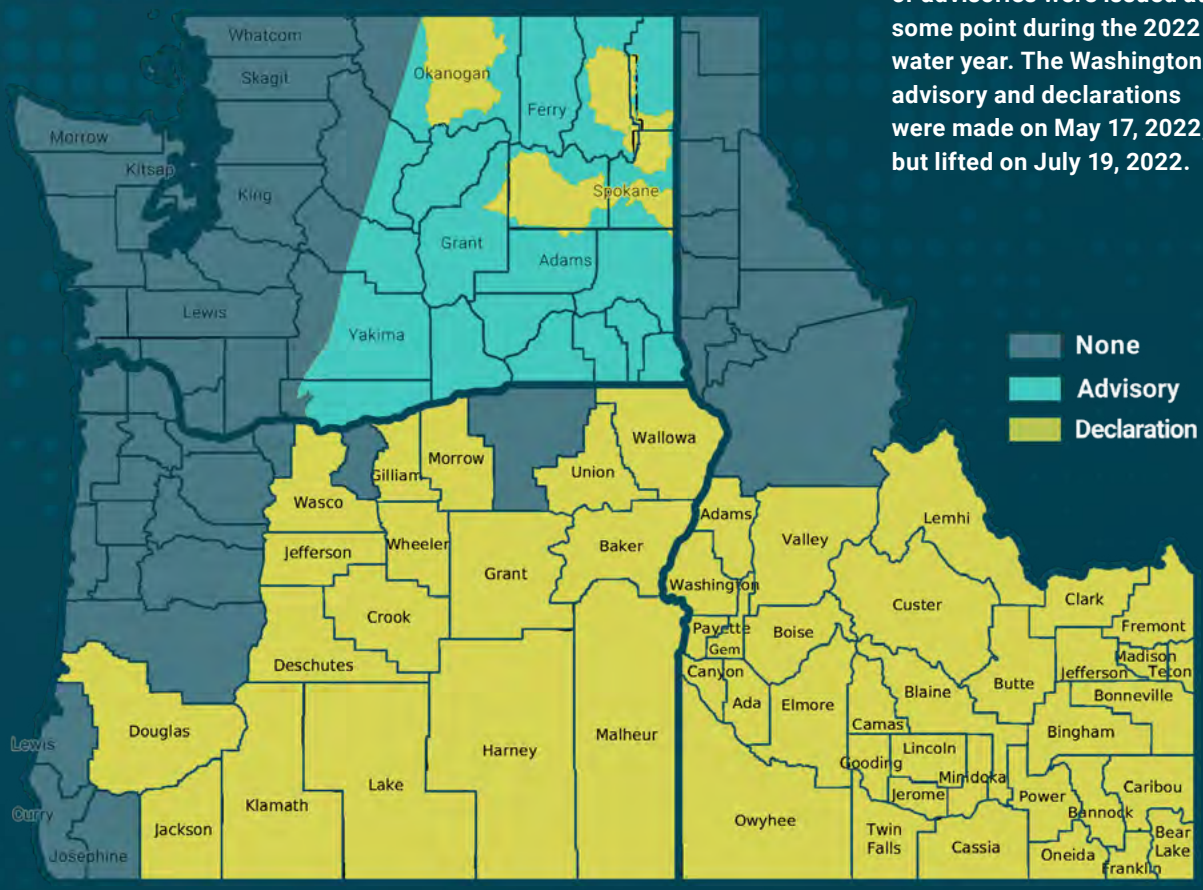


Figure 23: Counties or watersheds in the PNW for which drought declarations or advisories were issued at some point during the 2022 water year. The Washington advisory and declarations were made on May 17, 2022, but lifted on July 19, 2022.

State Responses

In the PNW, state drought declarations are used to facilitate the temporary transfer of water rights and offer short-term solutions to water supply challenges. The declarations are primarily used by the agricultural sector, although Washington, for example, has used emergency drought funds for drinking water purposes. Legislation passed in 2020 in Washington now allows emergency drought funds to be used for projects that build long-term drought resiliency, not strictly for emergency projects.

Drought declarations (*Figure 23*) were issued at varying times of the year for each state. In Oregon, 18 counties received state drought declarations through executive orders signed by Governor Brown. The first drought-related executive order of the 2022 water year was issued for Curry County on November 17, 2021. Drought in Klamath County wasn't declared until March 4, 2022, and a majority of the declarations were made between March and mid-May. The final Oregon drought declaration, for Wasco County, was issued on June 7, 2022. In Idaho, Governor Little approved 34 county drought declarations, spanning all of southern Idaho below Idaho County, on April 29.

On May 17, 2022, the Washington State Department of Ecology, with Governor Inslee's approval, extended the drought declaration that was issued in 2021 for five watersheds in the northeastern portion of the state. The rest of eastern Washington was included in a Drought Advisory that was issued to promote early awareness of the possible development of drought conditions. As a result of the cool and wet spring, both the Drought Advisory and Drought Emergency were lifted on July 19.

Emergency proclamations were also made in response to the weather and climate conditions in both Oregon and Washington. In Oregon, a state of emergency was issued statewide on December 23, 2021, due to the forecast of heavy snow, extreme cold, and potential travel disruptions and power outages. On January 26, 2022, a state of emergency was declared for Clackamas, Clatsop, Columbia, Curry, Douglas, Lane, Lincoln, Multnomah, Polk, and Yamhill counties due to a winter storms with high winds, rain, flooding, landslides, power outages, and transportation infrastructure damage that began on December 30, 2021, and continued through January 10, 2022. The wet spring (May 21 through June 15) prompted the proclamation of a state of emergency for Crook, Jefferson, Umatilla, Union, Wallowa, and Wheeler counties on July 13, 2022. On July 25, twenty-five Oregon counties were included in a state of emergency due to heat. Five emergency conflagration acts were issued between August 2 and September 9, 2022, as a result of wildfires in Wasco, Josephine, Wallowa, and Lane counties. On August 27, a statewide state of emergency was issued given the threat of wildfires.

In western Washington, a state of emergency was declared on November 15, 2021 for 14 counties, and December 1 for one county, due to the heavy rain, wind, flooding, and landslides associated with the atmospheric rivers described in this assessment. On January 7, 2022, a statewide emergency was declared in response to the rain and snow that began on December 17, 2021, and caused hazardous driving conditions and road closures over the mountain passes. No weather-related proclamations were made during spring or summer.

Sector-Specific Changes in Operations

The Annual Pacific Northwest Water Year Impacts Survey asked respondents if they modified operations *in anticipation of* or *in response to* abnormally dry or wet conditions during the water year. More than half of the respondents in most sectors indicated that they changed operations in response to abnormally dry or wet conditions.

Survey responses suggested high operational flexibility during drought conditions. More respondents changed operations in response to dry conditions than wet. Seventy-four percent of respondents in drinking water, 65% of respondents in agriculture, and 67% of respondents in recreation indicated that they changed operations due to abnormally dry conditions. In general, a lower percentage of respondents in each sector changed operations in response to abnormally wet conditions. The exceptions were the recreation and stormwater sectors, in which 63% and 80% of respondents, respectively, changed operations.

Drinking water sector: Operational changes reported in response to abnormally dry conditions in the drinking water sector included water conservation, altered pumping regimes, and use of alternative water supplies, especially in the case of wells with insufficient water.

Agriculture sector: Operational changes reported in response to abnormally dry conditions in the agricultural sector included planting different crops, reductions in water use, and more supplemental pumping. No specific examples were given for operational changes due to wet conditions.

Recreation sector: All operational changes reported in response to abnormally dry conditions in the recreation sector were related to wildfire. Changes included reducing or restricting recreational activities and increasing staff and equipment to respond to wildfire. Operational changes reported in response to abnormally wet conditions in the recreation sector generally include delayed openings and reduced access due to the cold, wet spring.

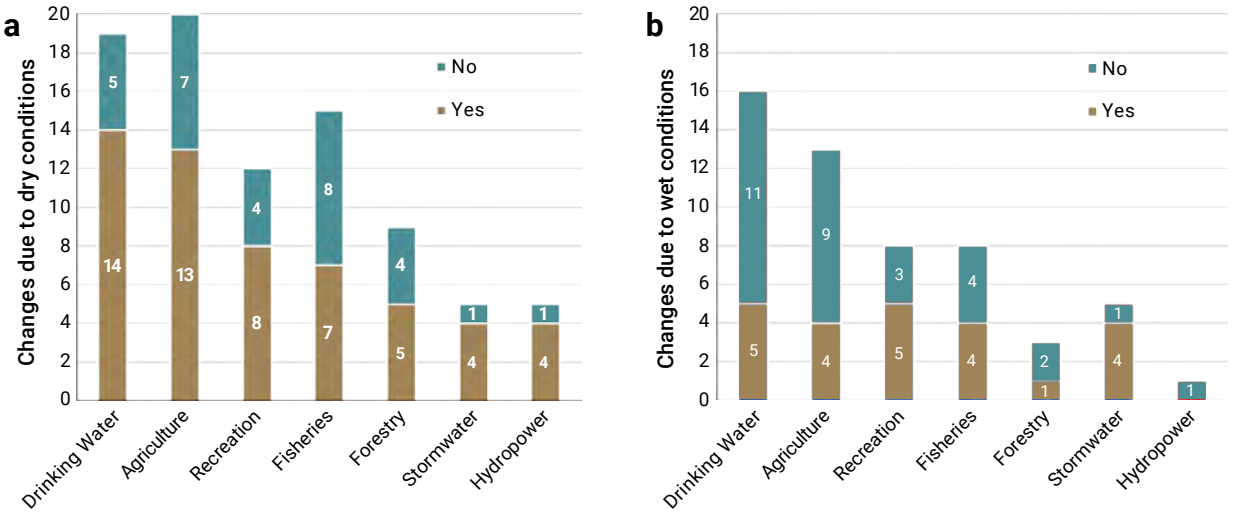


Figure 24: Annual PNW Water Year Impacts Survey responses to whether operations in multiple sectors were changed in response to unusually (*a*) dry or (*b*) wet conditions.

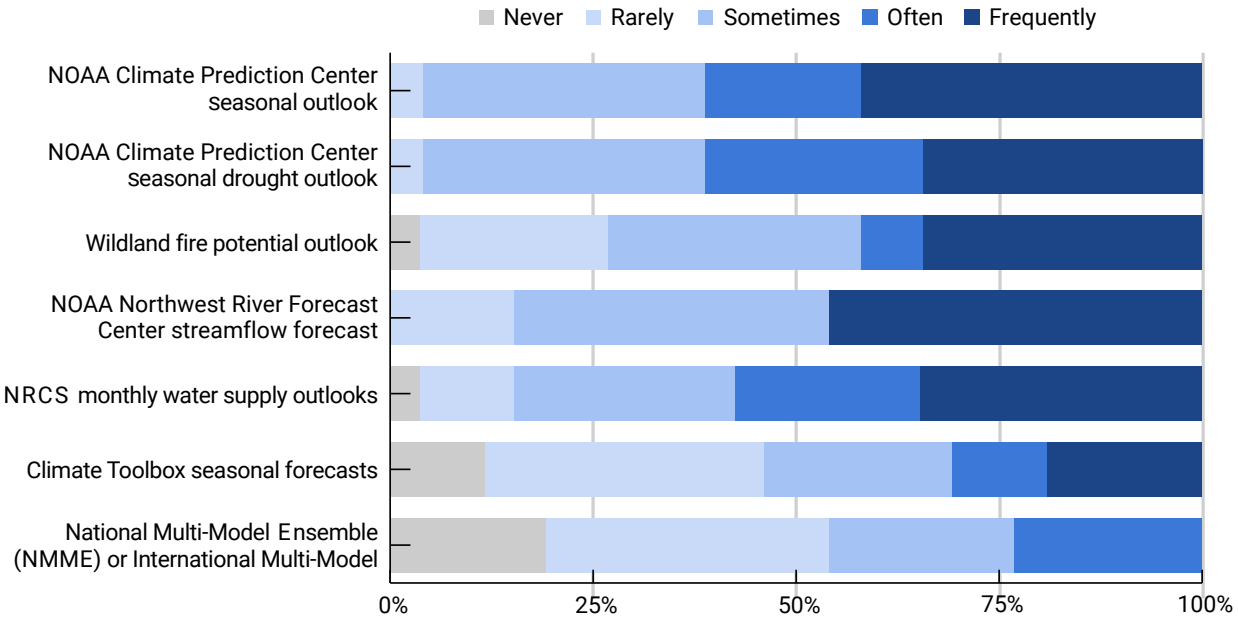


Figure 25. The Annual PNW Water Year Impacts Survey responses to the question, "During the water year, how often do you use these seasonal forecasts and outlooks?"

Changes in Operations Based on Forecasts and Outlooks

Most respondents of the Annual PNW Water Year Impacts Survey used seasonal outlooks or forecasts during the water year at least sometimes. Both the NOAA Climate Prediction Center seasonal outlook and drought outlook were used "often" or "frequently" by 60% of the survey respondents. Other respondents indicated that outlooks are too vague to be useful, and some indicated that they relied on recent historical data and past experience.

Survey respondents described some specific ways that they use seasonal forecasts and outlooks, with most responses in the following categories.

- Optimize resources such as water, energy, and visitation to recreation sites.
- Communications, guidance, alerts, and other forms of outreach with customized messages based on outlooks and forecasts.
- Manage timing of activities and operations such as river-based construction projects, field work, planting, and monitoring.

6 FORECAST VERIFICATION

La Niña was predicted, and emerged, in the tropical equatorial Pacific Ocean during winter 2021–2022, marking the second consecutive winter with La Niña conditions. Typically, La Niña events are associated with colder and wetter than normal winters in the PNW, with above normal snowpack by April 1, although there is some variability in the strength of that relationship throughout the PNW.

NOAA's Climate Prediction Center (CPC) and other centers for long-term forecasts use empirical relationships based on past La Niña events, other observed properties of the global climate system that provide predictability, and projections from global atmosphere-ocean climate models to produce the seasonal weather predictions.

Most of our survey respondents are familiar with and use the NOAA Climate Prediction Center (CPC) seasonal outlooks.

The majority of seasonal forecasts made during the 2022 water year were consistent with those typical La Niña relationships. Since most of our survey respondents are familiar with and use the CPC seasonal outlooks, we qualitatively examined the accuracy of two example seasonal forecasts, one for January through March 2022 (JFM) and one for April through June 2022 (AMJ).

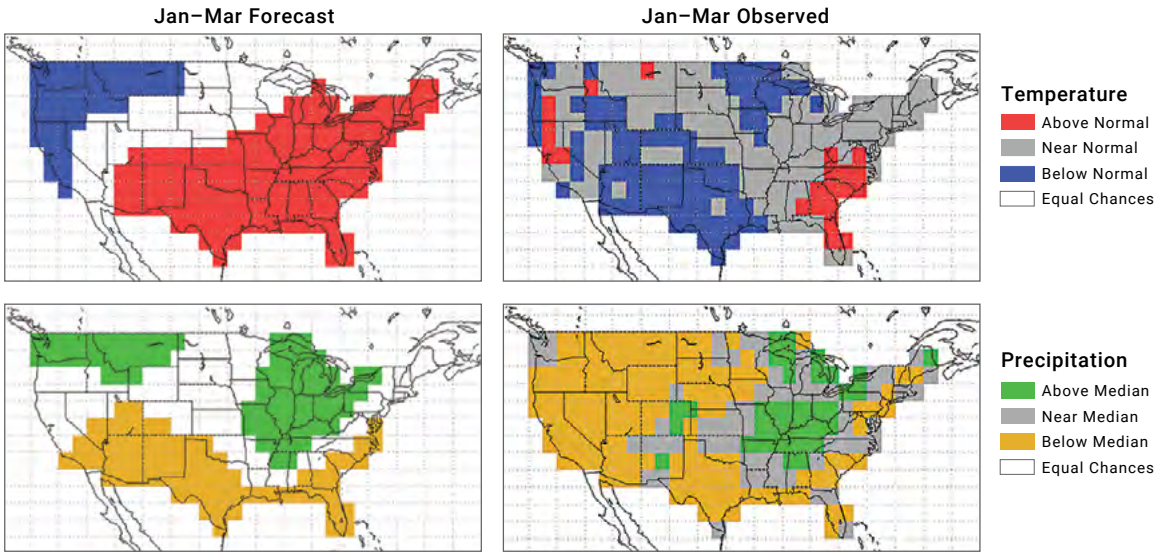


Figure 26: Categorical temperature and precipitation forecasts for January–March 2022 (JFM), issued in December 2021, compared to observations for those months. Source: *Climate Prediction Center*.

January–March 2022 Forecast and Verification

The CPC temperature forecast for JFM issued in December 2021 (*Figure 26*) favored higher odds of below-normal temperatures for nearly the entire PNW. Southernmost Idaho and northern Nevada and Utah had equal (33% each) chances of below, near-normal, or above-normal JFM temperatures.

Both forecasted and observed temperatures in most of western Washington, coastal Oregon, northern Idaho, east central Oregon, and southern Idaho were below normal. Observed JFM temperatures across most other areas of the PNW were near-normal, one category different from the below-normal temperature forecast. The exceptions were the central and southern Cascade Mountains of Oregon and southern portion of the Idaho panhandle, where JFM temperatures were above normal, two categories different from the forecast.

JAN–MAR 2022 FORECAST

The region was much drier than the forecast indicated.

The CPC precipitation forecast for JFM indicated above-median precipitation for all of Washington, northern Oregon, northern Idaho, and central eastern Idaho (*Figure 26*). Most of Oregon and the remaining areas of Idaho had equal chances of below, equal to, or above-median precipitation. The JFM precipitation forecast issued in December 2021 turned out to be inaccurate for the entire region; the drier than normal conditions were not foreseen given the presence of La Niña in the tropical Pacific. Observed precipitation totals for JFM were below median for nearly the entire PNW with the exception of western Washington and northern Oregon, where observed precipitation was near-median but forecasted precipitation was above-median.

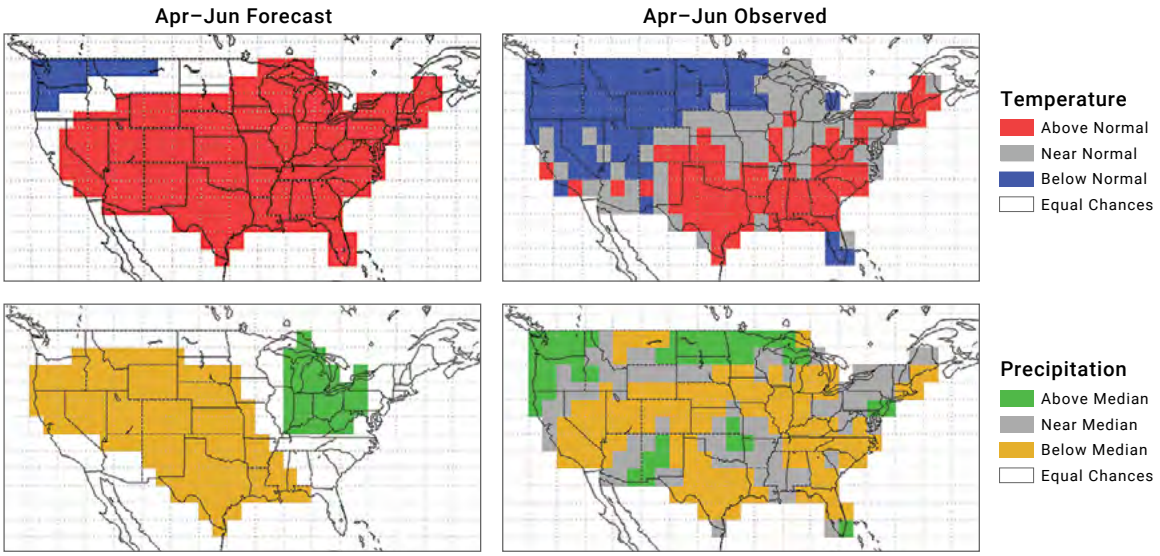


Figure 27: Categorical temperature and precipitation forecasts for April–June 2022, issued in March 2022, compared to observations for that period. Source: *Climate Prediction Center*.

April–June 2022 Forecast and Verification

The CPC temperature forecast for AMJ issued in March 2022 (*Figure 27*) favored higher odds of below-normal temperatures for Washington, northern Oregon, central Oregon west of the Cascade Mountains, and northernmost Idaho. Equal odds of below-normal, near-normal, or above-normal temperatures were forecasted across the majority of the rest of the PNW, but southern Oregon, southeast Idaho, and the southernmost portion of Idaho had elevated odds of above-normal AMJ temperatures.

Observed AMJ temperatures were below normal throughout the entire PNW, resulting in a mostly accurate forecast. Those areas in southeast Oregon and southern Idaho for which above normal temperatures were forecasted were the only true miss in the seasonal temperature outlook.

APR–JUN 2022 FORECAST

The region was much wetter than the forecast indicated, though the forecasted below-normal temperatures were as observed.

The above-median AMJ precipitation was not well-predicted. The CPC precipitation forecast for AMJ indicated higher chances of below median precipitation through most of Oregon and Idaho, and equal chances of the three outcomes for most of Washington. Observed AMJ precipitation was above median in all of Washington, most of Oregon, and parts of Idaho. Observed precipitation in all of the remaining areas in the PNW was near-median, except for a small area of south central Idaho where below-median precipitation was both forecasted and observed.

These forecast verifications are recent examples, and should not be generalized. They illustrate that two periods of anomalous precipitation during the 2022 water year (the drier than normal January–March and the wetter than normal April–June) were not anticipated in the CPC seasonal outlooks. The observed seasonal temperature anomalies from January–March 2022 were patchier than the extensive anomalies that were forecasted, as is typical. During the 2022 water year, the April–June temperature outlook appeared to be more skillful than the January–March outlook.

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2022

PACIFIC NORTHWEST WATER YEAR

IMPACTS ASSESSMENT

Supported by the
NOAA National Drought
Information System

NIDIS

Excess Injury Mortality in Washington State During the 2021 Heat Wave

Joan A. Casey, PhD, MA, Robbie M. Parks, PhD, MA, Tim A. Bruckner, PhD, MPH, Alison Gemmill, PhD, MA, MPH, and Ralph Catalano, PhD, MRP

Objectives. To determine whether the 2021 Pacific Northwest heat wave resulted in excess injury (both unintentional and intentional) deaths.

Methods. With US death certificate data from December 29, 2013, to July 31, 2021, we generated weekly counts of injury deaths in Washington State and the rest of the country. We used time-series methods to identify excess injury deaths that may have occurred during and following the anomalously warm temperature period based on those expected from history and from simultaneous deaths in the remainder of the United States.

Results. Beginning the week including June 25, 2021 (heat wave initiation), 3 weeks exceeded the expected count of injury deaths in Washington State, with an estimated total of 159 excess injury deaths (95% detection interval = 122, 195) during the 3-week period.

Conclusions. The 2021 Pacific Northwest heat wave was associated with an increase in injury deaths.

Public Health Implications. Under global warming scenarios, heat waves of this magnitude will become much more common. Adaptation and planning efforts are needed to protect residents of the historically temperate Pacific Northwest for a range of health outcomes. (*Am J Public Health*. 2023;113(6): 657–660. https://doi.org/10.2105/AJPH.2023.307269)

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Heat waves—extended periods of anomalously warm temperatures—are a critical public health concern, and a key driver for seeking adaptation measures against climate change.[1] Although assessments of the health effects of anomalously warm temperatures have largely focused on natural causes of deaths, including cardiorespiratory diseases and parasitic and infectious diseases, there is growing evidence of a robust association with deaths from injuries, such as from drownings, transport accidents, assaults, and suicides.[2–4] Previous work has also illustrated the risk of injury that heat poses among construction[5] and agricultural[6] workers in Washington State.

The Pacific Northwest region of the United States has a historically temperate climate. Late June and early July 2021, however, brought the highest temperatures ever recorded in the region.[7] Seattle, Washington, for example, experienced record heat on 3 consecutive days ending June 28, when temperatures peaked at 42°C, exceeding the previous recorded high by 3°C.[7] Attributed to climate change,[7] this period of anomalously warm temperatures centered on the Pacific Northwest, a region with minimal history of extreme heat events and thus relatively unprepared regarding infrastructure and prevalence of air conditioning.[8]

Such an anomalously warm temperature period may have induced excess injury deaths. Here, we define excess injury deaths as the difference between the observed number of injury deaths during a period of anomalously warm temperatures and a counterfactual scenario in which elevated temperatures had not occurred.[9] We estimate excess injury deaths, if any, during the anomalously warm temperature 2021 period, as the difference between injury deaths in Washington State expected from history and injury deaths in the rest of the United States at the same time as the heat wave.

METHODS

We used nationwide death certificate data from December 29, 2013, to July

31, 2021 (provisional at the time of analysis in December 2022). Death certificates in the United States use a "manner of death" classification, set by the Centers for Disease Control and Prevention, that includes "natural death," defined as "due solely or nearly totally to disease and/or the aging process." Based on data from 2010 to 2020, natural deaths accounted for approximately 89% of deaths in the United States.[10] We calculated the weekly count of Washington State injury deaths, also known as external or unnatural deaths, in the 396 study period weeks by subtracting natural from all-cause deaths.

We used time-series methods to determine whether the late June to early July 2021 heat wave in Washington State coincided with excess injury deaths. Our analyses, conducted using Scientific Computing Associates Software (Villa Park, IL), proceeded through the following steps:

1. We regressed the weekly count of injury deaths in Washington State on those in the remainder of the United States for the 390 weeks (i.e., December 29, 2013, through June 19, 2021) before the onset of the heat wave. This regression controlled determinants of temporal variation in injury death (e.g., long-term trends, seasonal trends, changes in death registration definitions and procedures) shared by Washington State and the rest of country.
2. We used Box–Jenkins methods to identify and model autocorrelation in the residuals of the step 1 regression. This step yielded a Box–Jenkins "transfer function" or equation that estimated Washington State injury deaths from those in the remainder of the United States and from autocorrelation specific to Washington State. Residuals of the transfer function satisfied the assumption of normal and independent distribution around 0.
3. We applied the Box–Jenkins transfer function devised in step 2, with coefficients fixed to those estimated for the first 390 weeks, to the full 396 weeks of observed data.
4. We combined the residuals from steps 1 and 3 and graphed them as well as the 95% detection interval of the residuals from step 1. We specified the lower and upper bounds of the detection interval as the negatively and positively signed product of 1.96 and the standard deviation of the residuals.

Because injury mortality (e.g., suicide) may lag exposure, and prior studies of heat and injury mortality relied on monthly data,[2,3] we evaluated excess injury mortality in the week of—and in the 5 weeks following—the heat wave. If the processes that yielded injury deaths in Washington State remained unaffected by the shock of the 2021 heat wave, the last 6 residuals (i.e., June–July 2021) in the graph produced in step 4 should have appeared randomly sampled from the prior 390 weeks. If, however, extreme ambient heat was associated with increased injury deaths, at least 1 of the last 6 residuals would rise above the 95% detection interval.

RESULTS

Between December 29, 2013, and June 19, 2021, weekly injury deaths in Washington State ranged from 56 to 154 (mean = 99; SD = 15). Figure 1 illustrates observed deaths throughout the study period, with noticeable upticks in injury deaths nationwide during the COVID-19 pandemic and in Washington State during the 2021 Pacific Northwest heat wave. As described in the Appendix (available as a supplement to the online version of this article at http://www.ajph.org), steps 1 and 2 produced a transfer function showing that weekly injury deaths in Washington State correlated with those nationwide. Time-series analyses found that injury death counts exceeded expected counts in the 3 weeks starting June 20 and ending July 10 (online Appendix, Figures A and B). During the week of June 20, injury deaths exceeded expected counts by 21 (1 injury death above the 95% detection interval of 20); during the week of record temperature (i.e., that ending July 3, 2021), injury deaths exceeded expected counts by 93 (72 injury deaths above the 95% detection interval of 20); and during the week beginning July 4, injury deaths exceeded expected counts by 45 (25 injury deaths above the 95% detection interval). We therefore estimated that the Pacific Northwest heat wave of 2021 coincided with 159 (95% detection interval = 122, 195) excess injury deaths in Washington State.

DISCUSSION

Our results show evidence of excess injury deaths after the 2021 Pacific Northwest heat wave, a 1-in-1000-years event caused by a ridge of high pressure resulting in a heat dome that trapped hot air over Washington State.[7] Anomalously warm temperatures plausibly influence injury deaths for several reasons. First, injury deaths vary seasonally in the United States,[11] which motivated us to explore whether temperature influences injury death rates. Second, plausible behavioral and physiological pathways exist

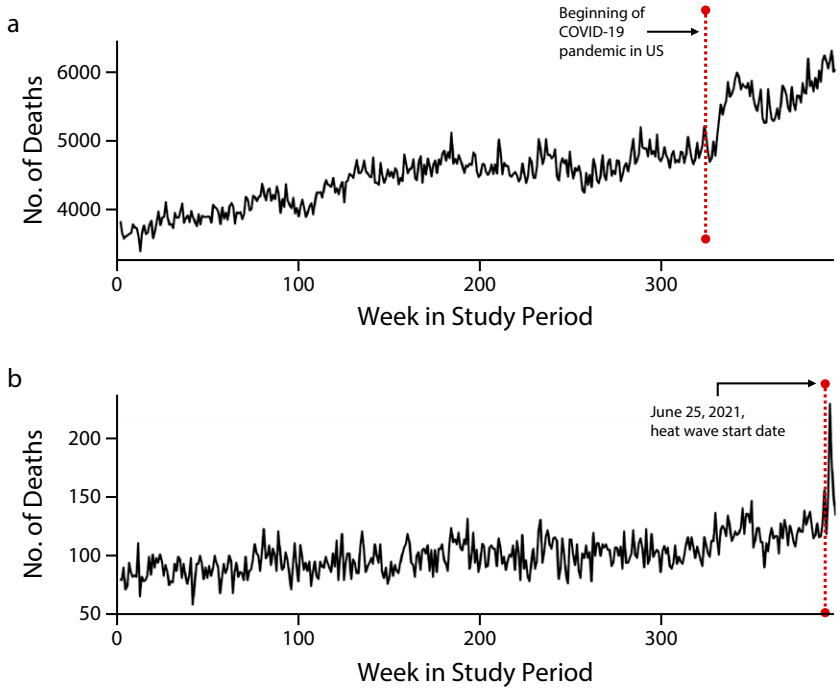

FIGURE 1— Observed Injury Deaths in (a) the United States and (b) Washington State: December 29, 2013–July 31, 2021

Note. The dashed red lines indicate the beginning of the COVID-19 pandemic (part a) and the beginning of the 2021 Pacific Northwest heat wave (part b). Observed injury deaths were obtained from the US Centers for Disease Control and Prevention and calculated as all-cause deaths minus "natural deaths."

for an association between temperature and injuries, such as changes in alcohol consumption, driving behavior, levels of anger and despair, and increased swimming.[1,2] Third, previous studies examining ambient temperature and injury outcomes in the United States have found positive associations.[2,3]

Public health programming during anomalously warm temperatures, intended to protect vulnerable communities from hazardous heat, should include ways to mitigate deaths from intentional injuries (such as assault and suicide) and unintentional injuries (such as falls, transport accidents, and drowning). Such programming will likely be needed more frequently given climate change.

We used provisional state-level death certificate data that do not specify cause or location of death (beyond state). Certain groups may be at disproportionate risk of the effects of heat, including older adults, workers, and others undertaking strenuous physical activity in uncooled spaces. Certain injury outcomes may also be more likely following heat exposure, but we could not disaggregate weekly injury deaths into subcategories (e.g., opioid-related mortality). Future studies should consider subcategories of injury and at-risk subgroups.

PUBLIC HEALTH IMPLICATIONS

Under climate scenarios with 2°C warming, models project that heat waves of this magnitude would occur every 5 to 10 years and that similar events would be 1.3°C hotter than today.[7] Public health interventions that broadly target the cause of injuries during periods of anomalously warm temperatures—for example, contacting isolated members of communities and campaigns promoting safe swimming or providing additional mental health services—should be a priority. AJPH

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CONTRIBUTORS

J. A. Casey and R. Catalano conceptualized the project. T. A. Bruckner and R. Catalano completed statistical analyses. J. A. Casey and R. M. Parks wrote the article. All authors provided feedback on analyses and article writing.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

HUMAN PARTICIPANT PROTECTION

This research relied on publicly available data that were exempt from institutional review board review.

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Our Communities Our Sexual Health

Awareness and Prevention for African Americans

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This groundbreaking book provides a comprehensive historical prospective of the disproportionate burden of HIV and other sexually transmitted infections (STIs) among African Americans.Chapters that follow explore the context of HIV and STIs in African American communities and include discussions of sexuality and the roles of faith and spirituality in HIV and STI prevention efforts. Additional chapters provide insight into strategies, e.g., HIV testing, condom distribution and marketing campaigns, parent-child communication, effective clinical care and support, and partnerships, for addressing HIV and other STI-related health disparities within these communities. The book is a valuable resource for practitioners, scholars, clinicians, educators, providers, policy makers and students.

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TABLE 1. Deaths, infant deaths, neonatal deaths and fetal deaths by county of residence, Oregon, 2021 death cohort

County of residence	Deaths		Infant deaths		Neonatal deaths		Fetal deaths	
	Number	Rate[1]	Number	Rate[2]	Number	Rate[2]	Number	Ratio[3]
Total	44,981	10.5	154	3.8	110	2.7	161	3.9
Baker	272	16.1	–	–	–	–	1	6.5
Benton	745	7.9	3	4.8	2	3.2	1	1.6
Clackamas	4,048	9.5	11	2.9	9	2.4	12	3.2
Clatsop	546	13.2	3	9.2	2	6.2	2	6.2
Columbia	627	11.8	2	4.0	1	2.0	3	6.1
Coos	1,140	17.5	3	5.5	2	3.7	3	5.5
Crook	322	12.6	1	4.0	–	–	1	4.0
Curry	512	21.6	–	–	–	–	–	–
Deschutes	1,811	8.9	2	1.0	2	1.0	8	4.1
Douglas	2,062	18.5	6	5.8	4	3.9	5	4.9
Gilliam	37	18.1	–	–	–	–	–	–
Grant	117	16.2	1	13.7	1	13.7	–	–
Harney	124	16.5	–	–	–	–	–	–
Hood River	200	8.4	1	4.3	–	–	2	8.5
Jackson	2,951	13.2	6	2.7	5	2.2	15	6.7
Jefferson	331	13.3	2	7.0	–	–	2	7.0
Josephine	1,572	17.7	4	4.7	2	2.4	3	3.5
Klamath	1,095	15.7	5	6.4	4	5.1	2	2.6
Lake	143	17.5	–	–	–	–	1	12.7
Lane	4,535	11.9	14	4.4	9	2.8	18	5.7
Lincoln	733	14.4	2	5.2	2	5.2	1	2.6
Linn	1,737	13.3	5	3.5	3	2.1	6	4.2
Malheur	394	12.3	2	5.4	–	–	–	–
Marion	3,436	9.9	12	3.1	8	2.1	16	4.2
Morrow	122	9.7	–	–	–	–	–	–
Multnomah	6,861	8.4	23	3.1	17	2.3	33	4.4
Polk	865	9.7	5	5.6	3	3.4	4	4.5
Sherman	26	13.6	–	–	–	–	–	–
Tillamook	418	15.1	–	–	–	–	–	–
Umatilla	886	11.0	5	5.2	4	4.2	2	2.1
Union	374	14.2	2	7.4	1	3.7	2	7.4
Wallowa	103	13.9	2	29.0	2	29.0	1	14.5
Wasco	381	14.3	5	19.9	4	15.9	2	8.0
Washington	4,205	6.9	22	3.5	20	3.2	15	2.4
Wheeler	21	14.4	–	–	–	–	–	–
Yamhill	1,229	11.4	5	4.7	3	2.8	–	–

– Quantity is zero.

[1] Rates per 1,000 population for deaths.

[2] Rates per 1,000 live births for infant and neonatal deaths.

[3] Ratios per 1,000 live births for fetal deaths.

WARNING: Rates based on fewer than five events are unreliable.

NOTE: Infant deaths occur in the first year of life. Neonatal deaths occur within the first 27 days of life. Fetal deaths include fetuses with birthweight of 350 grams or more or, if birthweight is unknown, gestational age of 20 weeks or more.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 2. Infant deaths by age and county of residence
Oregon residents, 2021 death cohort

County of residence	Total infant deaths[1]	Infant death rate[2]	Neonatal deaths[3] (Age <28 days)				Neonatal rate[2]	Post-neonatal deaths[4]	Post-neonatal rate[2]
			Total neonatal	Under 1 day	1-6 days	7-27 days			
Total	154	3.8	110	70	25	15	2.7	44	1.1
Baker	–	–	–	–	–	–	–	–	–
Benton	3	4.8	2	1	1	–	3.2	1	1.6
Clackamas	11	2.9	9	3	5	1	2.4	2	0.5
Clatsop	3	9.2	2	–	2	–	6.2	1	3.1
Columbia	2	4.0	1	1	–	–	2.0	1	2.0
Coos	3	5.5	2	2	–	–	3.7	1	1.8
Crook	1	4.0	–	–	–	–	–	1	4.0
Curry	–	–	–	–	–	–	–	–	–
Deschutes	2	1.0	2	1	–	1	1.0	–	–
Douglas	6	5.8	4	3	–	1	3.9	2	1.9
Gilliam	–	–	–	–	–	–	–	–	–
Grant	1	13.7	1	1	–	–	13.7	–	–
Harney	–	–	–	–	–	–	–	–	–
Hood River	1	4.3	–	–	–	–	–	1	4.3
Jackson	6	2.7	5	5	–	–	2.2	1	0.4
Jefferson	2	7.0	–	–	–	–	–	2	7.0
Josephine	4	4.7	2	1	1	–	2.4	2	2.4
Klamath	5	6.4	4	3	–	1	5.1	1	1.3
Lake	–	–	–	–	–	–	–	–	–
Lane	14	4.4	9	5	4	–	2.8	5	1.6
Lincoln	2	5.2	2	1	–	1	5.2	–	–
Linn	5	3.5	3	3	–	–	2.1	2	1.4
Malheur	2	5.4	–	–	–	–	–	2	5.4
Marion	12	3.1	8	5	2	1	2.1	4	1.0
Morrow	–	–	–	–	–	–	–	–	–
Multnomah	23	3.1	17	11	4	2	2.3	6	0.8
Polk	5	5.6	3	2	1	–	3.4	2	2.2
Sherman	–	–	–	–	–	–	–	–	–
Tillamook	–	–	–	–	–	–	–	–	–
Umatilla	5	5.2	4	1	–	3	4.2	1	1.0
Union	2	7.4	1	1	–	–	3.7	1	3.7
Wallowa	2	29.0	2	–	1	1	29.0	–	–
Wasco	5	19.9	4	3	–	1	15.9	1	4.0
Washington	22	3.5	20	14	4	2	3.2	2	0.3
Wheeler	–	–	–	–	–	–	–	–	–
Yamhill	5	4.7	3	3	–	–	2.8	2	1.9

– Quantity is zero.

[1] Infant deaths occur in the first year of life.

[2] Rates per 1,000 live births.

[3] Neonatal deaths occur in the first 27 days of life.

[4] Postneonatal deaths occur from day 28 through 364 after birth.

WARNING: Rates based on less than five events are unreliable.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 3. Deaths by age, sex, and county of residence
Oregon residents, 2021

County of residence	Total*	Age and sex											
		All ages		< 1		1-4		5-14		15-24		25-34	
		M	F	M	F	M	F	M	F	M	F	M	F
Total	44,981	24,159	20,816	82	72	12	7	30	20	302	101	624	241
Baker	272	140	132	–	–	–	–	–	–	4	1	2	1
Benton	745	366	378	2	1	–	–	–	–	7	–	6	2
Clackamas	4,048	2,100	1,948	7	4	–	–	3	1	23	8	42	16
Clatsop	546	297	249	2	1	1	–	1	–	1	1	6	–
Columbia	627	358	269	1	1	–	–	1	–	5	2	9	4
Coos	1,140	622	518	1	2	1	–	–	–	–	4	9	5
Crook	322	190	132	–	1	–	–	–	–	3	1	5	–
Curry	512	290	222	–	–	–	–	1	–	2	1	6	1
Deschutes	1,811	976	835	–	2	1	–	1	–	4	5	25	7
Douglas	2,062	1,150	912	2	4	–	–	–	1	4	3	19	11
Gilliam	37	20	17	–	–	–	–	–	–	–	–	2	–
Grant	117	64	53	–	1	–	–	–	–	–	–	–	–
Harney	124	65	59	–	–	–	–	–	–	1	–	3	1
Hood River	200	100	100	1	–	–	–	–	–	5	1	1	1
Jackson	2,951	1,634	1,317	2	4	1	–	4	3	13	4	46	15
Jefferson	331	197	134	–	2	–	–	–	–	1	–	6	4
Josephine	1,572	887	685	2	2	1	–	–	–	6	2	24	6
Klamath	1,095	606	489	2	3	–	2	–	1	9	3	9	1
Lake	143	85	58	–	–	–	–	–	–	1	–	1	–
Lane	4,535	2,427	2,108	4	10	–	1	1	2	34	10	56	22
Lincoln	733	407	326	2	–	–	–	2	–	2	1	3	7
Linn	1,737	936	801	3	2	–	1	–	–	13	3	21	10
Malheur	394	228	166	2	–	–	–	–	–	1	–	4	1
Marion	3,436	1,816	1,619	6	6	–	–	–	–	43	9	50	26
Morrow	122	66	56	–	–	–	–	1	–	1	1	2	2
Multnomah	6,861	3,723	3,136	16	7	5	1	6	8	60	20	148	54
Polk	865	462	403	3	2	–	–	–	1	4	3	8	3
Sherman	26	17	9	–	–	–	–	–	–	–	–	–	–
Tillamook	418	240	178	–	–	–	–	–	1	3	1	7	4
Umatilla	886	477	409	3	2	–	1	–	–	8	–	19	6
Union	374	196	178	2	–	–	–	–	–	4	2	1	1
Wallowa	103	58	45	1	1	–	–	–	–	–	–	2	–
Wasco	381	207	174	–	5	1	–	–	–	3	–	5	5
Washington	4,205	2,116	2,089	16	6	1	1	7	2	28	13	63	23
Wheeler	21	14	7	–	–	–	–	–	–	–	–	–	–
Yamhill	1,229	622	605	2	3	–	–	2	–	9	2	14	2

– Quantity is zero.
* Includes sex designations X (nonbinary) and U (unknown), as well as unknown ages.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 3. Deaths by age, sex, and county of residence
Oregon residents, 2021 (cont.)

County of residence	Age and sex											
	35-44		45-54		55-64		65-74		75-84		85+	
	M	F	M	F	M	F	M	F	M	F	M	F
Total	920	478	1,530	878	3,444	2,181	5,625	4,006	6,103	5,182	5,484	7,650
Baker	3	–	6	6	22	15	38	28	42	26	23	55
Benton	8	4	12	8	42	28	71	68	101	85	117	182
Clackamas	78	31	143	73	259	161	455	322	553	488	537	844
Clatsop	15	5	20	14	42	26	82	66	72	74	55	62
Columbia	7	8	21	12	72	39	90	53	95	83	57	67
Coos	18	11	25	23	96	57	172	114	178	148	122	154
Crook	5	1	14	6	23	14	26	32	66	28	48	49
Curry	7	5	12	9	34	25	82	54	68	57	78	70
Deschutes	28	20	55	30	118	59	216	154	287	234	241	324
Douglas	32	26	71	39	173	121	276	196	319	225	254	286
Gilliam	–	1	1	–	2	1	4	4	5	1	6	10
Grant	2	1	2	2	7	7	16	9	17	19	20	14
Harney	3	–	6	3	4	7	19	12	21	20	8	16
Hood River	–	1	6	1	13	10	22	10	21	24	31	52
Jackson	57	24	97	49	204	145	348	234	454	326	408	513
Jefferson	6	4	16	6	35	18	43	28	53	34	37	38
Josephine	24	15	53	15	130	72	206	145	224	173	217	255
Klamath	37	12	39	21	101	64	154	99	143	144	111	139
Lake	–	2	5	1	10	9	22	14	25	11	21	21
Lane	90	56	142	88	338	234	597	397	613	533	552	755
Lincoln	12	4	24	16	59	38	113	77	107	90	83	93
Linn	37	15	52	33	136	86	235	174	230	198	209	279
Malheur	13	4	8	10	30	12	58	35	61	41	51	63
Marion	83	36	104	66	244	171	427	306	442	395	417	604
Morrow	5	3	1	1	10	8	14	11	21	15	11	15
Multnomah	194	111	335	154	619	358	894	632	789	744	656	1,047
Polk	13	8	20	26	57	29	98	70	134	94	125	167
Sherman	1	1	1	–	3	1	1	2	6	2	5	3
Tillamook	9	3	14	8	32	26	71	45	56	37	47	53
Umatilla	11	8	29	19	77	51	129	74	111	103	90	145
Union	8	4	5	7	36	16	51	32	44	56	45	60
Wallowa	4	1	2	1	5	5	14	8	10	5	20	24
Wasco	11	2	14	9	21	20	34	36	59	38	59	59
Washington	83	38	139	101	310	178	417	340	491	496	561	891
Wheeler	1	–	1	–	1	–	5	4	5	1	1	2
Yamhill	15	13	35	21	79	70	125	121	180	134	161	239

– Quantity is zero.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 4. Deaths by race, ethnicity, and county of residence
Oregon residents, 2021

County of residence	Total	Non-Hispanic single mention race						Two or more races	His-panic[3]
		White	Black	Am. Indian	Asian[1]	HI & Pac Is.[2]	Other & not stated		
Total	44,981	40,384	765	526	818	132	190	403	1,763
Baker	272	265	–	–	–	–	1	2	4
Benton	745	696	3	–	8	–	6	6	26
Clackamas	4,048	3,746	25	23	78	10	12	42	112
Clatsop	546	519	4	2	2	1	1	5	12
Columbia	627	589	–	8	5	4	4	7	10
Coos	1,140	1,064	2	23	5	3	–	12	31
Crook	322	313	–	2	–	–	1	–	6
Curry	512	488	–	7	5	–	1	4	7
Deschutes	1,811	1,727	5	11	11	–	8	7	42
Douglas	2,062	1,978	6	20	7	1	4	14	32
Gilliam	37	36	–	–	–	–	–	–	1
Grant	117	113	–	2	–	1	–	–	1
Harney	124	114	–	3	–	–	–	1	6
Hood River	200	173	–	2	4	–	–	4	17
Jackson	2,951	2,749	19	13	24	3	8	21	114
Jefferson	331	258	1	49	2	1	1	1	18
Josephine	1,572	1,472	2	10	7	3	2	17	59
Klamath	1,095	943	13	62	7	–	17	10	43
Lake	143	134	–	3	–	–	–	3	3
Lane	4,535	4,243	39	33	51	4	16	38	111
Lincoln	733	662	5	24	4	2	6	9	21
Linn	1,737	1,648	3	24	7	3	10	8	34
Malheur	394	328	3	4	9	–	–	–	50
Marion	3,436	2,985	27	35	37	25	8	32	287
Morrow	122	102	–	–	–	–	1	1	18
Multnomah	6,861	5,471	529	71	329	44	64	100	253
Polk	865	797	7	8	5	4	2	5	37
Sherman	26	26	–	–	–	–	–	–	–
Tillamook	418	392	1	3	5	1	1	2	13
Umatilla	886	760	5	33	9	2	–	2	75
Union	374	362	–	3	–	1	1	3	4
Wallowa	103	102	–	–	1	–	–	–	–
Wasco	381	342	1	16	4	2	4	1	11
Washington	4,205	3,611	61	20	185	17	10	38	263
Wheeler	21	21	–	–	–	–	–	–	–
Yamhill	1,229	1,155	4	12	7	–	1	8	42

– Quantity is zero.

[1] Includes Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, and other Asian.

[2] Includes Guamanian, Hawaiian, Samoan, and other Pacific Islander.

[3] Decedents of Hispanic ethnicity may belong to any race but have been removed from all race categories in this table.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 5. Deaths due to firearms by manner, sex, age, race/ethnicity, county of residence, and weapon type, Oregon residents, 2021

Characteristics	Total		Unintended injuries		Suicide		Homicide		Legal intervention[1]		Undeterm. manner	
	All guns	Hand-guns	M	F	M	F	M	F	M	F	M	F
Total	670	398	2	1	428	76	120	26	12	–	3	1
Age												
<1	–	–	–	–	–	–	–	–	–	–	–	–
1-4	–	–	–	–	–	–	–	–	–	–	–	–
5-9	–	–	–	–	–	–	–	–	–	–	–	–
10-14	4	3	–	–	4	–	–	–	–	–	–	–
15-17	13	3	–	–	5	–	7	1	–	–	–	–
18-19	16	8	–	–	8	–	6	2	–	–	–	–
20-21	24	9	–	–	15	2	5	2	–	–	–	–
22-24	36	14	–	–	23	1	9	1	2	–	–	–
25-34	129	61	–	–	59	13	41	8	7	–	–	–
35-44	103	64	1	1	54	13	29	3	1	–	1	–
45-54	96	52	1	–	62	13	15	4	1	–	–	–
55-64	105	73	–	–	75	19	6	2	1	–	1	1
65-74	76	59	–	–	61	11	2	2	–	–	–	–
75-84	46	39	–	–	41	4	–	–	–	–	1	–
85+	22	13	–	–	21	–	–	1	–	–	–	–
Single mention race/ethnicty												
White	546	339	2	1	386	69	57	17	9	–	3	1
Black	37	19	–	–	4	1	27	5	–	–	–	–
American Indian	7	3	–	–	3	1	3	–	–	–	–	–
Asian[2]	4	1	–	–	3	–	1	–	–	–	–	–
HI & Pac. Is[3]	2	–	–	–	–	–	2	–	–	–	–	–
Other & not stated	5	4	–	–	4	–	1	–	–	–	–	–
Two or more races	15	7	–	–	9	2	4	–	–	–	–	–
Hispanic[4]	54	25	–	–	19	3	25	4	3	–	–	–
County of residence												
Baker	4	1	–	–	4	–	–	–	–	–	–	–
Benton	10	6	–	–	6	1	1	1	1	–	–	–
Clackamas	57	37	1	–	41	2	12	1	–	–	–	–
Clatsop	2	–	–	–	2	–	–	–	–	–	–	–
Columbia	7	4	–	–	6	1	–	–	–	–	–	–
Coos	16	11	–	–	11	2	1	1	1	–	–	–
Crook	6	5	–	–	5	–	1	–	–	–	–	–
Curry	8	8	–	–	4	4	–	–	–	–	–	–
Deschutes	21	13	–	–	17	2	2	–	–	–	–	–
Douglas	31	23	–	–	20	6	4	1	–	–	–	–
Gilliam	1	–	–	–	1	–	–	–	–	–	–	–
Grant	–	–	–	–	–	–	–	–	–	–	–	–

See footnotes at end of table.

TABLE 5. Deaths due to firearms by manner, sex, age, race/ethnicity, county of residence, and weapon type, Oregon residents, 2021

Characteristics	Total		Unintended injuries		Suicide		Homicide		Legal intervention[1]		Undeterm. Manner	
	All guns	Hand-guns	M	F	M	F	M	F	M	F	M	F
County of residence (cont.)												
Harney	–	–	–	–	–	–	–	–	–	–	–	–
Hood River	4	–	–	–	4	–	–	–	–	–	–	–
Jackson	43	22	–	–	26	6	8	2	1	–	–	–
Jefferson	9	5	–	–	7	–	1	–	–	–	1	–
Josephine	28	14	–	–	20	2	4	–	1	–	–	1
Klamath	20	13	–	–	14	2	1	2	–	–	1	–
Lake	5	3	–	–	2	2	–	1	–	–	–	–
Lane	78	62	–	–	58	13	5	1	1	–	–	–
Lincoln	12	10	–	–	9	1	1	1	–	–	–	–
Linn	24	15	–	–	16	5	3	–	–	–	–	–
Malheur	9	6	–	–	5	1	2	–	1	–	–	–
Marion	47	24	1	–	24	8	7	3	3	–	1	–
Morrow	4	1	–	–	2	–	2	–	–	–	–	–
Multnomah	111	55	–	–	45	6	51	8	–	–	–	–
Polk	14	9	–	–	14	–	–	–	–	–	–	–
Sherman	–	–	–	–	–	–	–	–	–	–	–	–
Tillamook	7	6	–	–	2	3	2	–	–	–	–	–
Umatilla	8	1	–	–	4	2	2	–	–	–	–	–
Union	4	1	–	–	4	–	–	–	–	–	–	–
Wallowa	3	1	–	1	2	–	–	–	–	–	–	–
Wasco	6	2	–	–	4	2	–	–	–	–	–	–
Washington	57	34	–	–	38	4	10	4	1	–	–	–
Wheeler	2	1	–	–	1	–	–	–	1	–	–	–
Yamhill	12	5	–	–	10	1	–	–	1	–	–	–
Weapon type												
Handgun	398	398	–	1	296	55	37	8	–	–	–	–
Long gun	79	–	1	–	66	4	4	3	–	–	1	–
Other & not stated[5,6]	193	–	1	–	66	17	79	15	12	–	2	1

⁻ Quantity is zero.

[1] Legal intervention is the intentional or unintentional death of a person resulting from the actions of a law enforcement agent. This category may not include all such deaths if the certifying medical examiner failed to note (on the death certificate) the involvement of a law enforcement agent.

[2] Includes Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, and other Asian.

[3] Includes Guamanian, Hawaiian, Samoan, and other Pacific Islander.

[4] Decedents of Hispanic ethnicity may belong to any race but have been removed from all race categories in this table.

[5] Because the ICD-10 does not include codes for the specific types of guns involved in legal intervention deaths, all such deaths are included here. However, nearly all legal intervention gunshot deaths involve handguns.

[6] It is the Oregon Medical Examiner's policy not to specify the type of firearm used in a homicide on the death certificate

Source: Oregon Health Authority, Center for Health Statistics

TABLE 6. Tobacco-linked deaths by cause of death
Oregon residents, 2021

Selected causes of death (and their ICD-10 codes)	Total	Linked[1]		Not linked		Unknown	
		No.	%	No.	%	No.	%
Total[2]	44,981	8,520	18.9	23,333	51.9	13,128	29.2
Malignant neoplasms	3,782	1,684	44.5	1,260	33.3	838	22.2
Oral cavity, lip, pharynx (C00.0-C14.8)	145	63	43.4	50	34.5	32	22.1
Esophagus (C15)	260	95	36.5	91	35.0	74	28.5
Stomach (C16)	111	17	15.3	64	57.7	30	27.0
Pancreas (C25)	687	71	10.3	438	63.8	178	25.9
Larynx (C32)	33	18	54.5	2	6.1	13	39.4
Lung, bronchi, trachea (C33-C34)	1,841	1,288	70.0	242	13.1	311	16.9
Cervic uteri (C53)	48	4	8.3	26	54.2	18	37.5
Kidney, other urinary tract (C64-C65)	218	32	14.7	117	53.7	69	31.7
Urinary bladder (C67)	284	87	30.6	115	40.5	82	28.9
Acute Myeloid Leukemia (C92.0)	155	9	5.8	115	74.2	31	20.0
Cardiovascular diseases	9,744	2,147	22.0	4,558	46.8	3,039	31.2
Ischemic heart disease (I20-I25)	3,651	1,115	30.5	1,433	39.2	1,103	30.2
Other heart disease (I00-I09, I26-I51)	3,393	566	16.7	1,817	53.6	1,010	29.8
Cerebrovascular disease (I60-I69)	2,321	334	14.4	1,158	49.9	829	35.7
Atherosclerosis (I70)	83	24	28.9	35	42.2	24	28.9
Aortic aneurysm (I71)	162	53	32.7	64	39.5	45	27.8
Other arterial disease (I72-I78)	134	55	41.0	51	38.1	28	20.9
Respiratory diseases	2,046	1,412	69.0	268	13.1	366	17.9
Pneumonia & influenza (J09-J18)	227	23	10.1	119	52.4	85	37.4
Bronchitis & emphysema (J40-J43)	167	127	76.0	8	4.8	32	19.2
Other chronic airways obstruction (J44)	1,652	1,262	76.4	141	8.5	249	15.1
Perinatal conditions[3]	47	–	–	40	85.1	7	14.9
Selected perinatal conditions[4]	33	–	–	31	93.9	2	6.1
Sudden infant death syndrome (R95)	14	–	–	9	64.3	5	35.7
Other causes	29,362	3,277	11.2	17,207	58.6	8,878	30.2

– Quantity is zero.

[1] The Oregon death certificate provides four possible answers to the question, "Did tobacco use contribute to death?": yes, probably, no and unknown. The linked category includes deaths listed as yes or probably, or if a contributing cause is F17.

[2] The causes of death shown in this table are those linked to tobacco use by the federal Centers for Disease Control and Prevention (CDC. Annual Smoking-Attributable Mortality, Years of Potential Life Lost, and Productivity Losses -- United States, 1997-2001.

[3] The number of infant deaths resulting from exposure to tobacco combustion products is underreported.

[4] The category includes the following conditions: other disorders related to short gestation and low birthweight (P07), respiratory distress of newborn (P22), congenital pneumonia (P23), neonatal aspiration syndromes (P24), and other respiratory conditions originating in the perinatal period (P25-P28).

Source: Oregon Health Authority, Center for Health Statistics

TABLE 7. Tobacco-linked deaths by county of residence
Oregon residents, 2021

County of residence	Total	Linked[1]		Not linked		Unknown	
		No.	%	No.	%	No.	%
Total	44,981	8,520	18.9	23,333	51.9	13,128	29.2
Baker	272	57	21.0	156	57.4	59	21.7
Benton	745	111	14.9	507	68.1	127	17.0
Clackamas	4,048	659	16.3	2,063	51.0	1,326	32.8
Clatsop	546	124	22.7	284	52.0	138	25.3
Columbia	627	180	28.7	262	41.8	185	29.5
Coos	1,140	276	24.2	540	47.4	324	28.4
Crook	322	87	27.0	172	53.4	63	19.6
Curry	512	106	20.7	206	40.2	200	39.1
Deschutes	1,811	416	23.0	1,023	56.5	372	20.5
Douglas	2,062	490	23.8	862	41.8	710	34.4
Gilliam	37	4	10.8	23	62.2	10	27.0
Grant	117	27	23.1	49	41.9	41	35.0
Harney	124	24	19.4	62	50.0	38	30.6
Hood River	200	28	14.0	130	65.0	42	21.0
Jackson	2,951	520	17.6	1,633	55.3	798	27.0
Jefferson	331	83	25.1	188	56.8	60	18.1
Josephine	1,572	293	18.6	702	44.7	577	36.7
Klamath	1,095	324	29.6	499	45.6	272	24.8
Lake	143	41	28.7	78	54.5	24	16.8
Lane	4,535	846	18.7	2,491	54.9	1,198	26.4
Lincoln	733	230	31.4	337	46.0	166	22.6
Linn	1,737	404	23.3	991	57.1	342	19.7
Malheur	394	79	20.1	254	64.5	61	15.5
Marion	3,436	561	16.3	1,665	48.5	1,210	35.2
Morrow	122	31	25.4	56	45.9	35	28.7
Multnomah	6,861	1,143	16.7	3,479	50.7	2,239	32.6
Polk	865	122	14.1	461	53.3	282	32.6
Sherman	26	6	23.1	11	42.3	9	34.6
Tillamook	418	62	14.8	249	59.6	107	25.6
Umatilla	886	205	23.1	494	55.8	187	21.1
Union	374	56	15.0	128	34.2	190	50.8
Wallowa	103	25	24.3	63	61.2	15	14.6
Wasco	381	73	19.2	213	55.9	95	24.9
Washington	4,205	598	14.2	2,287	54.4	1,320	31.4
Wheeler	21	8	38.1	6	28.6	7	33.3
Yamhill	1,229	221	18.0	709	57.7	299	24.3

⁻ Quantity is zero.

[1] The Oregon death certificate provides four possible answers to the question, "Did tobacco use contribute to death?": yes, probably, no and unknown. The linked category includes deaths listed as yes or probably, or if a contributing cause is F17.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 8. Deaths by disposal of remains and county of residence
Oregon occurrences, 2021

County of residence	Total	Cremation		Burial		Removal		Donation		Entombment		Other	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total	45,028	35,539	79	6,312	14	2,125	5	439	1	332	1	281	1
Baker	215	182	85	30	14	1	0	2	1	–	–	–	–
Benton	739	606	82	101	14	16	2	8	1	5	1	3	0
Clackamas	3,962	3,022	76	623	16	155	4	55	1	68	2	39	1
Clatsop	515	454	88	47	9	11	2	2	0	–	–	1	0
Columbia	512	406	79	57	11	37	7	3	1	5	1	4	1
Coos	1,126	995	88	93	8	21	2	15	1	–	–	2	0
Crook	318	271	85	41	13	3	1	3	1	–	–	–	–
Curry	463	407	88	28	6	19	4	9	2	–	–	–	–
Deschutes	1,768	1,556	88	162	9	27	2	20	1	3	0	–	–
Douglas	2,037	1,712	84	211	10	24	1	13	1	1	0	76	4
Gilliam	33	25	76	7	21	1	3	–	–	–	–	–	–
Grant	110	86	78	21	19	2	2	–	–	1	1	–	–
Harney	112	94	84	16	14	2	2	–	–	–	–	–	–
Hood River	195	133	68	43	22	10	5	5	3	4	2	–	–
Jackson	2,898	2,463	85	369	13	43	1	17	1	5	0	1	0
Jefferson	324	229	71	84	26	7	2	4	1	–	–	–	–
Josephine	1,547	1,316	85	185	12	32	2	10	1	3	0	1	0
Klamath	1,068	897	84	136	13	25	2	10	1	–	–	–	–
Lake	140	120	86	19	14	1	1	–	–	–	–	–	–
Lane	4,491	3,884	86	465	10	58	1	52	1	14	0	18	0
Lincoln	708	632	89	50	7	13	2	10	1	1	0	2	0
Linn	1,712	1,381	81	280	16	26	2	15	1	8	0	2	0
Malheur	275	80	29	50	18	145	53	–	–	–	–	–	–
Marion	3,388	2,570	76	670	20	86	3	29	1	26	1	7	0
Morrow	105	81	77	22	21	2	2	–	–	–	–	–	–
Multnomah	6,699	4,900	73	1,037	15	492	7	77	1	110	2	83	1
Polk	854	669	78	160	19	15	2	6	1	3	0	1	0
Sherman	22	14	64	6	27	–	–	1	5	1	5	–	–
Tillamook	409	350	86	44	11	9	2	5	1	1	0	–	–
Umatilla	709	445	63	172	24	87	12	3	0	2	0	–	–
Union	322	236	73	81	25	4	1	1	0	–	–	–	–
Wallowa	95	71	75	20	21	4	4	–	–	–	–	–	–
Wasco	367	281	77	56	15	27	7	2	1	–	–	1	0
Washington	4,131	3,121	76	653	16	236	6	39	1	55	1	27	1
Wheeler	21	19	90	2	10	–	–	–	–	–	–	–	–
Yamhill	1,213	941	78	202	17	37	3	15	1	12	1	6	0

– Quantity is zero.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 9. Term fetal deaths[1] by planned attendant and planned place of birth, Oregon occurrences, 2021

Planned birth attendant	**Total term fetal deaths[2]**	Planned hospital birth[3]	Planned out-of-hospital birth		
			Total	Intrapartum transfer to hospital[4]	Non-hospital delivery[5]
Total	41	38	1	1	-
MD's and DO's	30	30	-	-	-
Certified nurse midwives	8	7	1	1	-
Licensed direct-entry midwives	-	-	-	-	-
Unlicensed direct-entry midwives	-	-	-	-	-
Naturopathic physicians	-	-	-	-	-
Other	3	1	-	-	-

– Quantity is zero.

[1] Term fetal deaths include fetal deaths with gestation of 37 weeks or more.

[2] Total includes two fetal deaths that occurred en route, were unplanned home deliveries, or were out-of-hospital deliveries not otherwise classified.

[3] For planned hospital births, actual attendant type is used.

[4] For planned out-of-hospital births with intrapartum transfer to hospitals, planned attendant type is reported by mother and not verified.

[5] For planned out-of-hospital births with non-hospital deliveries, the actual attendant type is used.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 10. Term early neonatal deaths[1] by planned attendant and planned place of birth, Oregon occurrences, preliminary 2021 birth cohort

Planned birth attendant	**Total term early neonatal deaths[2]**	Planned hospital birth[3]	Planned out-of-hospital birth		
			Total	Intrapartum transfer to hospital[4]	Non-hospital delivery[5]
Total	19	14	5	2	3
MD's and DO's	14	14	–	–	–
Certified nurse midwives	1	–	1	1	–
Licensed direct-entry midwives	3	–	3	1	2
Unlicensed direct-entry midwives	–	–	–	–	–
Naturopathic physicians	–	–	–	–	–
Other	1	–	1	–	1

– Quantity is zero.

[1] Term early neonatal deaths include infant deaths of less than seven days and with gestation of 37 weeks or more.

[2] Totals include term early neonatal births resulting in death that occurred en route, were unplanned home deliveries, or were other out-of-hospital births not otherwise classified. There were no such births in 2021.

[3] For planned hospital births, actual attendant type is used.

[4] For planned out-of-hospital births with intrapartum transfer to hospitals, planned attendant type is reported by the parent and not verified.

[5] For planned out-of-hospital births with non-hospital deliveries, the actual attendant type is used.

NOTE: The 2021 birth cohort may include infant deaths that occurred in 2021 or 2022. Data for 2022 are undergoing editing processes and are subject to change.

Source: Oregon Health Authority, Center for Health Statistics

TABLE 11. Life expectancy at birth and remaining years at selected ages by county and sex, Oregon residents, 2017-2021

County of residence	At birth (with C.I.)[1]	At birth		At age 25		At age 35	
		M	F	M	F	M	F
Oregon	79.4 (79.3 - 79.4)	76.9	81.9	53.0	57.6	43.7	47.9
Baker	77.0 (75.8 - 78.2)	74.9	79.6	52.3	56.2	43.6	46.6
Benton	83.0 (82.6 - 83.4)	81.4	84.7	56.9	60.2	47.4	50.5
Clackamas	80.9 (80.7 - 81.1)	78.8	83.0	54.8	58.6	45.6	49.0
Clatsop	78.3 (77.6 - 79.0)	75.7	81.0	51.9	56.4	43.1	47.0
Columbia	78.9 (78.3 - 79.5)	76.1	81.8	52.5	57.4	43.5	47.8
Coos	76.2 (75.7 - 76.7)	73.9	78.8	49.7	54.4	40.5	45.0
Crook	78.9 (78.0 - 79.9)	76.0	82.1	52.5	58.5	44.1	48.8
Curry	75.9 (74.9 - 76.9)	72.9	79.2	49.3	55.3	40.7	45.8
Deschutes	81.2 (81.0 - 81.5)	78.9	83.6	55.0	59.2	45.9	49.4
Douglas	76.3 (75.9 - 76.8)	73.5	79.5	50.0	55.3	41.0	46.1
Gilliam	81.0 (77.3 - 84.6)	76.4	86.9	52.9	61.9	45.8	51.9
Grant	79.7 (77.9 - 81.5)	77.0	82.8	53.4	59.9	43.9	49.9
Harney	77.3 (75.6 - 78.9)	75.3	79.2	51.0	55.8	42.8	46.6
Hood River	81.7 (80.9 - 82.4)	79.5	83.8	55.5	59.5	45.9	49.8
Jackson	78.7 (78.4 - 79.0)	75.9	81.6	52.1	57.4	43.2	47.9
Jefferson	75.9 (74.9 - 76.8)	74.1	78.0	51.2	54.5	42.7	45.6
Josephine	76.2 (75.7 - 76.7)	72.6	80.0	49.1	56.0	40.7	46.6
Klamath	75.1 (74.6 - 75.7)	72.1	78.4	48.9	54.7	40.1	45.0
Lake	77.4 (75.8 - 78.9)	76.8	78.2	53.2	54.8	43.7	44.8
Lane	78.7 (78.5 - 78.9)	76.1	81.4	52.0	57.0	42.8	47.5
Lincoln	77.4 (76.7 - 78.0)	74.3	80.5	50.8	56.2	41.9	47.0
Linn	77.0 (76.7 - 77.4)	74.5	79.7	50.9	55.3	41.8	45.6
Malheur	77.8 (77.0 - 78.5)	75.9	80.0	52.2	55.6	42.8	45.9
Marion	79.0 (78.7 - 79.2)	76.4	81.5	52.5	57.2	43.3	47.5
Morrow	79.8 (78.6 - 81.1)	77.7	82.3	54.5	58.2	44.9	48.8
Multnomah	79.0 (78.9 - 79.2)	76.3	81.8	52.3	57.3	43.0	47.6
Polk	79.4 (79.0 - 79.9)	77.2	81.6	53.3	57.5	44.1	47.7
Sherman	81.1 (78.1 - 84.1)	**	**	**	**	**	**
Tillamook	77.6 (76.8 - 78.5)	75.8	79.6	51.8	55.4	43.2	46.2
Umatilla	77.7 (77.2 - 78.1)	75.4	80.3	51.7	55.9	42.7	46.3
Union	78.1 (77.3 - 78.9)	75.5	80.7	52.4	56.5	43.6	46.9
Wallowa	80.6 (78.8 - 82.5)	77.5	83.7	55.5	59.8	46.1	49.8
Wasco	77.2 (76.4 - 78.0)	74.8	79.7	51.1	56.3	41.9	46.9
Washington	82.4 (82.2 - 82.5)	80.2	84.4	56.1	59.9	46.6	50.1
Wheeler	83.1 (80.2 - 85.9)	**	**	**	**	**	**
Yamhill	79.3 (78.9 - 79.7)	77.4	81.3	53.4	57.1	44.3	47.4

See footnotes at end of table.

TABLE 11. Life expectancy at birth and remaining years at selected ages by county and sex, Oregon residents, 2017-2021

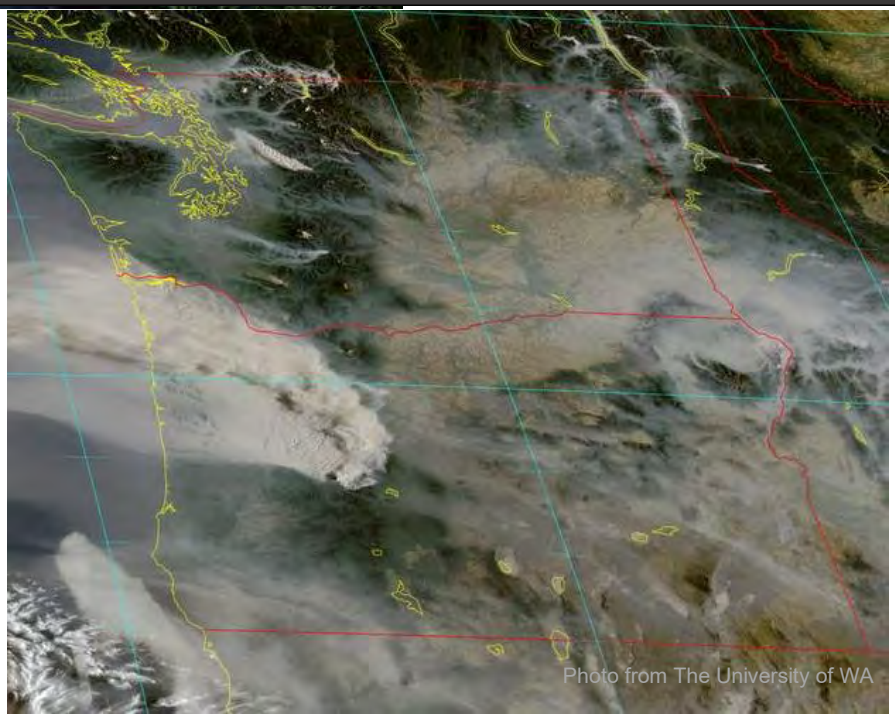
County of residence	At age 45		At age 55		At age 65		At age 75		At age 85	
	M	F	M	F	M	F	M	F	M	F
Oregon	34.6	38.5	26.0	29.4	18.5	21.1	11.7	13.5	6.4	7.4
Baker	34.6	37.3	26.0	28.8	18.4	20.5	11.4	12.7	6.2	6.5
Benton	38.0	40.9	29.0	31.4	20.7	22.5	13.1	14.3	7.3	7.7
Clackamas	36.3	39.5	27.5	30.3	19.3	21.6	11.9	13.6	6.4	7.3
Clatsop	34.2	37.8	26.2	29.0	19.2	21.0	12.5	13.5	8.0	7.8
Columbia	34.1	38.4	25.7	29.3	18.4	21.1	11.9	14.0	7.3	8.6
Coos	31.6	35.7	23.7	27.2	17.3	19.5	10.9	12.3	6.0	6.4
Crook	35.1	39.4	26.8	30.6	19.2	22.2	12.2	14.5	7.5	8.0
Curry	32.3	36.4	24.6	27.8	17.2	19.9	11.1	12.3	5.8	6.4
Deschutes	36.6	39.8	27.7	30.6	19.6	21.7	12.1	13.7	6.3	7.4
Douglas	32.3	37.1	24.4	28.4	17.7	20.9	11.4	13.9	6.9	8.4
Gilliam	37.4	43.2	28.9	33.2	19.7	24.7	11.8	18.0	6.0	12.0
Grant	35.6	40.9	27.3	31.6	20.0	23.6	13.7	15.6	7.5	10.6
Harney	34.2	37.3	26.7	28.7	18.9	20.1	12.4	12.6	7.9	8.4
Hood River	36.5	40.1	27.5	30.7	18.9	21.7	11.7	13.3	5.8	7.6
Jackson	34.2	38.6	25.8	29.6	18.3	21.3	11.7	13.7	6.3	7.6
Jefferson	33.7	36.8	25.3	28.5	17.7	20.6	10.6	13.3	5.4	6.9
Josephine	32.2	37.6	24.2	28.6	17.5	20.6	11.2	13.4	6.2	7.7
Klamath	31.8	35.9	23.8	27.4	17.1	19.7	10.7	12.3	5.3	6.6
Lake	34.3	36.3	25.6	27.3	17.9	19.6	11.7	12.9	6.6	6.2
Lane	33.9	38.1	25.5	29.2	18.3	21.0	11.7	13.4	6.3	7.4
Lincoln	33.5	37.9	25.2	29.5	18.2	21.2	11.8	13.7	6.3	7.2
Linn	32.8	36.3	24.3	27.5	17.0	19.4	10.6	12.3	5.3	6.4
Malheur	34.0	36.7	25.3	28.0	17.8	20.1	11.8	12.9	7.4	6.9
Marion	34.3	38.1	25.6	29.0	18.1	20.7	11.5	13.3	6.3	7.2
Morrow	36.2	39.5	27.3	30.5	19.4	21.8	12.9	14.1	7.5	7.9
Multnomah	33.8	38.2	25.2	29.1	17.9	20.8	11.4	13.4	6.1	7.4
Polk	35.0	38.2	26.2	29.2	18.6	20.8	11.7	13.1	5.8	6.3
Sherman	**	**	**	**	**	**	**	**	**	**
Tillamook	34.0	37.1	25.7	28.6	18.6	20.7	12.2	13.2	7.0	6.5
Umatilla	33.6	37.0	25.0	28.3	17.6	20.2	11.3	12.9	6.3	7.3
Union	34.6	37.7	25.7	29.0	18.5	21.1	12.0	14.0	7.0	8.5
Wallowa	37.4	40.0	28.1	30.4	20.5	22.5	13.5	14.3	7.9	8.2
Wasco	33.0	37.4	24.9	28.5	18.0	20.5	11.0	13.0	5.9	7.6
Washington	37.2	40.5	28.2	31.1	19.9	22.3	12.6	14.3	6.9	7.8
Wheeler	**	**	**	**	**	**	**	**	**	**
Yamhill	35.0	38.0	26.1	28.8	18.4	20.6	11.4	13.1	6.3	7.0

** Insufficient population size for calculation.

[1] C.I. = 95% confidence interval.

Wildfire Smoke Trends and the Air Quality Index

May 2023



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Executive Summary

Large wildfires have been increasing across the western United States over the last decade and are expected to become more frequent, according to the National Interagency Fire Center. This report summarizes Oregon DEQ's air quality monitoring for particulate matter during wildfire season through 2022, how that information is translated into an Air Quality Index with categories of potential health effects, and what trends in the AQI are showing over the last several years.

State of Oregon Department of Environmental Quality

Across Oregon, smoke from wildfires is causing increases in AQI values that are **unhealthy for sensitive groups or worse, or ≥USG**, for short. Some examples from Eastern, Southern, and Western Oregon illustrate this.

- Eastern Oregon (Bend): From 1989 to 2016, Bend only had 10 days ≥ USG from wildfire smoke, or 0.4 ≥USG days/year. From 2017 to 2022, Bend jumped to 58 days ≥ USG or 9.7 ≥ USG days/yr. That is a 24.2 fold increase in days impacted per year. Bend also had hazardous AQI levels for the first time in 2020, with six days and 2021 with one day. In 2022 Bend had 5 days ≥ USG.
- Southeastern Oregon (Klamath Falls): From 1989 to 2014, Klamath Falls had 37 ≥USG days from wildfire smoke, or 1.4 ≥USG days/year. From 2015 to 2022, they have had 117 ≥ USG days, or 14.6 ≥USG days/yr. That is a 10.4 fold increase in days impacted per year. Klamath Falls had its first hazardous AQI day in 2020. In 2022, Klamath Falls had no ≥ USG days.
- Northwestern Oregon (Portland). Before 2015, Portland had not had a single day with air quality that was ≥ USG from wildfire smoke since air quality monitoring began in 1985. From 2015 to 2022, Portland had 26 ≥ USG days or 3.3 ≥ USG days/year. In 2020 Portland had its first days over the unhealthy AQI level with three very unhealthy and five hazardous days. In 2022, Portland had three ≥ USG days.
- Southwestern Oregon (Medford). From 1985 to 2012, Medford had 41 days ≥ USG from wildfire smoke, or 1.5 ≥ USG days/year. From 2013 to 2022, Medford had 127 days ≥ USG or 12.7 ≥ USG days/yr. That is an 8.7 fold increase in days impacted per year. Medford also had one hazardous AQI day between 1985 and 2012, and four from 2013 to 2022. In 2022 Medford had 6 days ≥ USG.

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Introduction

Oregon and surrounding states have temperate rainforests west of the Cascade Mountains and more arid ponderosa pine forests east of the Cascades. Fire is a natural part of the ecology of these forests and occasional burning is healthy for forests. However, fires in these forests have become more massive and burn more acres, according to the National Interagency Fire Center. Figure 1 shows increasing wildfire trends over the last decade for Oregon, Washington, and Northern California. The fire season starts earlier and ends later with larger fires than in the past. The 2022 fire data was published by the National Interagency Fire Center.

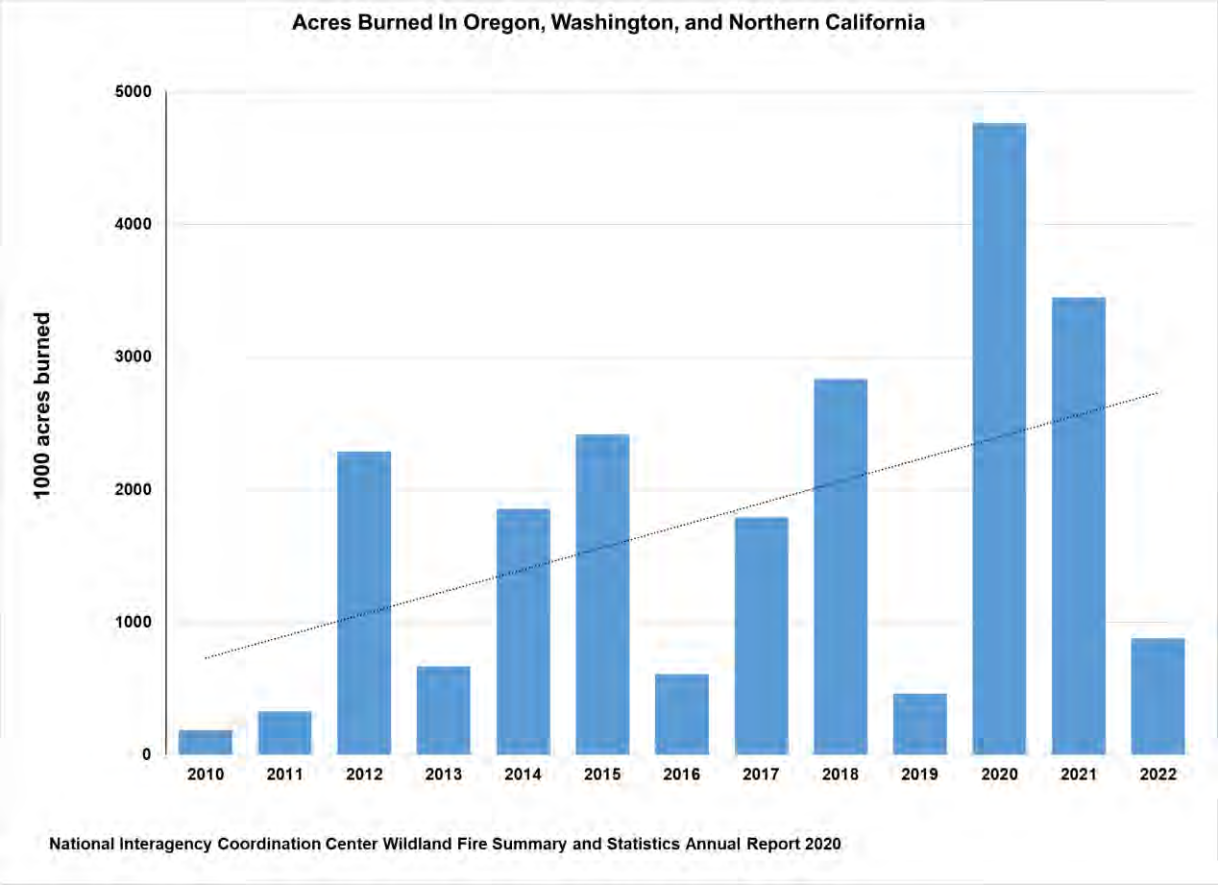

Figure 1. Acreage burned by wildfire in areas impacting the Pacific Northwest.

Scope of This Report

This report is limited to the presentation of AQI PM2.5 trends and associated categories of potential health impacts. The report can be used as a reference for more in depth discussion of the causes, prevalence, and impacts of wildfire smoke.

Wildfire Smoke Impacts

Oregon's wildfire season historically started in late July and continued into early September. More recently, there have been fires starting in mid-July and lasting until early October. Fires impacting Oregon have been mainly in the Southern, Central and Northeastern Oregon and Northern California mountains. Some recent impacts have come from British Columbia and Central Washington. In 2020 large fires also occurred in the Cascades and on the coast.

Wildfire smoke emits a wide variety of pollutants measured as particulate matter (PM2.5 and PM10), black carbon, nitrogen dioxide, carbon monoxide, volatile organic compounds, polycyclic aromatic hydrocarbons and metals. According to the Oregon Health Authority's publication, Wildfire Smoke and Your Health, of these pollutants, PM2.5 may represent the greatest health concern since it can be inhaled deeply into the lungs and a fraction may even reach the bloodstream. Volatile organic compounds can cause early symptoms such as watery eyes, respiratory tract irritation and headaches. Higher levels of ozone (smog) can also be formed from an increase in the precursor pollutants: nitrogen dioxide and volatile organic compounds.

Air Quality Index

PM2.5 is a criteria pollutant that is easily measured and has well established National Ambient Air Quality Standards (NAAQS). The U.S. EPA created the color-coded Air Quality Index, or AQI, which is used to convert pollutant concentrations into understandable health risk language. The AQI uses PM2.5, ozone, PM10, nitrogen dioxide, carbon monoxide and sulfur dioxide data to calculate health indices. In Oregon, PM2.5 and ozone measurements typically have the highest AQI and are therefore considered drivers of air quality related health risks. In the summer, the ozone AQI in urban areas is usually higher than the PM2.5 unless there is wildfire smoke.

Calculating AQI Trends

The AQI is useful for calculating trends of wildfire smoke impact on public health. The AQI used in the trends are calculated using PM2.5 measurements because PM2.5 has the highest AQI levels of any of the continuously measured pollutants during wildfire smoke intrusions.

DEQ measures PM2.5 using Federal Reference Method (FRM) filter samplers in several locations. These work by passing air through a filter for 24 hours starting at midnight and sampling every third day. The filter samplers are co-located with nephelometers that measure continuous, real-time light scattering due to particulate matter. DEQ uses linear regression to compare the light scattering from the nephelometer and the PM2.5 from the filter samplers to get a correlation between the two methods. The correlation equation is used to convert the nephelometer's light scattering into a real-time PM2.5 estimate. The 24-hour PM2.5 average is used to calculate the daily AQI presented in this report.

DEQ and Lane Regional Air Protection Agency have been updating the PM2.5 network with Federal Equivalence Method (FEM) monitors, which collect data hourly and operate continuously. The nephelometers are currently being correlated to the FEMs to update their calibration.

PM2.5 estimate calculations

To calculate the AQI, the PM2.5 FRM or FEM data is used when available. When there is no FRM/FEM data, the nephelometer derived PM2.5 estimates are used. Most days and locations do not have FRM/FEM data so the PM2.5 estimates consist of over half of the values. For this trend report, when no data was available for a monitor, DEQ used a nearby individual PurpleAir monitor and correlated that with the nearest DEQ nephelometer when both were running. The correlation was used to estimate PM2.5 during times the DEQ monitor was down.

For this trend report, DEQ used the 2013 to 2015 PM2.5 Federal Reference Method/nephelometer correlation equations to recalculate the nephelometer light scattering values. The PM2.5 estimates were updated using a more recent correlation equation to eliminate variations from changing correlations over the years. *Note that correlation equations change very little, but a small change can be significant if the PM2.5 estimate is near a break point between AQI categories.*

AQI calculations

The AQI was also updated using the most recent AQI breakpoints provided by EPA. The AQI breakpoints changed when EPA updated the PM2.5 standards in 2012. In order for past and present data to be comparable, all the data has to be recalculated using the same AQI breakpoints. The most recent breakpoints are based on the most current health information. The current EPA breakpoints are in Table 6 of the EPA's **Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI), September 2018.** The AQI calculation is Equation 1 in the document. The AQI categories and breakpoints are shown in Table 1 below.

Table 1. The PM2.5 Air Quality Index, breakpoints, and potential health effects.

AQI Category and Color	AQI value	PM2.5 ($\mu g/m^3$) 24-hr Aver.	Air Quality and Health
Good	0 to 50	0.0 to 12.0	Air quality is satisfactory. Air pollution poses little or no health risk.
Moderate	51 to 100	12.1 to 35.4	Air quality is acceptable; however, there may be a moderate health concern for a very small number of people. Respiratory symptoms are possible in people unusually sensitive to air pollution. Heart or lung disease (such as asthma) symptoms may be aggravated in people with cardiopulmonary disease and older adults. These groups should consider *reducing prolonged* or *heavy* outdoor exertion.
Unhealthy for Sensitive Groups	101 to 150	35.5 to 55.4	Members of sensitive groups may experience health effects. People with heart or lung disease may experience increased symptoms and premature mortality; older adults, pregnant women and children, are also among the groups most at risk of respiratory symptoms. These groups should *reduce prolonged* or *heavy* outdoor exertion. The general public is not likely to be affected.
Unhealthy	151 to 200	55.5 to 150.4	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. These groups should *avoid prolonged* or *heavy* exertion: People with heart or lung disease, children, pregnant women and older adults. Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy	201 to 300	150.5 to 250.4	Health alert: everyone may experience more serious health effects. These groups should *avoid all* physical activity outdoors: People with heart or lung disease, children, pregnant women and older adults. Everyone else should avoid prolonged or heavy exertion.
Hazardous	>300	>250.5	Health warnings of emergency conditions. The entire population is more likely to be affected. See EPA AirNow "Extremely High Levels of PM2.5: Steps to Reduce Your Exposure" when PM2.5 levels are "Hazardous" or above on the AQI.

Trends

DEQ compiled the wildfire AQI trends for “Unhealthy for Sensitive Groups,” “Unhealthy,” “Very Unhealthy” or “Hazardous” categories of the AQI. Collectively these categories are known as unhealthy for sensitive groups or worse, or **≥USG** for short. In Oregon, wildfire smoke occurs during the summer, so for this report values from June 1 to October 20 were selected. July 4 was removed from the trends because of outliers due to fireworks. DEQ evaluated summertime AQI trends up to 2021 for 24 communities in Oregon. A map of wildfire related AQI trends for various cities around the state is shown in Figure 2. The charts on the map show the ≥USG for each city.

To simplify the discussion in this report, only four of the cities from across the state are provided in the main body. They are Bend, Klamath Falls, Medford and Portland. The trends for the number of days ≥USG for these cities are provided in Figures 3 through 6. The graphs for the remaining cities are shown in the appendix.

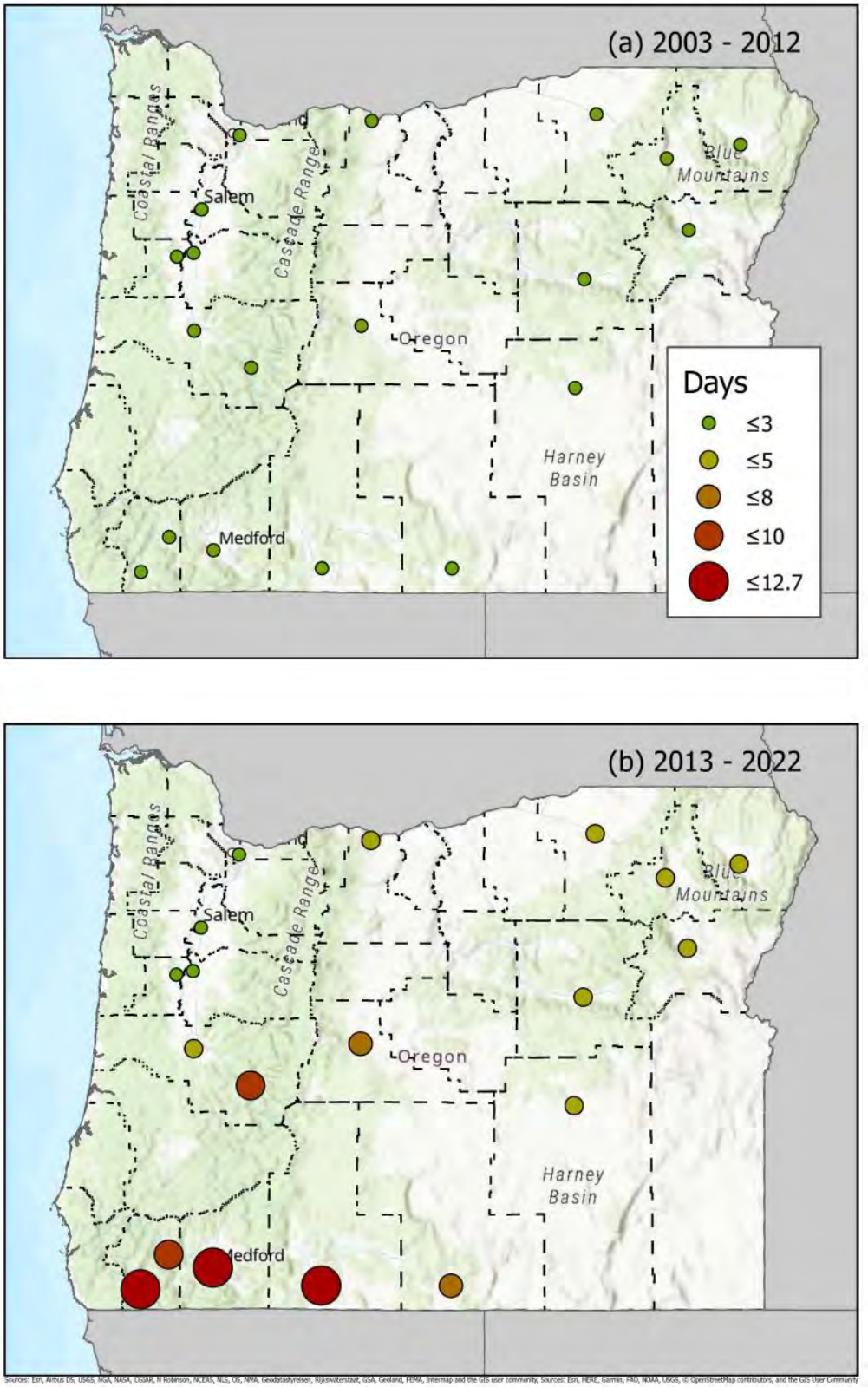

Figure 2. Average number of AQI days at USG or above from wildfire smoke, 2003 to 2022.

Discussion

Wildfire smoke impacts are increasing across the state. There are more ≥USG days per year and more years with at least one ≥USG event. The most significant impacts from fires are in Southern Oregon, however, smoke impacts Eastern Oregon the Willamette Valley, and Portland as well.

The 2022 wildfire season was less smokey than recent years in SW Oregon with two large fires, one in Oregon and one in California, at the border. The Rum Creek Fire in Josephine County started on August 17th and burned 21 thousand acres. It mainly impacted Grants Pass. The other large fire was the McKinney Fire just south of the Oregon border in Siskiyou County, California. It started on July 29th and lasted until September 7th, burning over 60 thousand acres. Its smoke mostly impacted SW Oregon communities like Medford.

The largest fire in Central Oregon was the Cedar Creek Fire just east of Oakridge, in the Western Cascades. It started on August 1st and burned into October. Its size increased rapidly in September when strong easterly winds and an unusually warm weather impacted Oregon. In total, 127 thousand acres burned and its smoke impacted communities such as Oakridge, Eugene, Springfield, Prineville, and Bend.

NE Oregon had a few large fires as well. The Double Creek Fire by Enterprise started on August 30th and burned into October. It charred over 171 thousand acres and the smoke impacted communities in NE Oregon. The Sturgill Fire just east of La Grande started on August 22nd and burned into October. It burned over 23 thousand acres impacting NE Oregon.

The Portland Metro area was impacted by smoke from Nakia Creek Fire in Clark County Washington just north of the border. The fire was only around two thousand acres but its close proximity to the Portland-Vancouver metro area created smokey conditions for around a week.

Even though 2022 was not as smokey as more recent years, there were still long-lasting fires producing USG to hazardous AQIs in communities across Oregon. The 2022 AQI data has been compiled into the following trends summaries.

- Between 1987 and 2014, Bend had three unhealthy days caused by wildfire smoke. Between 2015 to 2022, Bend had 22 unhealthy days, five very unhealthy days and seven hazardous days.
- Klamath Falls had 20 unhealthy days before 2015 and had 61 unhealthy days between 2015 and 2022 from wildfire smoke. Klamath Falls had two very unhealthy days before 2015, five between 2015 and 2022, and its first hazardous day in 2020.
- Medford had 18 unhealthy days between 1985 and 2014 and had 66 between 2015 and 2022 from wildfire smoke. Medford had nine very unhealthy days between 1985 and 2014, mostly in 1987. From 2015 to 2022 Medford had nine. Medford had one hazardous day in 1987 and did not have another one until 2017. It had three in 2020.
- Portland had no unhealthy days or worse between 1985 and 2014 from wildfire smoke. From 2015 to 2022 it had seven unhealthy, three very unhealthy, and five hazardous days from wildfire smoke. The very unhealthy and hazardous days occurred in 2020.

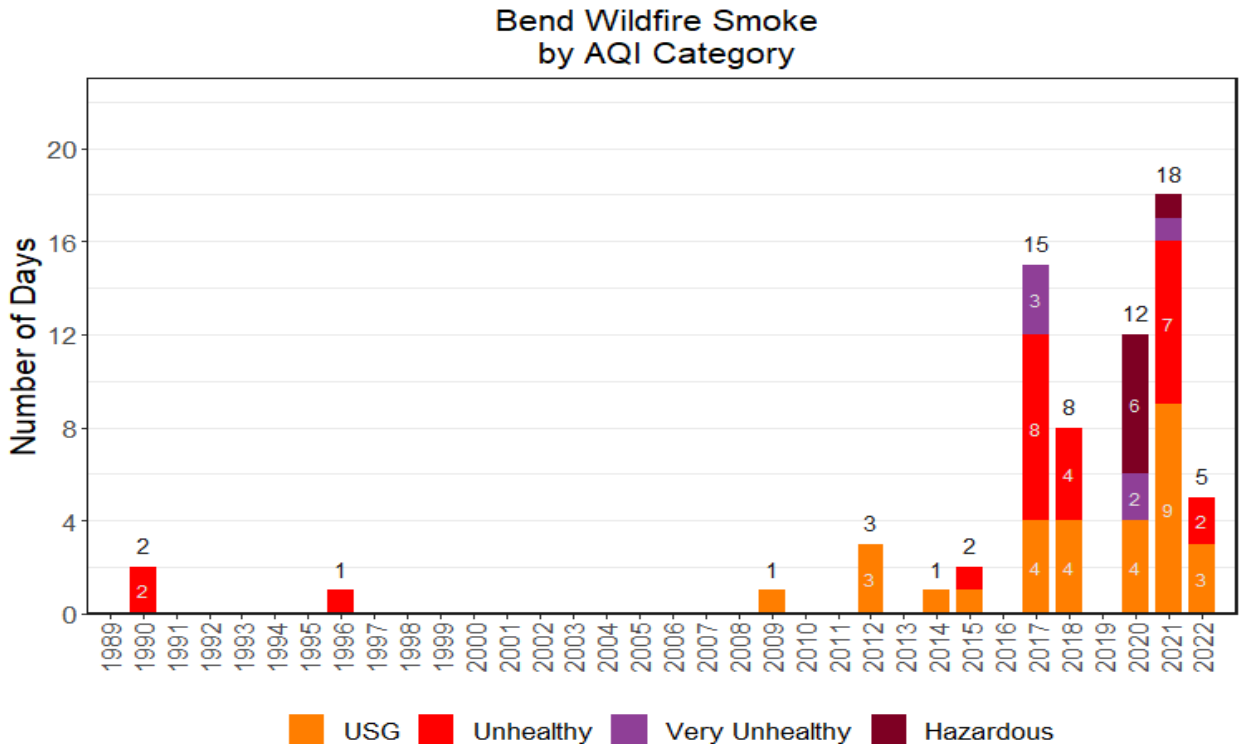

Figure 3. Bend ≥ USG AQI wildfire smoke trends.

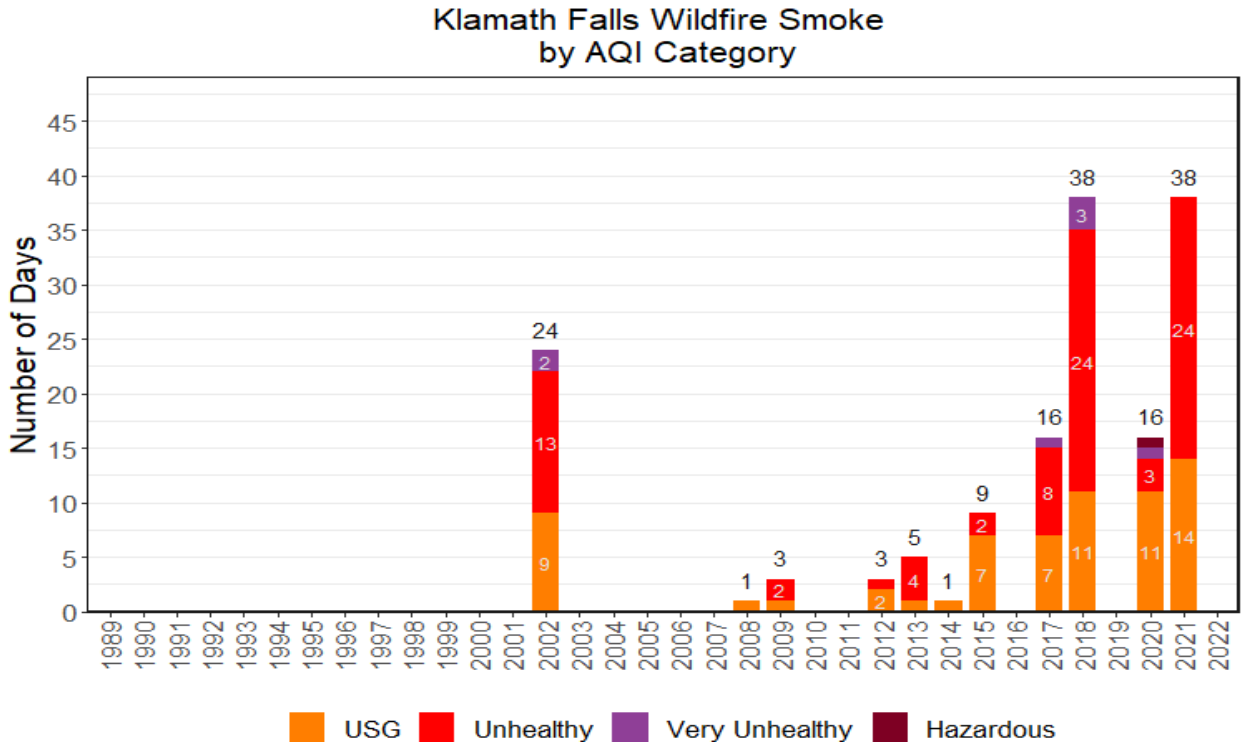

Figure 4. Klamath Falls ≥ USG AQI wildfire smoke trends.

Note: No data was collected during the summer from 1991 through 1995, 1997, and 1998.

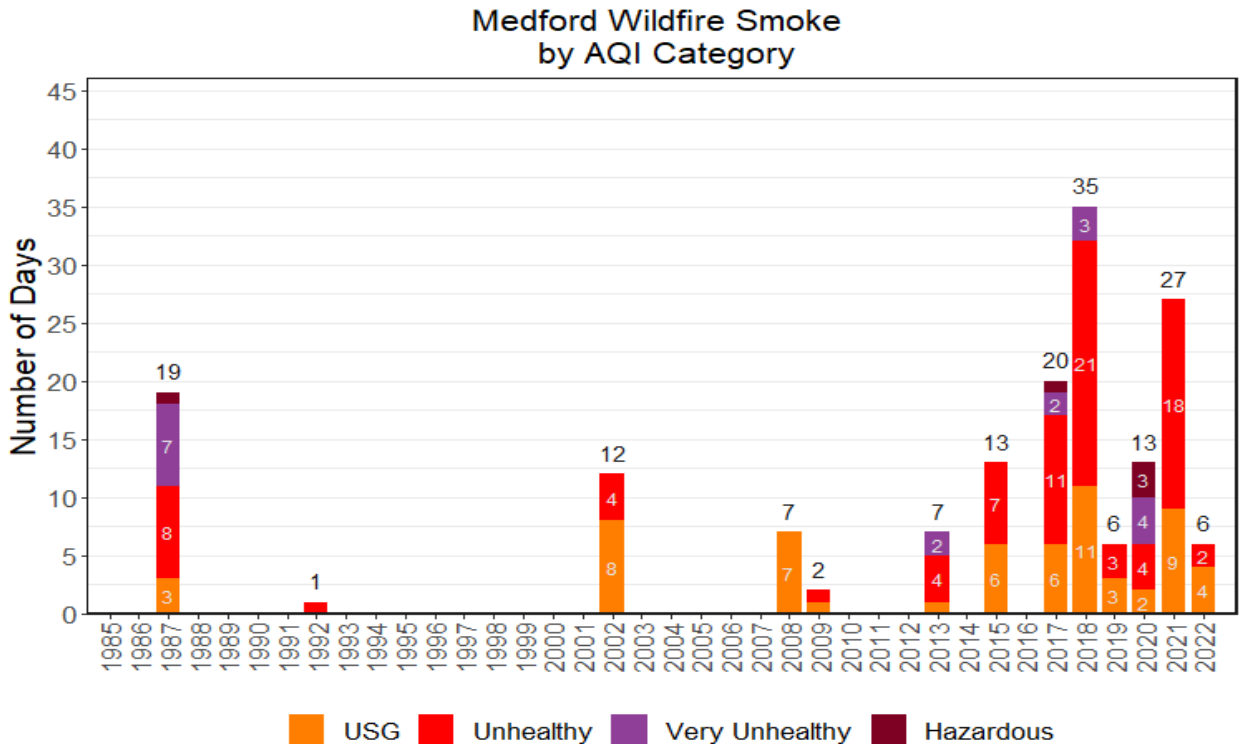

Figure 5. Medford ≥ USG AQI wildfire smoke trends.

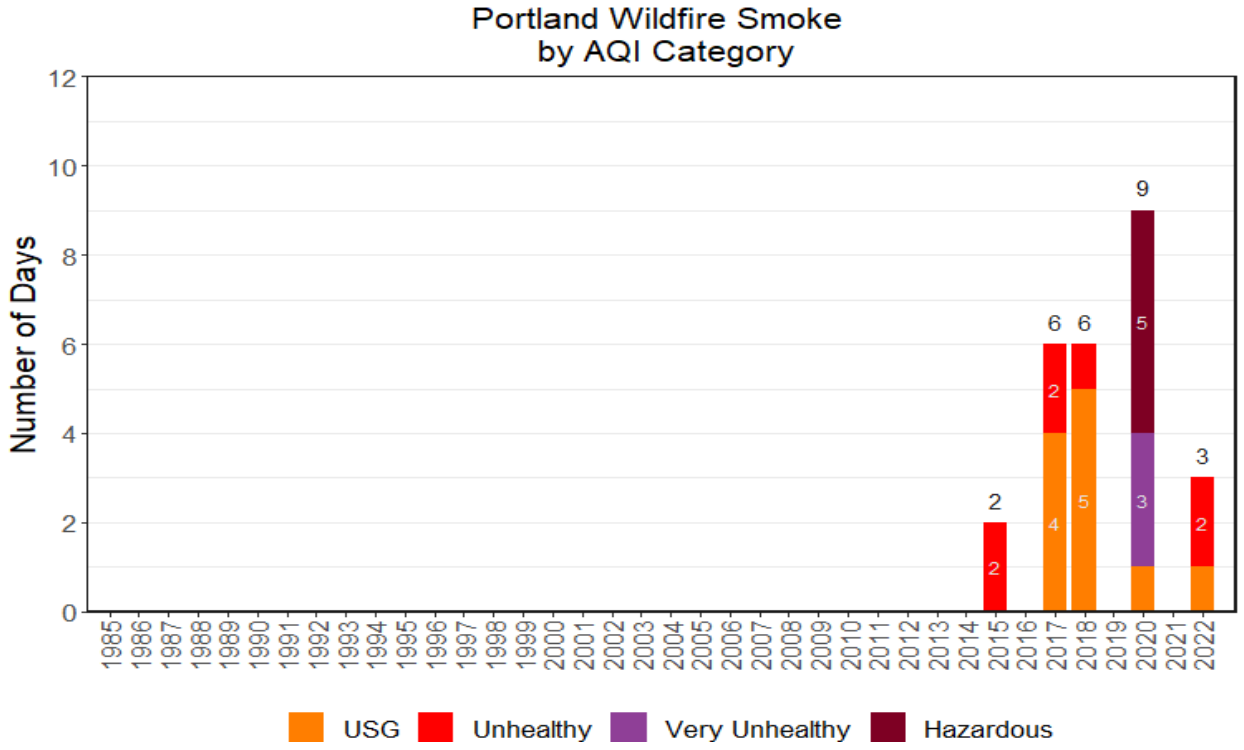

Figure 6. Portland ≥ USG AQI wildfire smoke trends.

Note: USG days not included: two in 1985, one in 1987, and one in 1990. These were likely from field burning.

Conclusion

This report is intended to explain the AQI and show AQI trends from wildfire smoke impacts. The data shows that AQI categories from wildfire smoke have been increasing starting around 2012, with more frequent days at more "unhealthy" or worse levels, including the record-breaking events of September 2020. If these trends continue, Oregon should expect to see an increasing number of days with an AQI ≥USG during the summer, and not just in Southern Oregon where it is more common, but across the state. This will include areas which have historically not seen significant smoke impacts, such as the north coast area, the Willamette Valley, and the Portland Metro area.

Learn More

EPA's Wildland Fire Publications, Fact Sheets and Other Resources

AQI – A Guide to Air Quality and Your Health

Track current air quality on DEQ's online Air Quality Index or the free Oregon Air app.

During wildfire season, you can also track air quality at OregonSmoke.org.

Wildfire Smoke and Your Health, Public Health Division, Oregon Health Authority.

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Appendix

Wildfire Trends for Individual Communities

The graphs below show the number of days with an AQI ≥USG for 20 communities with monitoring data. The horizontal axis (or date) varies for each chart depending on when monitoring was started.

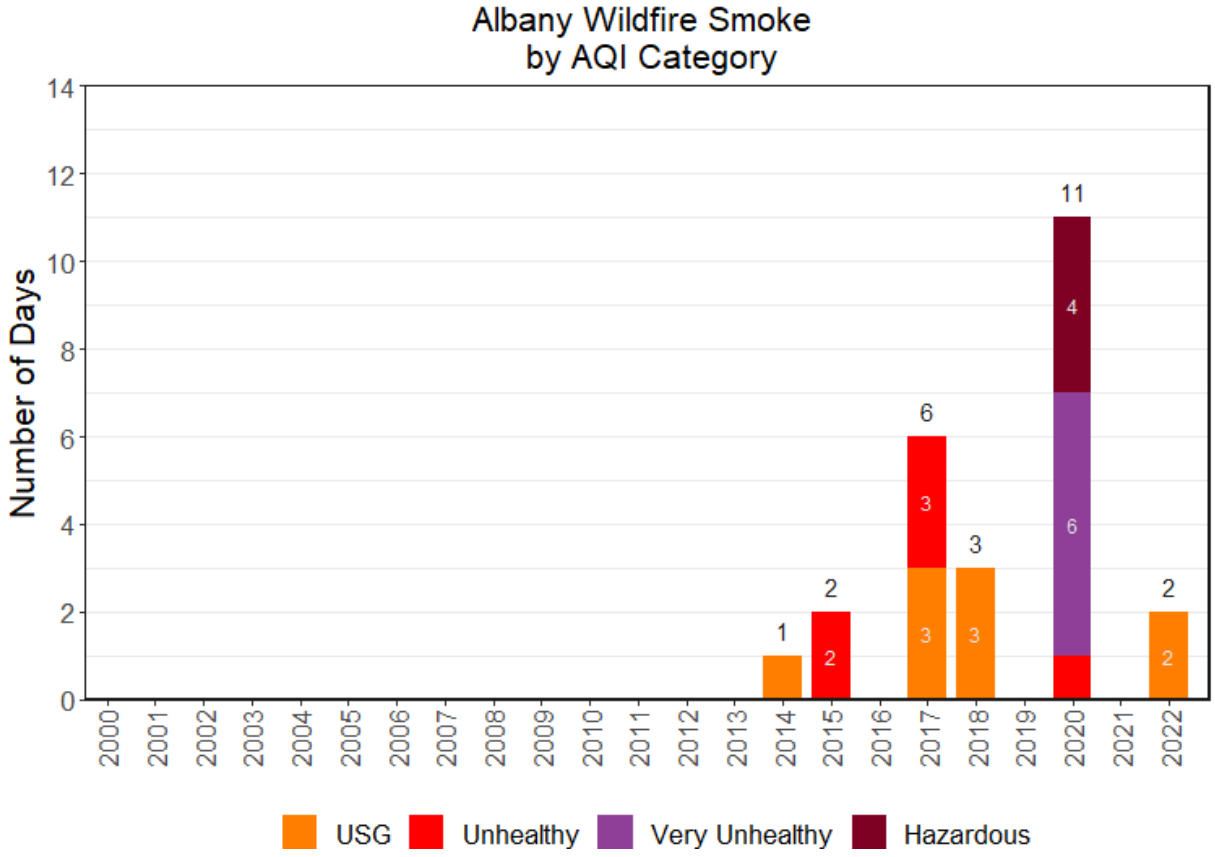


Figure 7. Albany wildfire ≥ USG AQI wildfire smoke trends.

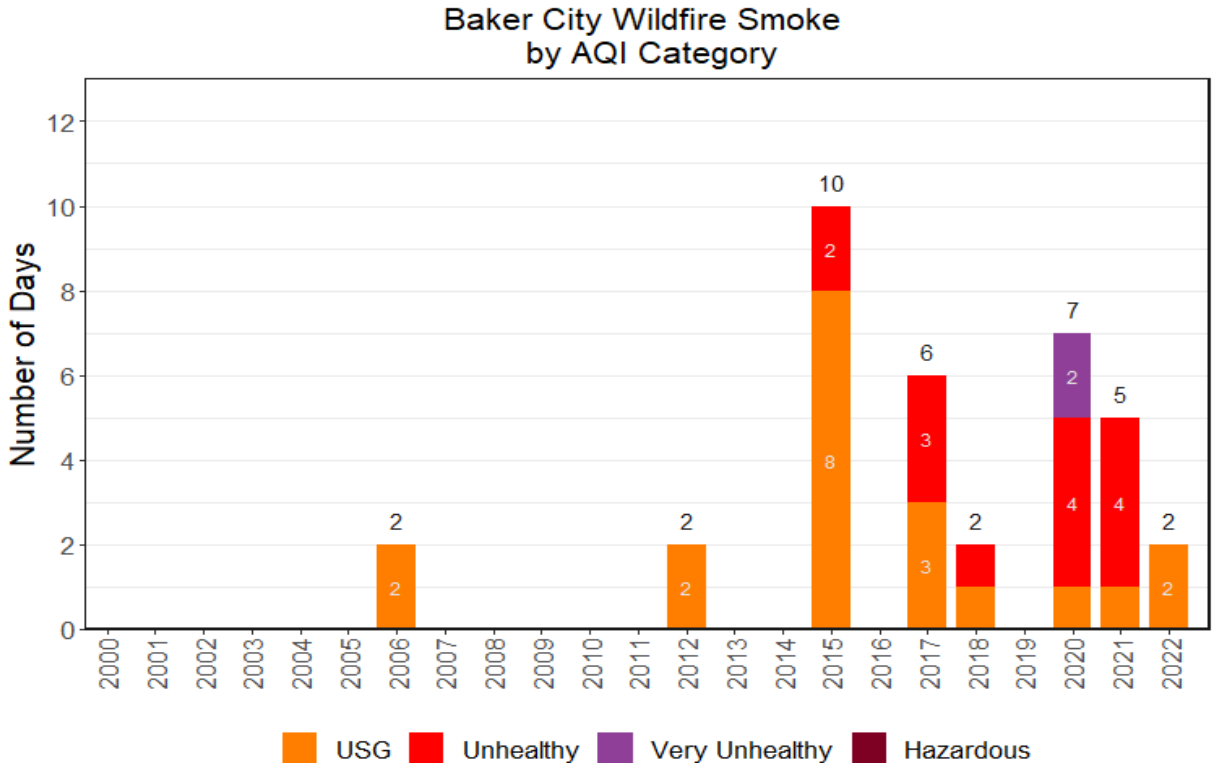


Figure 8. Baker City wildfire ≥ USG AQI wildfire smoke trends.

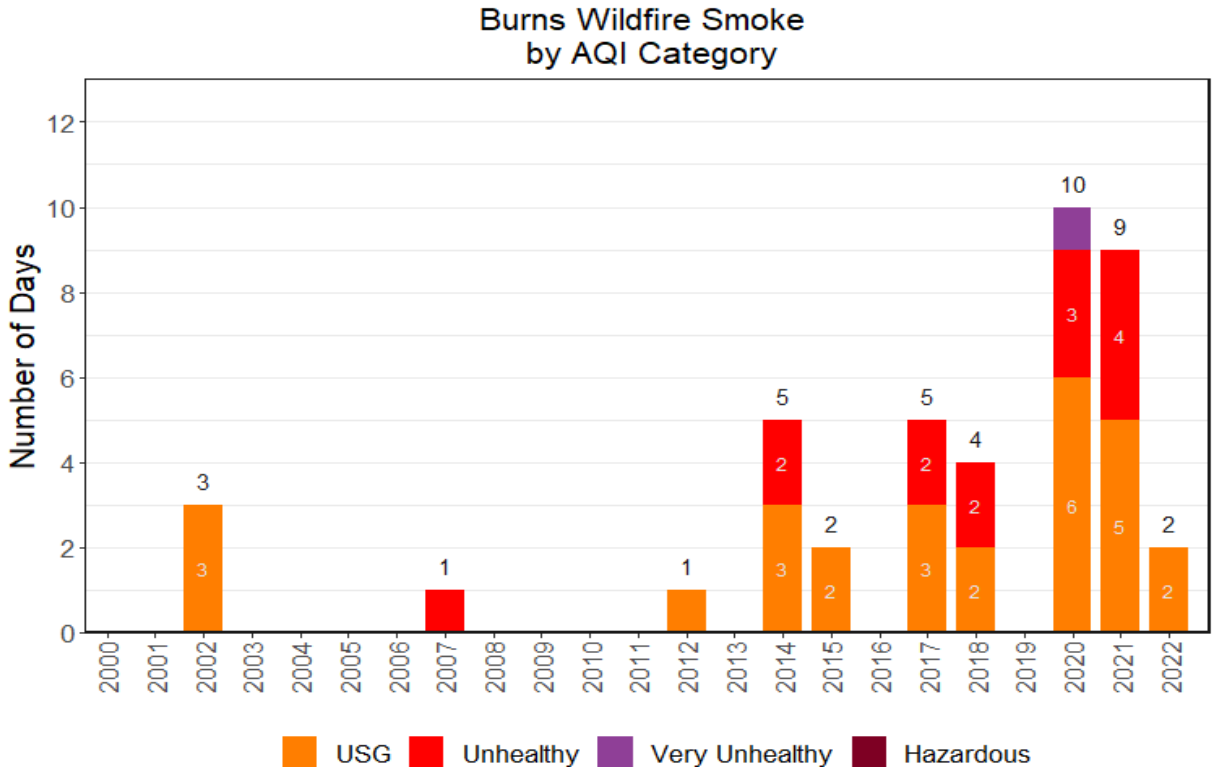


Figure 9. Burns wildfire ≥ USG AQI wildfire smoke trends.

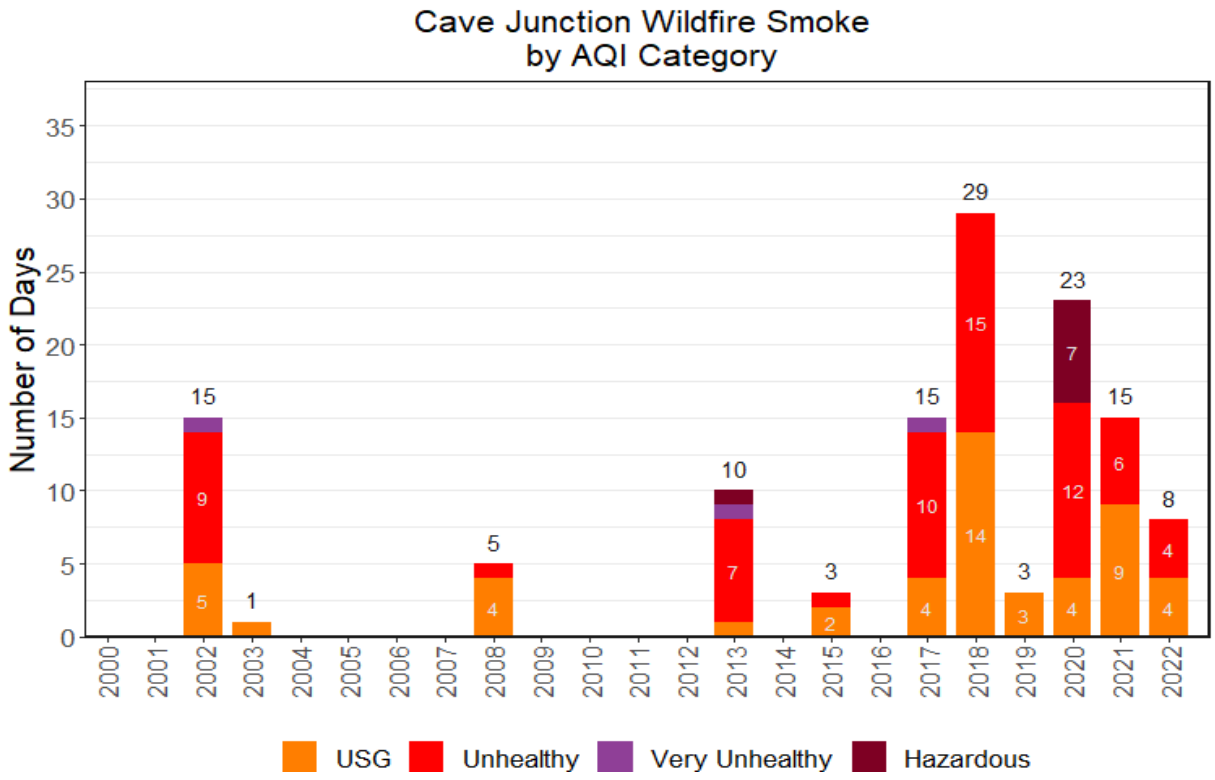


Figure 10. Cave Junction wildfire ≥ USG AQI wildfire smoke trends.

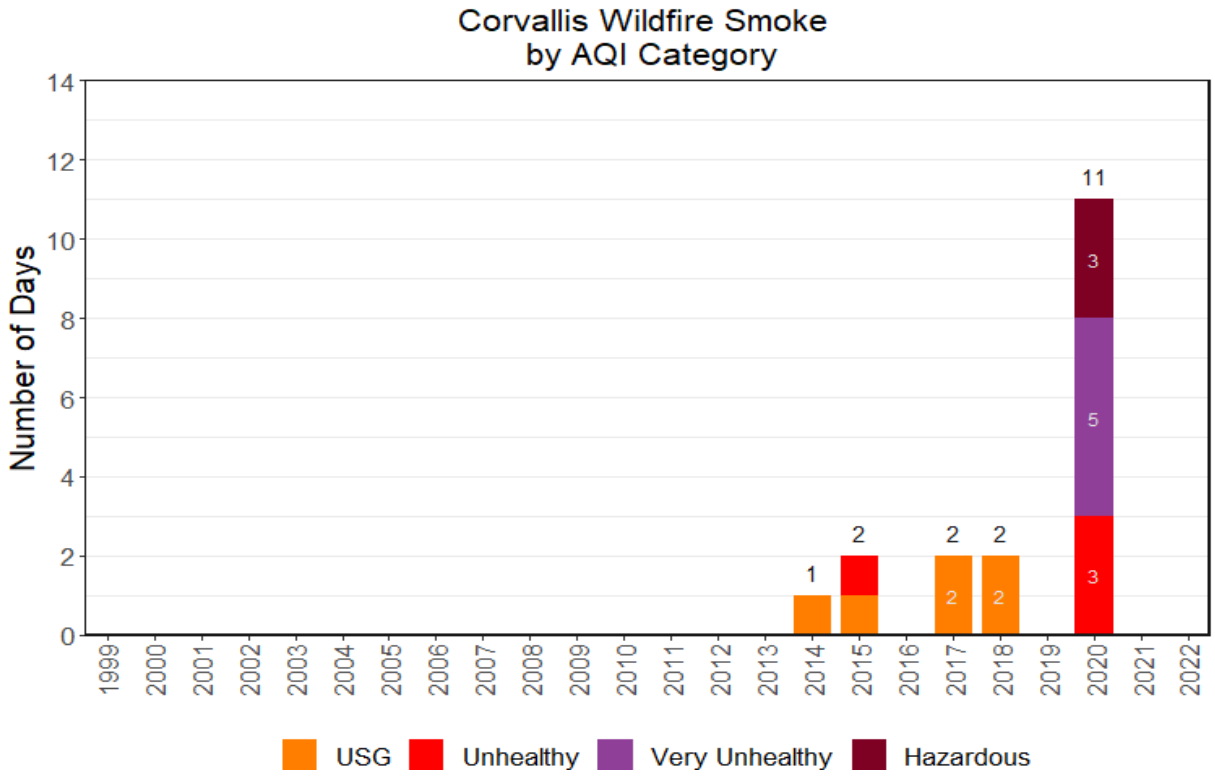


Figure 11. Corvallis wildfire ≥ USG AQI wildfire smoke trends.

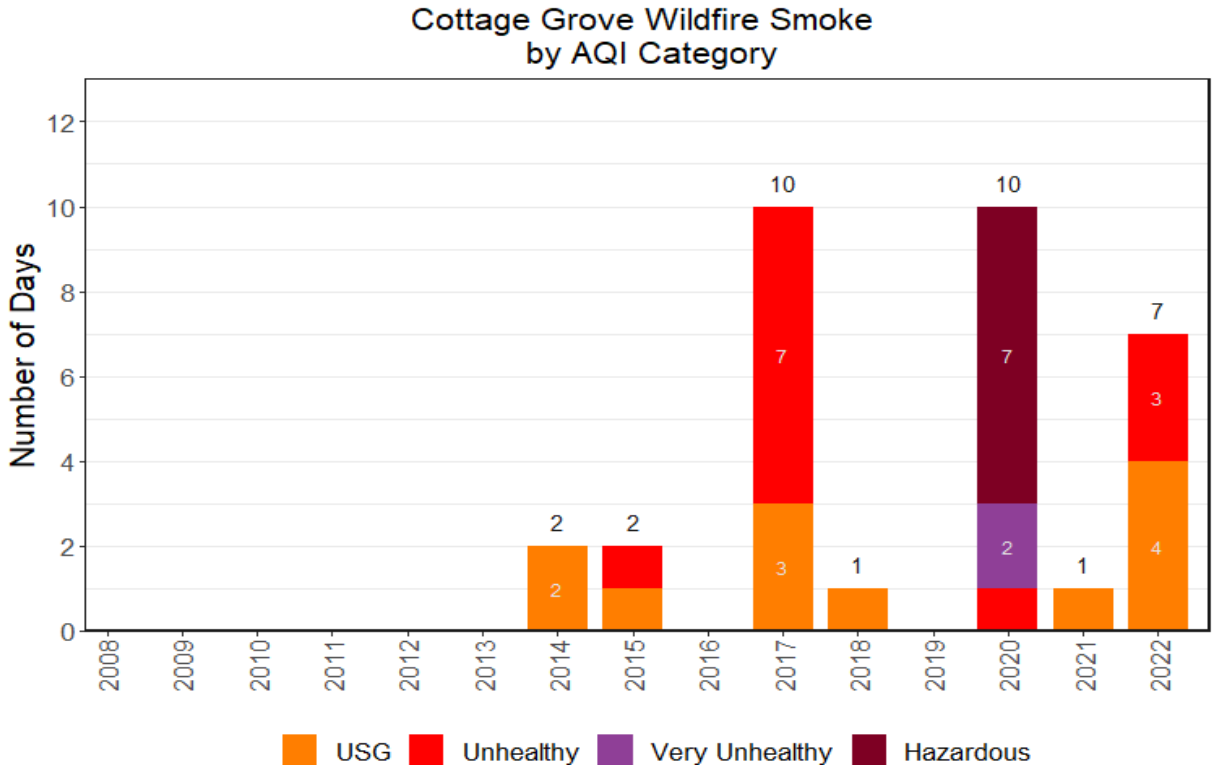


Figure 12. Cottage Grove wildfire ≥ USG AQI wildfire smoke trends.

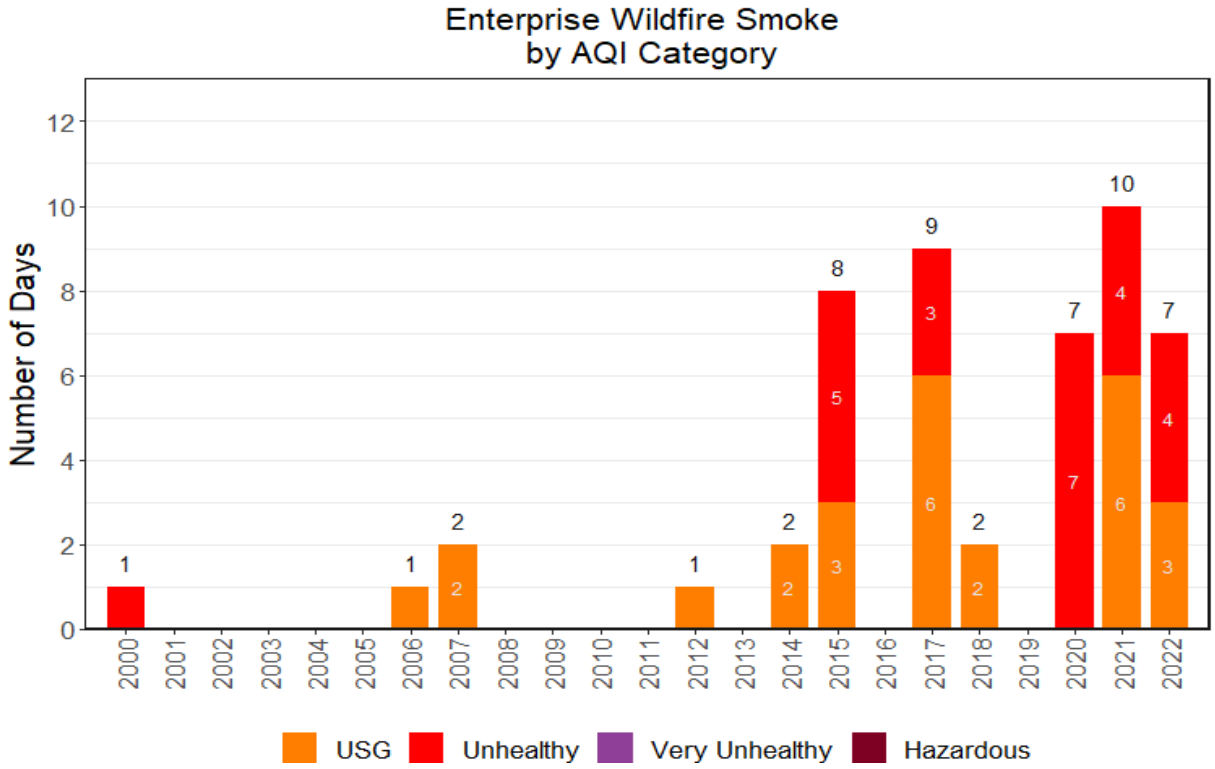


Figure 13. Enterprise wildfire ≥ USG AQI wildfire smoke trends.

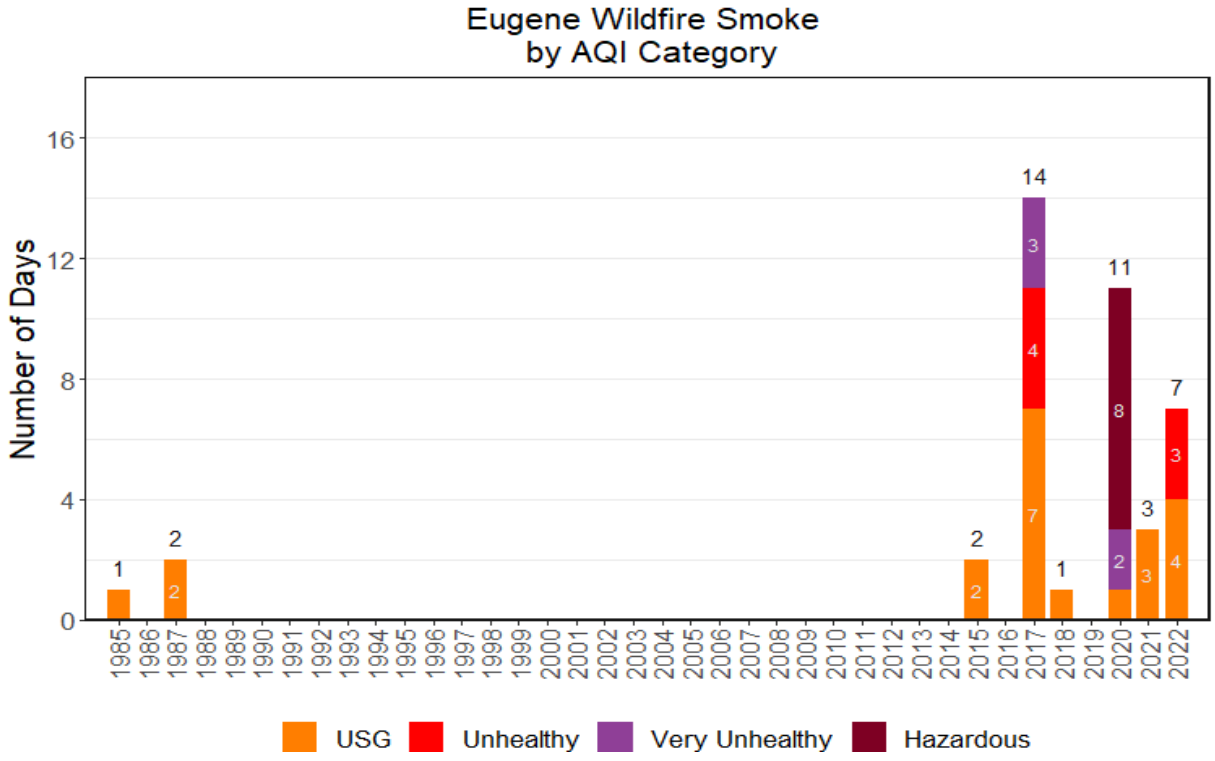


Figure 14. Eugene/Springfield wildfire ≥ USG AQI wildfire smoke trends.
1985 and 1987 were likely field burning.

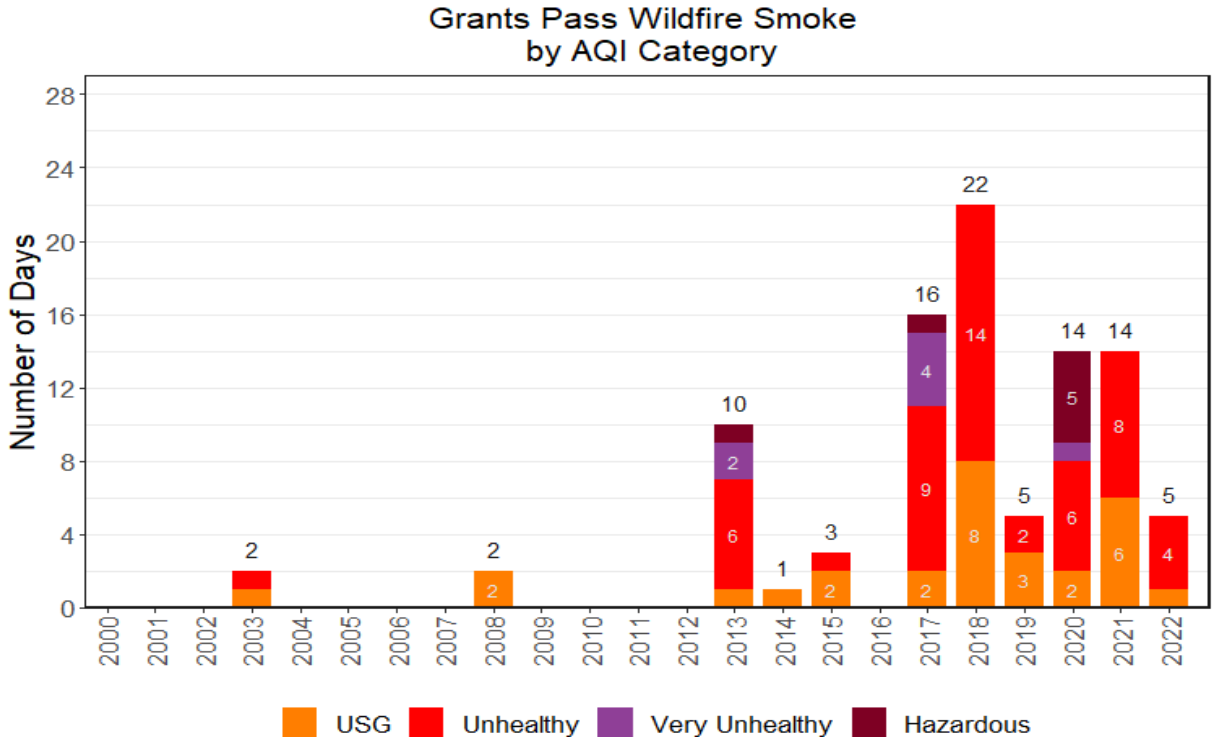


Figure 15. Grants Pass wildfire ≥ USG AQI wildfire smoke trends.

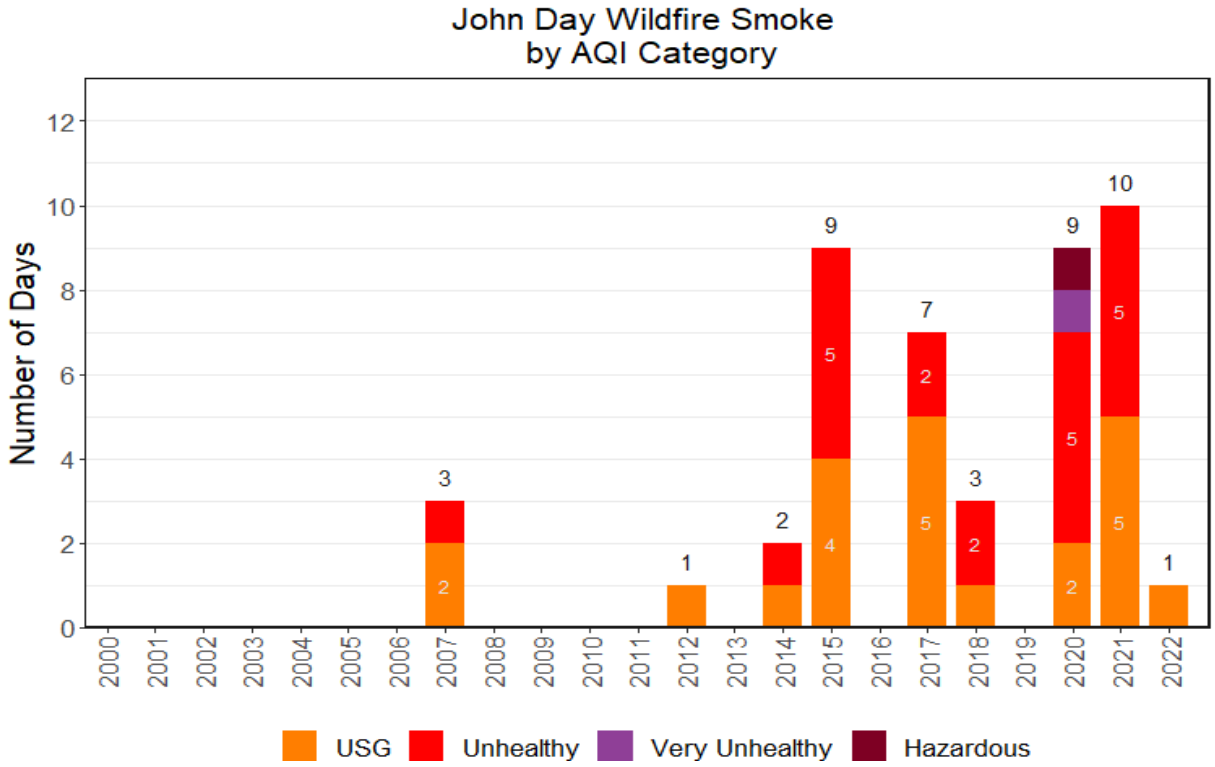


Figure 16. John Day wildfire ≥ USG AQI wildfire smoke trends.

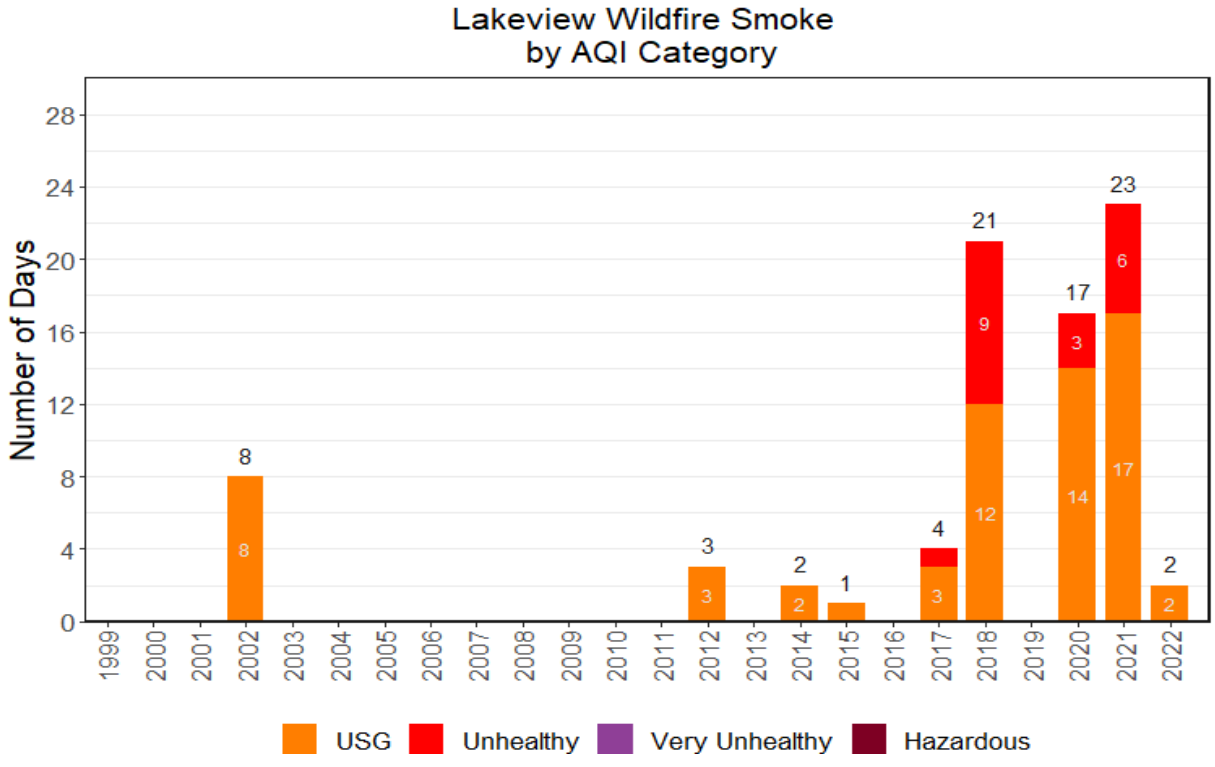


Figure 17. Lakeview wildfire ≥ USG AQI wildfire smoke trends.

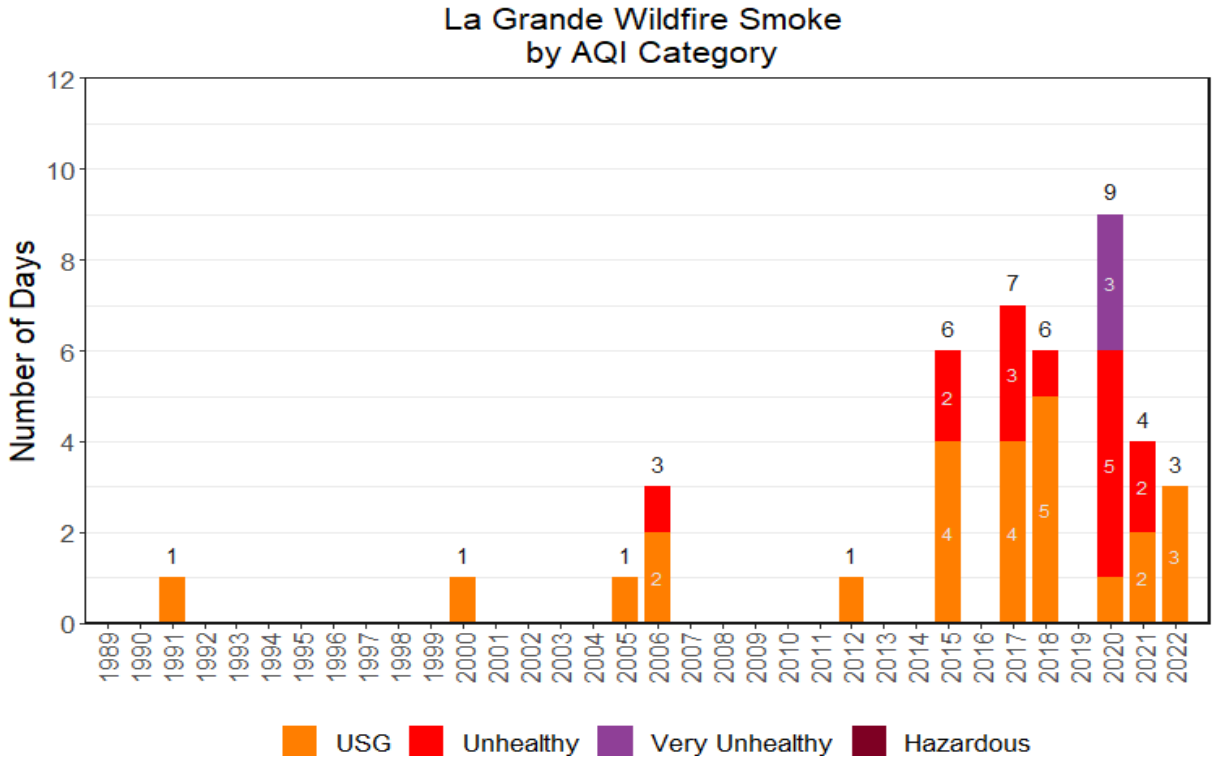


Figure 18. La Grande wildfire ≥ USG AQI wildfire smoke trends.

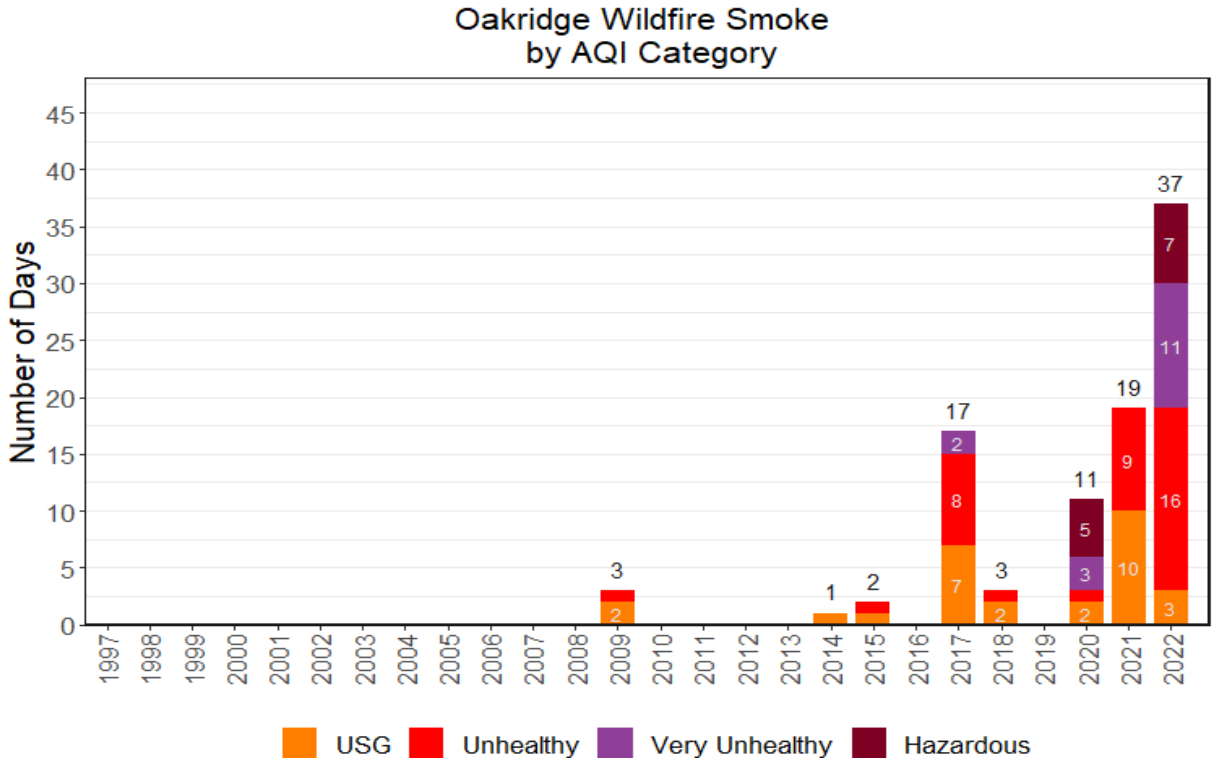


Figure 19. Oakridge wildfire ≥ USG AQI wildfire smoke trends.

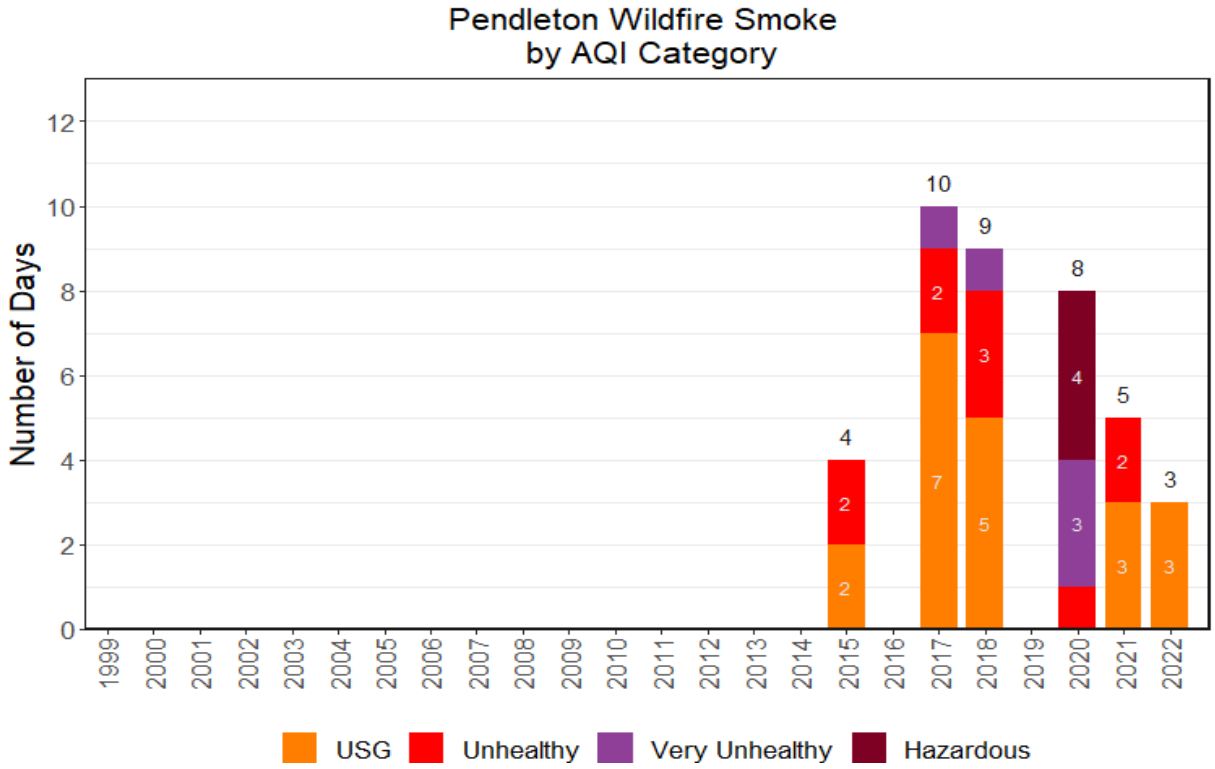


Figure 20. Pendleton wildfire ≥ USG AQI wildfire smoke trends.

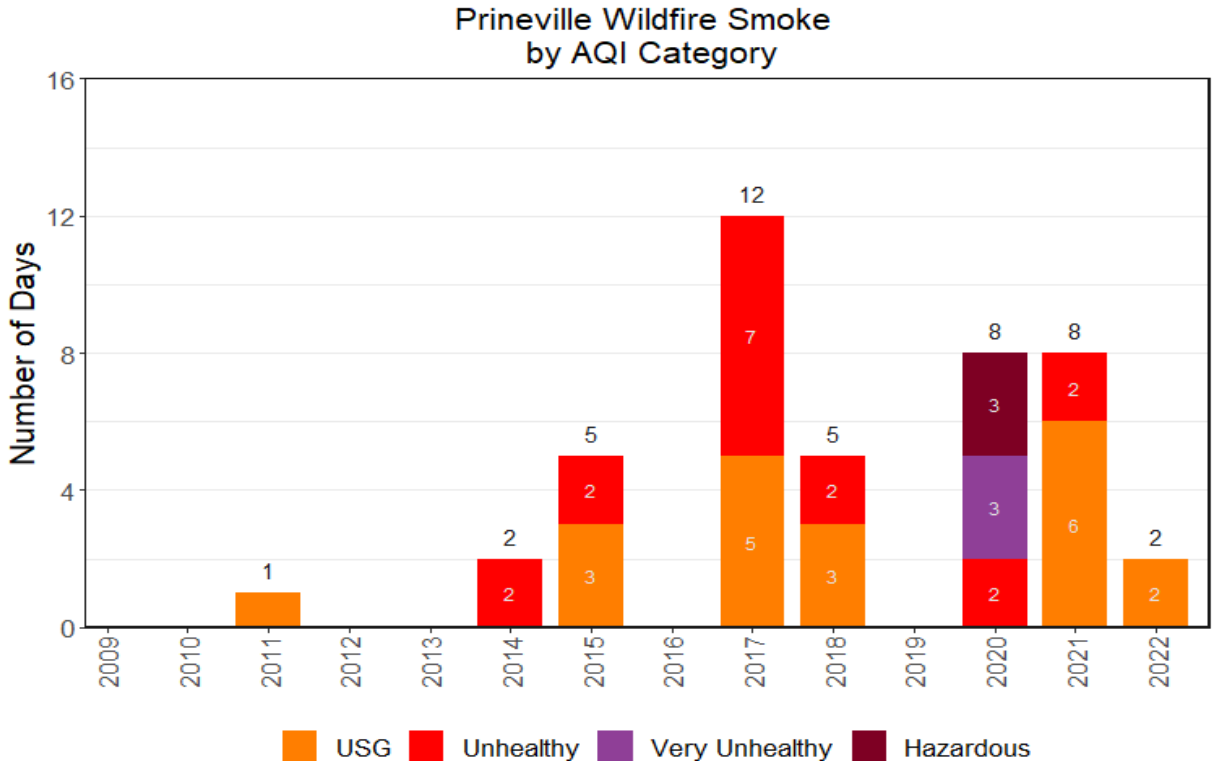


Figure 21. Prineville wildfire ≥ USG AQI wildfire smoke trends.

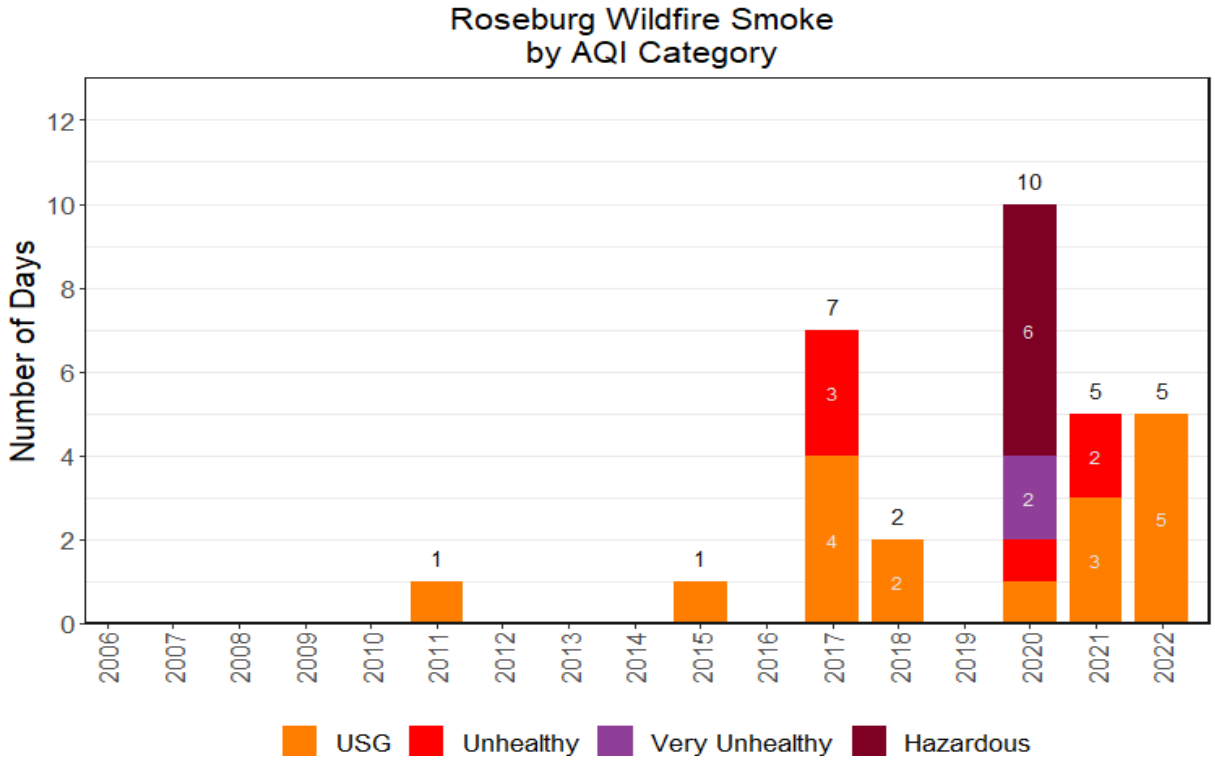


Figure 22. Roseburg wildfire ≥ USG AQI wildfire smoke trends.

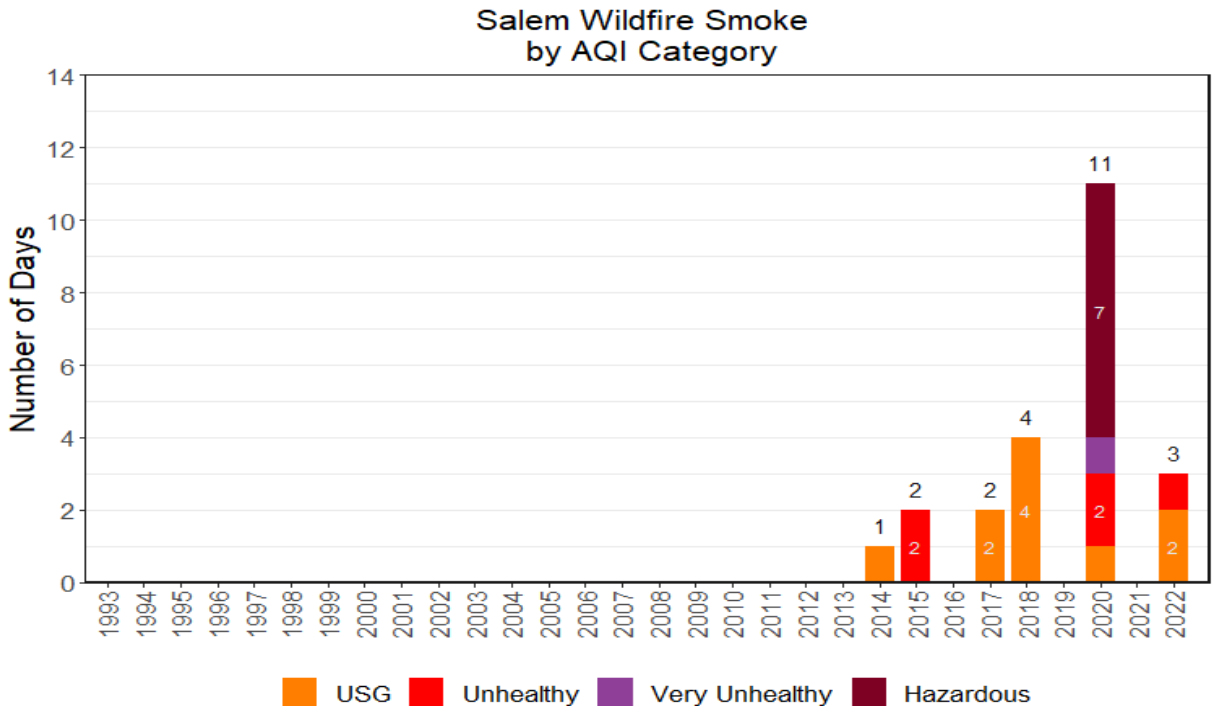


Figure 23. Salem wildfire ≥ USG AQI wildfire smoke trends.

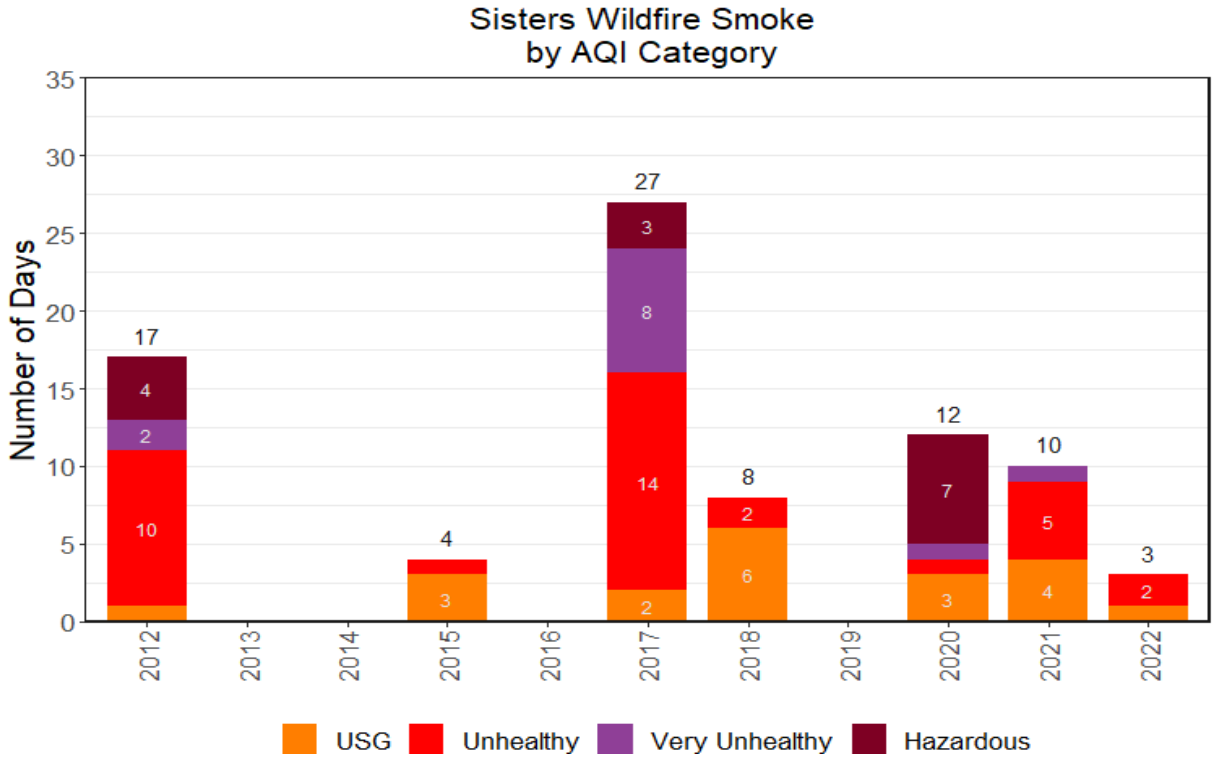


Figure 24. Sisters wildfire ≥ USG AQI wildfire smoke trends.

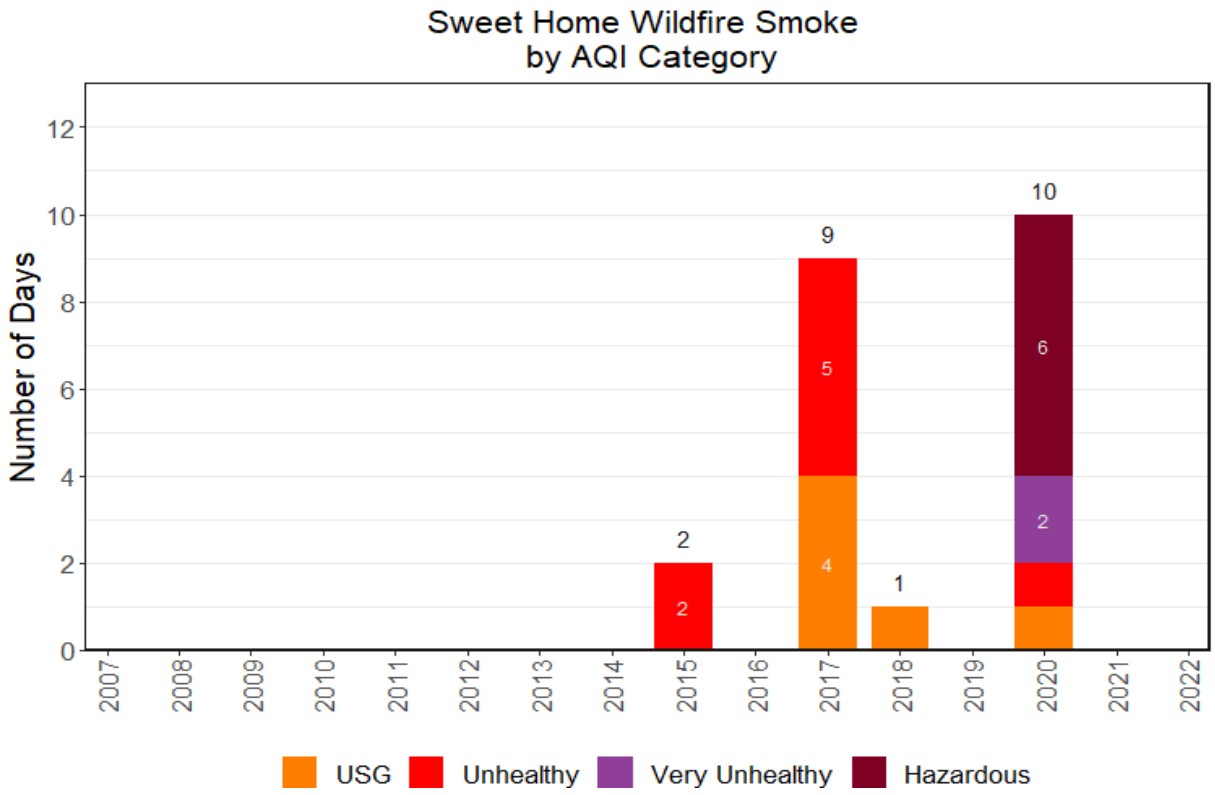


Figure 25. Sweet Home wildfire ≥ USG AQI wildfire smoke trends.

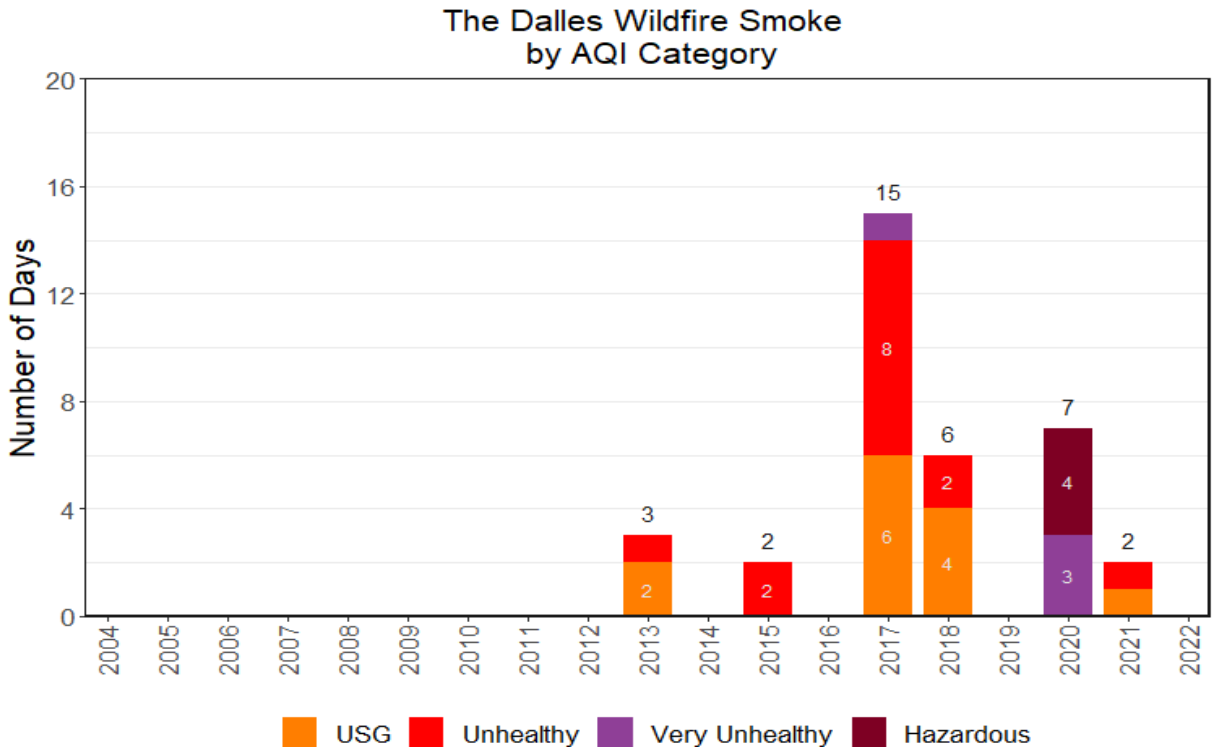


Figure 26. The Dalles wildfire ≥ USG AQI wildfire smoke trends.

How will climate change affect Northwest water?

PART ONE OF FIVE IN THE SERIES: CLIMATE IMPACTS IN THE NORTHWEST

Climate change will alter patterns of snowfall, rain and snowmelt, shifting how our region receives and stores water. These changes will have an impact on every aspect of life in the Northwest, from forests to farms, ski areas to cities.

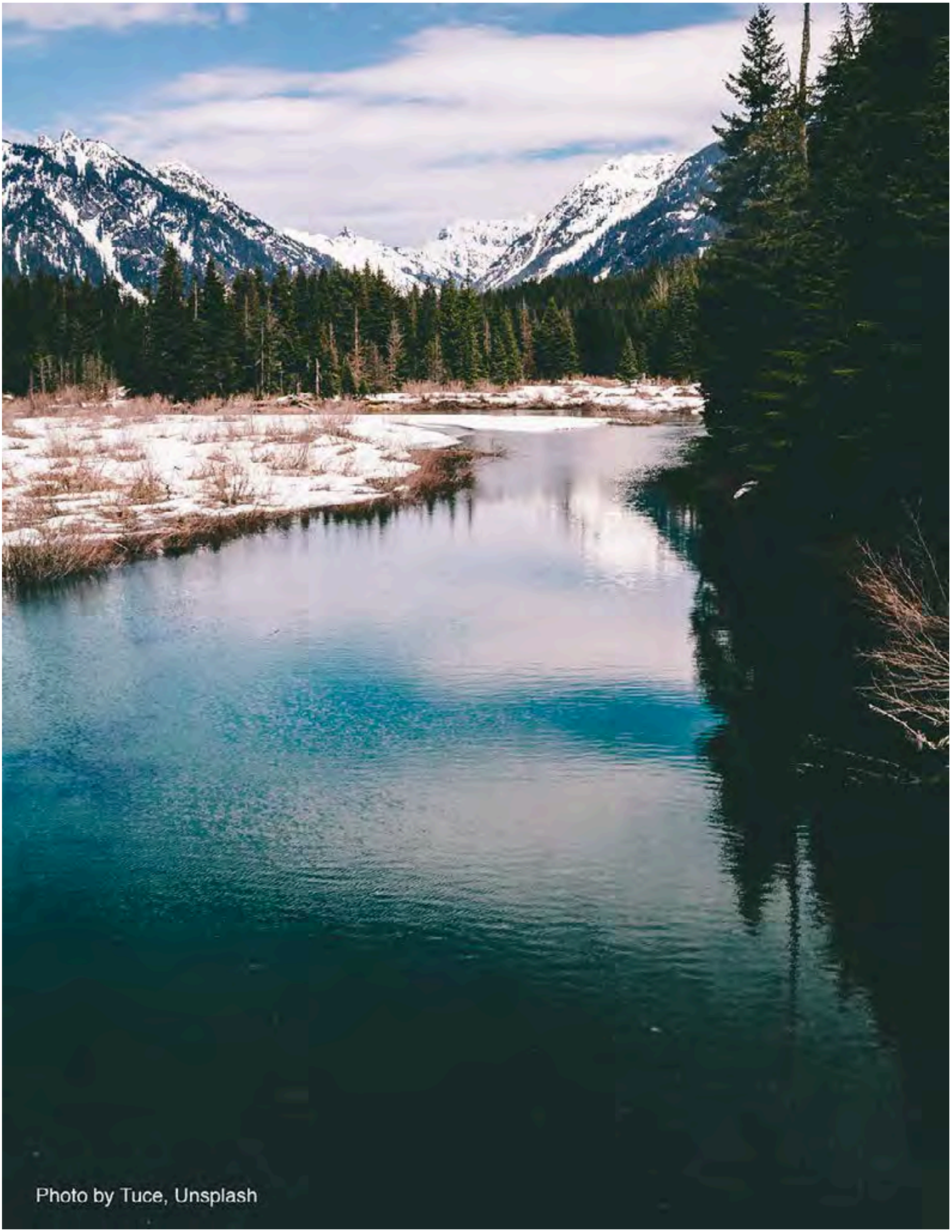


Photo by Tuce, Unsplash

Mountain snowpack is nature's water bottle – storing water for summer when there is less rain. Snowmelt from Northwest mountains provides water for drinking, hydropower, fish and more.

Warmer winters will mean less snowfall and earlier snowmelt in the mountains.

Snow melting earlier in the spring will lead to earlier spring flows, meaning a stream that typically was at its peak water level in May or June may see peak streamflows in April or May in the coming decades.

Summer precipitation is likely to decrease.

Most climate models suggest that we should expect less rain in summer. The results are more mixed for other seasons, but generally suggest slightly more rain in fall, winter and spring.

Decreased snowpack, earlier snowmelt and decreasing summer precipitation mean less water will be naturally available in the summer, when we need it most.

Photo credit Kendra Kaiser

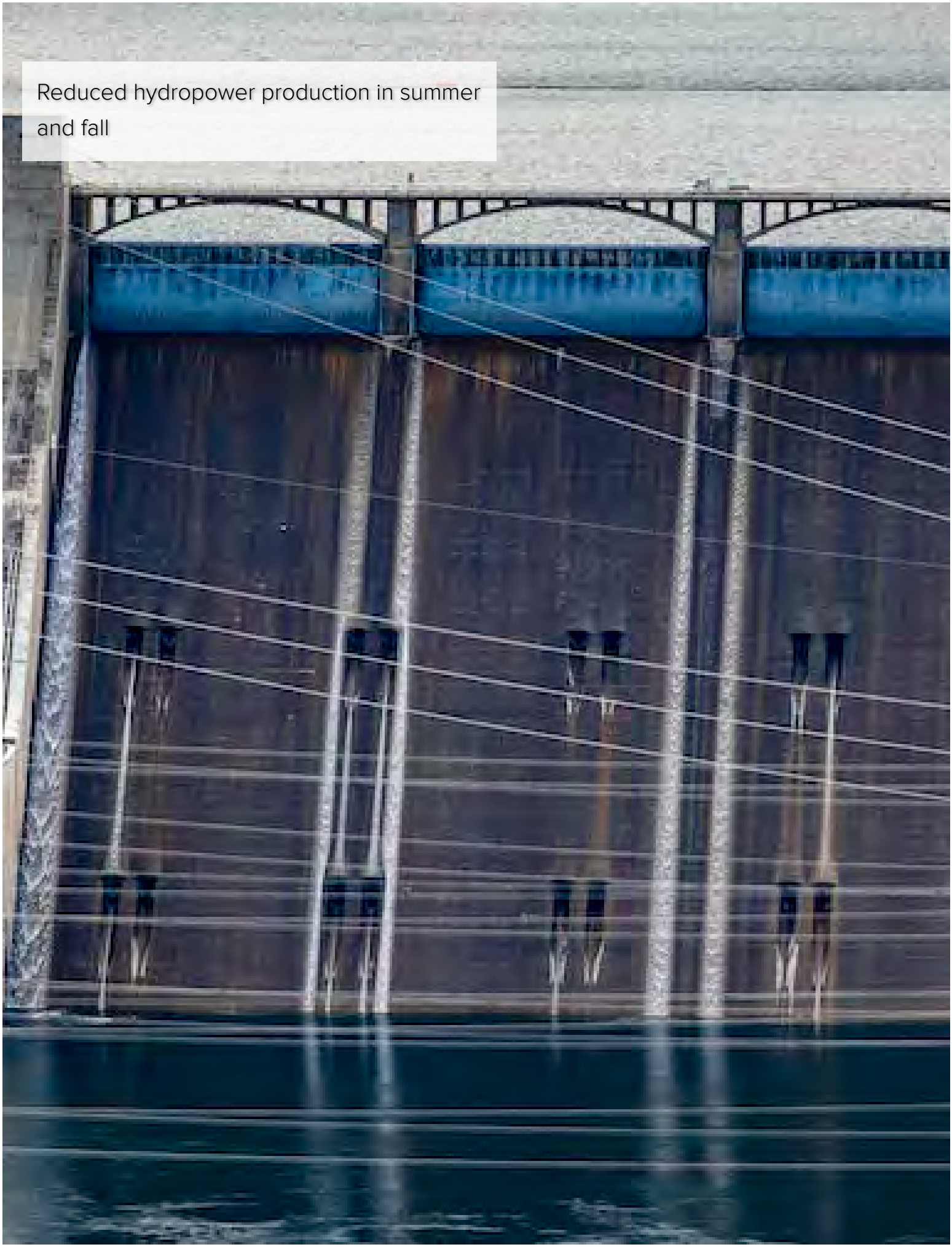
Higher river flows as well as heavier rainfall could increase flood risk, particularly in the fall and winter.

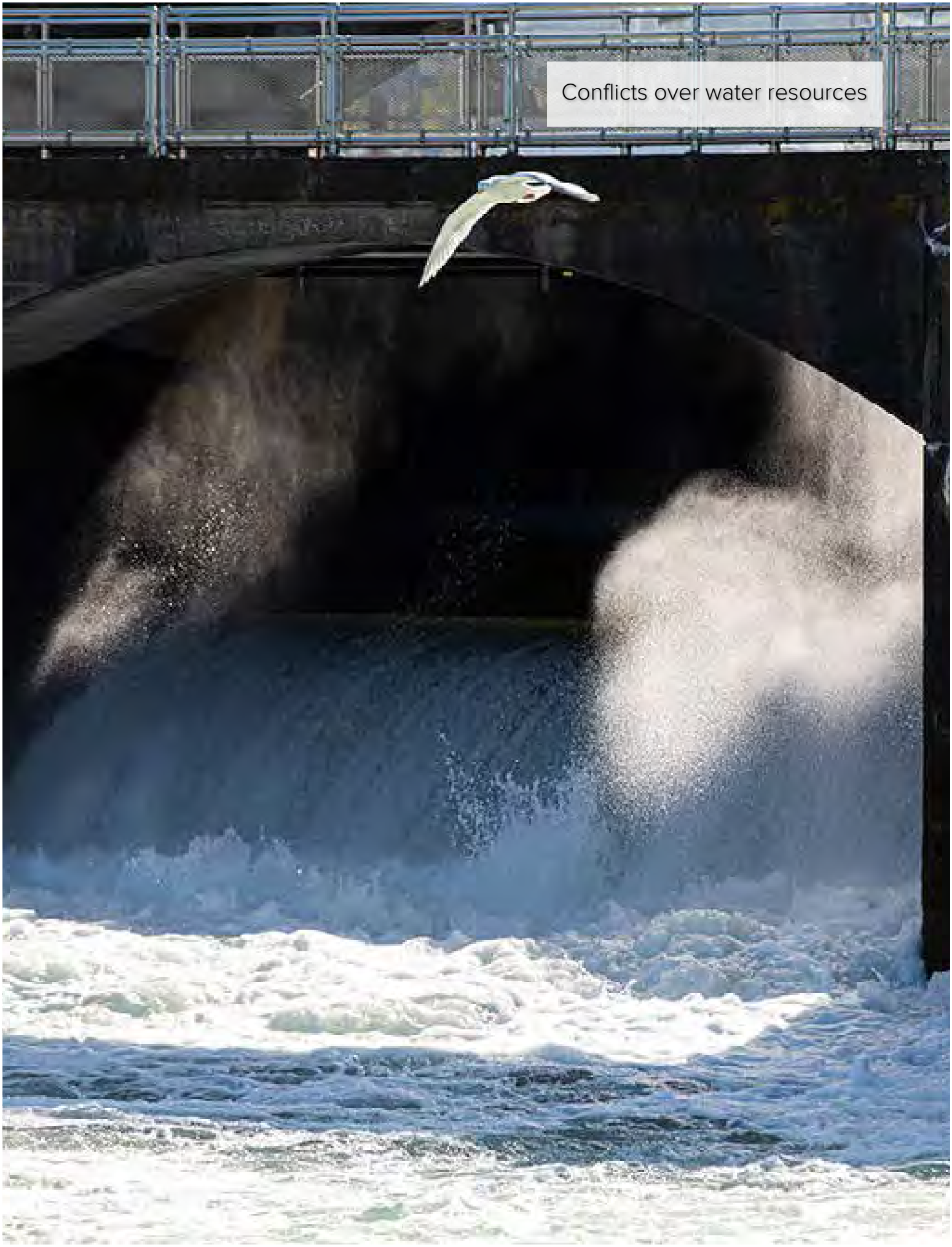
What does this mean for the Northwest?

Increased water in winter could lead to:

Water shortages

Reduced water available for growing crops


Reduced hydropower production in summer and fall


Conflicts over water resources

Threats to salmon populations

Declines in drinking water quality

Increased flooding in winter could lead to:

River flooding

More erosion and landslides

Costly stormwater management and flood protection

Threats to salmon populations

The impacts of climate change on water availability and flooding are daunting, but there is a lot we can do to prepare. For example, when roads or culverts are updated due to damage or for regular maintenance, we can incorporate projections of future precipitation into their design to better accommodate future heavy rains and snowmelt.

How are communities preparing for climate impacts on water?

How will climate change affect Northwest forests?

Appreciate

Credits:

Created with images by Markus Gjengaar - "A visit to the summit of Mt. Rainier" · Nathan Dumlao - "untitled image"

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Climate change and chill accumulation: implications for tree fruit production in cold winter regions

Hossein Noorazar[1] · Lee Kalcsits[2] · Vincent P. Jones[3] · Matthew S. Jones[3] · Kirti Rajagopalan[1]

Received: date / Accepted: date

Abstract Winter chill accumulation is critical for the productivity and profitability of perennial tree fruit systems. Several studies have quantified the impacts of global warming on chill accumulation in the warmer tree fruit and nut production regions of the world, where insufficient chill events are currently prevalent and the frequency of these events is increasing. In contrast, we focus on an important tree fruit production region with relatively cold winters and current absence of insufficient chill events, and quantify the potential for introduction of these risks under climate change and understand the key drivers and management implications. Our case study is the Pacific Northwest United States (PNW)- the leading apple producing region in the county. Our results identify large spatial variations in response within the PNW, with chill accumulation projected to increase in northern areas but decrease in southern areas. There is also spatial and temporal variation in the driving factors resulting in changes to chill accumulation. Our results highlight that with warming, colder regions can potentially shift from being regions where the spring phenology is primarily forcing-driven to one where the chilling and forcing processes significantly overlap and the dynamic interplay between these processes become important. These complex dynamics potentially create new production risks which have not historically been a concern and necessitate planning for management strategies

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such as overhead irrigation for cooling and chemical management of budbreak. Future work should focus on understanding, modeling and projecting responses across these overlapping chilling and forcing processes. Additionally, given significant spatial differences across a relatively small geographic range, it is also critical to understand and model these dynamics at a local landscape resolution for regions such as the PNW.

Keywords climate change · chill requirement · global warming · Dynamic Model · tree fruit · dormancy · bloom

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1 Introduction

Winter chill accumulation is critical for productive and profitable temperate tree fruit production systems. Specifically, chilling affects the emergence from endodormancy, transition to ecodormancy, and the resumption of growth in spring [1]. Commercial varieties have a breadth of chilling requirements that make them suitable for diverse regions [2,3,4]. Insufficient chill accumulation has adverse impacts (e.g. increased flower bud abscission, non-uniform bud break, reduced flower and fruit quality), affecting both fruit and vegetative development [5]. Currently, these issues are important in warmer temperate tree-fruit growing regions such as Israel, South Africa, Spain, and California where varietal selection can be often be based largely on chill requirements [6,7,8,9,10,11]. While climate change impact studies on insufficient chill accumulation have focused on these currently at-risk areas [7,8,9,12,13,14,15,16], future warming and associated decreases or delays in winter chill accumulation can introduce risks in regions with historically cooler winters.

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Dormancy in tree fruit species is a time period where buds remain inactive. Establishing more accurate terminology, Lang et al. [17] proposed two dormancy stages - endodormancy and ecodormancy - defined by physiological and environmental inhibitions of regrowth, respectively. The stages are not discrete, but dynamic in response to environmental stimuli [18]. Dormancy induction in fall is regulated by either photoperiod, or temperature, or a combination of both [19,20,21]. Once dormancy is induced, a tree will remain endodormant until it fulfills its chilling requirement at which point it enters ecodormancy when environmental conditions prevent budbreak; chilling and heating (forcing) requirements need to be fulfilled for budbreak. The chill and heat accumulation periods can overlap. However, in relatively cool temperate climates, chill requirements are frequently met during early winter and spring phenology is primarily affected by the forcing requirements and minimally affected by chill accumulation [22,23]. In contrast to relatively warmer regions, which currently experience higher risks of insufficient chill accumulation, there can be high overlaps between chilling and forcing processes and the dynamic interplay between them are more relevant for spring phenology and bud break [22]. With climate change, regions with cold winters can face delayed chill accumulation and advanced forcing resulting in a regime shift: spring phenology shifts from one that is primarily forcing driven to one where the interplay between chilling and forcing processes become more important.

Our objective was to focus on a region with cooler winters - that does not currently face risks of insufficient chill accumulation - and understand the potential evolving risks under climate change. We take the US Pacific Northwest (PNW) as a case study. Although temperate tree fruit crops are grown throughout the continental US, the PNW is the largest apple and sweet cherry production region in the country. The PNW accounted for 67% of the US apple production in 2018 with a value of $2.1 billion, and 87% of the US fresh cherry production valued at $470 million (USDA NASS 2018 statistics). Cool wet winters and warm dry summers of the PNW are ideal for specialty crop production. Irrigation water availability and proximity to processors and markets provide an additional competitive advantage [24]. Therefore, while risk of insufficient chill accumulation is currently insignificant in the PNW, given its position as the largest production area in the US for multiple tree fruit, it is an ideal case study to understand future production risks under warming. Only two studies have addressed climate change impacts on chill accumulation for tree fruit in the PNW and they were either restricted to two locations with only one time-frame (2020–2049) [24] or in the larger context of tree fruit production worldwide [3], and diverge in results. In the first study [24], high chill-requirement cultivars in one location faced insufficient chill accumulation as early as the 2030s, but was relatively unaffected in another. In contrast, the second study, which highlighted a location in Canada close to the northern part of the PNW, reported an increase in chill accumulation [3]. Neither considered chill accumulation in the context of forcing nor described potential shifts in processes that drive

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spring phenology. Unrelated to tree-fruit, Harrington and Gould [25] noted potential reductions in chill accumulation in boreal tree species in the PNW.

A variety of temperature-based empirical models have been developed to estimate chill accumulation and the transition from endo- to ecodormancy. These include the Chilling Hour Model [26], the Utah Model [27], and the Dynamic Model [28,29]. The Dynamic Model takes into account the positive effect of cool temperatures, the negative effect of high temperatures, the positive effect of moderate temperatures, the effect of moderate temperatures alternating with chilling temperatures, and the time heterogeneity of chilling negation. The Dynamic Model has been reported to better capture the dynamic nature of the chilling process compared to other models [2,30,31,32]. This model has been reported to closely align with observations for a variety of crops and cultivars [8,33,34], and for a variety of climatic regimes [30, 35]. Moreover, the Dynamic Model has been shown to work well in warmer climatic regimes [8,28,30]-critical in the context of climate change and a shift to warmer temperature regimes.

Our study takes a spatially-explicit approach that covers all current tree fruit production areas in the PNW and aims to (a) quantify changes to risk of insufficient chill accumulation as a result of climate change in colder tree-fruit production regions, and (b) describe factors that lead to this change in risk. We do this by driving the Dynamic Chilling Portions Model [28,29] with historical climate and future climate projections, and accounting for shifts in the timing of conditions conducive to forcing accumulation. The results of this study will improve our understanding of productions risks related to chill accumulation in regions that currently have relatively cooler winters. It can also help PNW growers develop adaptation strategies for potential new insufficient chill accumulation risks they are not currently exposed to, and sustain the region's standing as the major apple and cherry production region in the US.

2 Methods

2.1 Study Area

Apple and cherry production areas in the PNW are primarily in Washington State with some production in Idaho and Oregon states. We identified tree fruit growing areas by overlaying two 2018 agricultural land use datasets on our gridded climate dataset (described below) and resulted in ∼2300 simulation grids (Fig. 1). For the Washington State part of our study area we used the Agricultural Land Use Database created the the Washington State Department of Agriculture [36]. For the remaining areas we used Cropland Data Layer created by the United States Department of Agriculture [37]. To highlight the spread in results, we also picked four representative locations spanning the breadth of our study area (Figure 1). The spread of elevation and climate data across these four locations are provided in Table 1.

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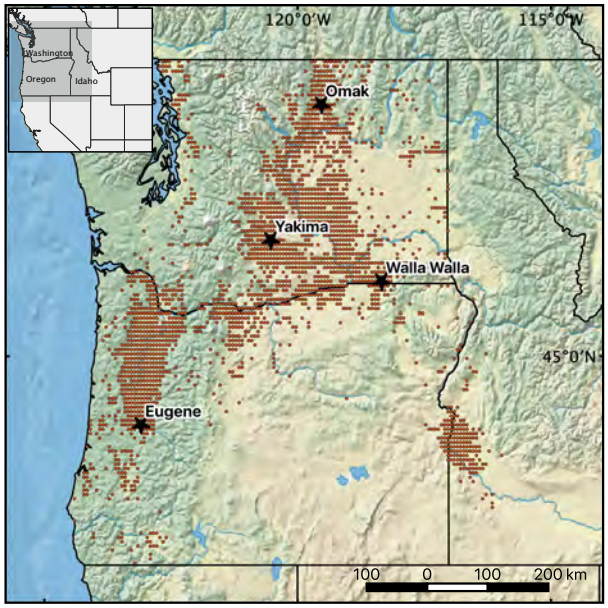

Fig. 1 Map of the study domain. Red dots correspond to tree fruit growing areas that we simulated. Stars correspond to four locations (Omak, Yakima, Walla Walla, Eugene) across the study domain that we selected to highlight some results in depth.

Table 1 Elevation and climate information for the four representative locations.

Location	Elevation (m)	Ann. Temp. Mean (°C)	Winter Temp. Mean (°C)	Ann. Precip. Mean (mm)	Winter Precip. Mean (mm)
Omak	318.7	9.9	4.2	312.1	203.8
Yakima	333.2	10.6	5.6	220.1	160.7
Walla Walla	272.9	12.2	7.4	459.7	317.7
Eugene	173.9	11.5	8.5	1164.4	934.2

2.2 Historical Climate and Future Climate Projections

Historical simulations (1979–2016) were based on the gridded meteorological observations product -GridMET [38]. Future climate projections (2006-2099) were based on the Coupled Model Intercomparison Project 5 (CMIP5; [39]) which were downscaled and bias corrected to the 4km resolution based on the Modified Multivariate Adaptive Constructed Analog (MACA) method [40], and subsequently re-gridded to the 1/16 degree ($\sim$ 6km) resolution by linear interpolation for computational efficiency. While the future simulations start from 2006, we use data starting from 2026 for aggregation into three time-frames: 2026-2050, 2051-2075, and 2076-2099. Nineteen climate projections under two representative concentration pathways (RCPs) were used for a total of 38 projections that captured the range in uncertainty in projections. The 19 models used in this study were bcc-csm1-1, bcc-csm1-1-m, BNU-ESM, CanESM2, CCSM4, CNRM-CM5, CSIRO-Mk3-6-0, GFDL-ESM2G, GFDL-ESM2M,

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HadGEM2-CC365, HadGEM2-ES365, inmcm4, IPSL-CM5A-LR, IPSL-CM5A-MR, IPSL-CM5B-LR, MIROC-ESM-CHEM, MIROC5, MRI-CGCM3, and NorESM1-M. The RCP 4.5 scenario assumes a stabilization or reduction of greenhouse gas emissions starting around mid-century while the RCP 8.5 is an extreme "no climate policy" scenario that assumes increasing emissions until the end of the century and is associated with relatively high temperature increases post mid-century compared with RCP 4.5 [41]. The temperature data were at a daily timestep and were then disaggregated into an hourly timestep using a sine-logarithmic algorithm [42].

2.3 Dynamic Model

The Dynamic Model [28,29], computes chill accumulation in units referred to as "chill portions" (CP). Chill accumulation is considered a two-step process. The first step is a reversible intermediary process where chill accumulates under low temperatures (a bell curve between -2°C and 13°C with optimal accumulation around 6°C), with no accumulation under -2°C, and potential for a negative accumulation by exposure to higher temperatures. The negation is a complex process that depends on the level, duration and cycle of exposure to high temperatures and only occurs during the intermediary process. Accumulation during this time can also be enhanced by exposure to moderately high temperatures (13°C-16°C) alternating with lower temperatures such as in a diurnal cycle. Once the intermediate accumulation threshold is surpassed, in the second step, chill accumulation increases by a unit called a chill portion unit. The accumulated chill portion units are conserved and cannot be reversed, and the intermediate level is set back to zero. Further details can be found in [28,29].

The Dynamic Model implementation we used was provided as part of the chillR package for the R software [43][1]. The function used is `chillR::Dynamic_Model(.)` and requires an hourly temperature time series as input. The daily maximum and minimum temperature inputs from Section 2.2 were converted to hourly temperatures by the `chillR::stack_hourly_temps(.)` function in the chillR package that was based on Linvill's work [42]. We used a simulation timeframe of September 1st to March 31st covering the timeframe for winter and spring phenology in our region. Chill accumulation in our area starts later than September 1st and this start date ensures that the Dynamic Model can capture the commencement of chill portions accumulation.

2.4 Chill Portion Requirements

Chill portion requirements are species- and cultivar-specific [2,3]. For the analysis to be applicable to a range of different tree fruit species and cultivars, we consider chill portion requirement thresholds from 20 to 75 at

[1] Our code is available on Github (https://github.com/HNoorazar/Ag/tree/master/chilling)

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Table 2 Chill Portions accumulation requirements for some commonly grown varieties in the PNW [45,46].

	Cultivar	Min. CP Req.
Sweet Cherry	Brooks	37
	Lapins	35
	Rainier	45
	Sam	70
Apple	Golden Delicious	50
	Gala	50-55

increments of 5 chill portions. This is based on the range of values compiled through literature reviews by [2] and [44]. Specific to varieties grown in the PNW, some of the known minimum chill portions requirements [45,46], are listed in Table 2 and they fall within the 20-75 chill portions range considered in this analysis.

2.5 Forcing Accumulation

In order to assess shifts in chill accumulation within the context of forcing accumulation, consistent with the approach taken by chill-overlap models (e.g. [47]) we start accumulating heat units when 75% of a varieties chill requirements are met. Heat units were calculated using the equations of [48], which fits a sine wave to the daily maximum and minimum temperatures and calculates the area under the curve for heat unit accumulation. Given that we are interested in the timing of when forcing accumulation starts taking off, we use a nominal heat accumulation of 25 heat units as a threshold. We used a base temperature of 6.1°C, an upper threshold of 25.9°C, and the vertical cutoff approach to accumulate daily values of heat units.

3 Results and Discussion

In this section, regional spatial maps of average results are presented. Four representative locations (Fig. 1) are used to highlight temporal aspects and the spread of results from the 19 climate models.

3.1 Chill Portions Accumulation

3.1.1 Magnitude of Chill Portions Accumulation

Historically, the southwestern tree fruit growing areas of Oregon State (Willamette Valley) accumulated the most, and the northern parts of Washington State accumulated the least chill portions (CP) units (Fig. 2). The apparent contradiction of the warmer areas (Willamette Valley) having the most CP units and the colder areas having the least is a function of colder areas having a

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higher exposure to temperatures lower than -2°C–temperatures that result in no CP accumulation. With climate change, modeled CP accumulations increased in the relatively colder northern parts of Washington state but decreased in other regions, with larger differences for the RCP 8.5 scenario. By the end of the century, in a switch from historical conditions, the northern parts of Washington state were projected to accumulate more CP than the southern regions in this study (Fig. 2).

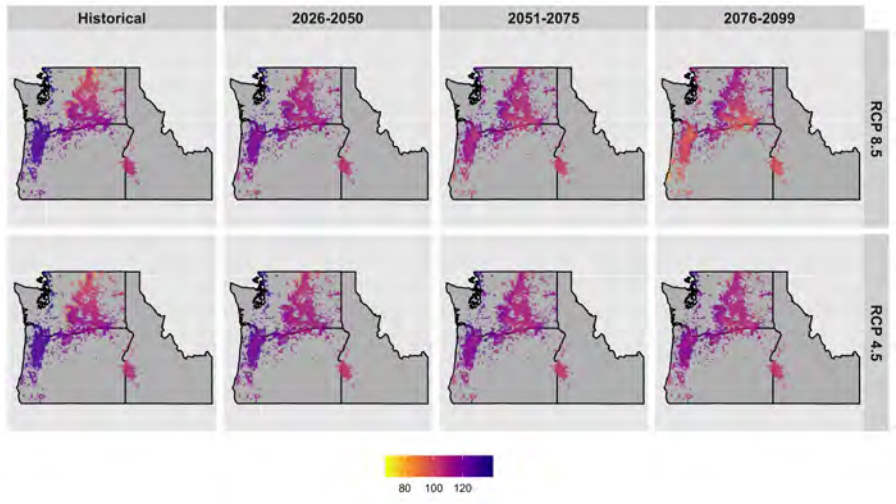

Fig. 2 Average CP accumulation between September 1st and March 31st for different time frames under multiple climate models. First, the accumulated CP by March 31st is computed for each location, year and model. Then for each location, the median of these values is taken over the years within each time window. Finally, the mean of these median values is taken over the 19 climate models. Results are shown for the RCP 8.5 and 4.5 scenarios.

3.1.2 Relative Change in CP Accumulation

Our simulations showed both increases and decreases across relatively short geographical ranges (Fig. 3). For the RCP 8.5 scenario, CP accumulation was generally projected to change by +/- 25% for most areas with some coastal areas showing decreases larger than 40% (Fig. 3). The negative changes are smaller in magnitude for the RCP 4.5 scenario, especially after 2050, and positive changes are similar to that for RCP 8.5. However, for all regions, by the end of the century, an average of more than 80 CP were forecasted to accumulate by March 31st (Fig. 2) for all 19 climate models, even under the RCP 8.5 scenario, implying that even with warming, forecasted temperatures are predicted to be conducive to chill accumulation. These levels of CP accumulation are above the range of minimum chilling requirements identified for different tree fruit species and cultivars in the PNW (Table 2). This

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suggests that there is limited risk of insufficient chill accumulation even for varieties with high chill requirements. This is in contrast to the results of Huston et al. [24] who quantified the risk for insufficient chill accumulation for two locations in the PNW; Corvallis (close to Eugene) and Wenatchee (close to Yakima). They noted that there is a likely risk of insufficient chill accumulation in Corvallis for high-chill-requirement varieties as early as the 2030s. The differences between our results and those reported by Huston et al. [24] are likely because they used the Chill Hour model while we used the Dynamic Model. The Chill Hour model does not account for dynamic conditions and studies using it tend to show exaggerated responses to warming compared to the Dynamic Model which is better able to capture changes to chilling conditions [9,30]. However, the general direction of change in Corvallis/Eugene is consistent across both studies. While Huston et al. [24] does not consider locations in northern Washington state, increases in chill accumulation in these colder regions are consistent with those reported by Luedeling et al. [3] in their global study which highlights changes in the Okanagan Valley in Canada which is just north of the Omak region in northern Washington state.

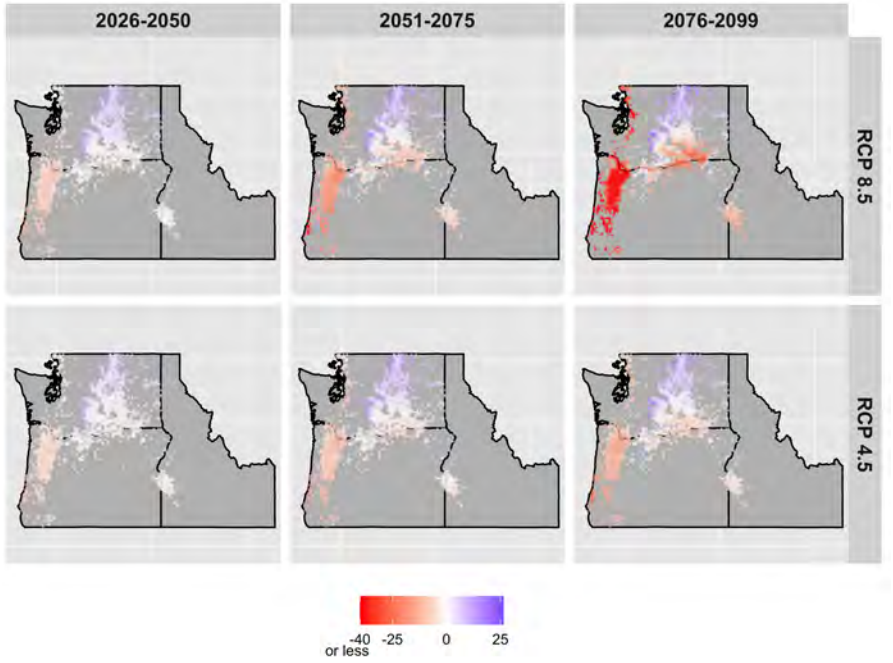

Fig. 3 Percentage differences of CP accumulation between projections and historical observations. In this plot, for a given location and model, we computed the median of CP accumulation across years in three future time periods. Then, the differences between these projections and historical observations were computed. Then, we computed the median of percentage differences over the 19 climatic models. Chill seasons start on September 1st and end on March 31st. Results are shown for the RCP 8.5 and 4.5 scenarios.

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3.1.3 *Temporal Pattern of CP Accumulation and Spread Across Models*

The temporal pattern of changes in CP as well as the spread across the different models for the four representatives locations shows the variable response (Fig. 4) in the rate of change over time and the different RCP scenarios. For RCP 8.5, accumulated CP was projected to increase slightly (from 105.2 in 2025-2026 winter season to 106.6 in 2049-2050) in Omak until about mid-century and then remain relatively flat (Fig. 4) until a small decrease at the of the century (from 106.6 in 2049-2050 to 105.6 in winter season of 2098-2099). Under RCP 8.5, Yakima stays flat until the mid-century and then it decreases at a nearly linear rate. Accumulated CP for Walla Walla in southern Washington State and Eugene in Oregon was projected to decrease at a nearly linear rate until the end of the century (Fig. 4). This was particularly true for the southwestern location in Eugene, Oregon. While there is a large spread across models, most models indicated meeting minimum CP requirements in all locations. There are just six climate model-year combinations that indicated a risk of not meeting minimum CP requirements for species and cultivars with high CP requirements (above 70 CP), especially in Oregon State (Eugene) and southeastern Washington State (Walla Walla) towards the end-of-century. The end-of-century minimum and maximum projected CP accumulation for Eugene (RCP 8.5) across the nineteen models were 56.4 and 119.2 CPs, respectively. For Omak, the minimum and maximum CP accumulations were 80.7 and 122.5 CP, respectively. Under RCP 4.5, changes are minimal as compared to RCP 8.5 as can be seen in Fig. 4.

3.1.4 *Reasons for Simulated Changes*

To highlight the factors producing regional differences presented above, we examined the fraction of total hours (%) spent in different temperature ranges as relevant for the Dynamic Model (see Section 2.3, and references [28,29]) for the simulation timeframe of September 1–March 31 (Table 3). We focused on the RCP 8.5 scenario in this section as this is the scenario with relatively larger projected changes (Fig. 4). The increasing trend in CP accumulation for northern Washington State (Figs. 3 and 4) can be attributed to the models projecting significantly less time (-19%) with exposure to very cold temperatures (less than -2°C) which do not accumulate CP, and more time (7%) with exposure to a range of temperatures where CP accumulate. In contrast, other regions see decreases in the relative time of exposure to temperatures conducive to chill accumulation (-18% for Eugene). This, coupled with CP negating effects of temperatures outside the optimum range of -2°C to 13°C, contributed to more rapid decreases in CP accumulation for the warmer southern regions.

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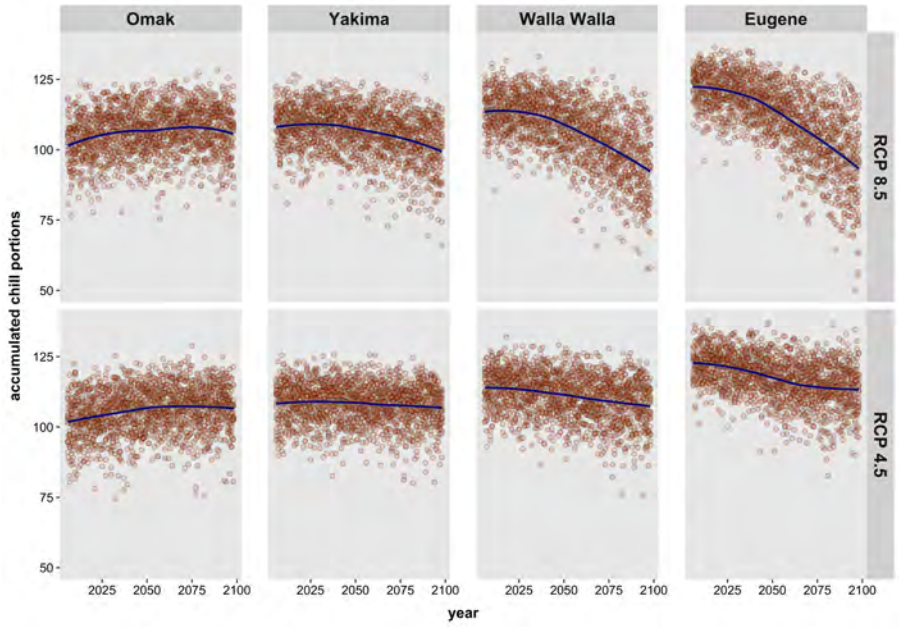

Fig. 4 Temporal pattern of CP accumulation (September 1- March 31st) in Omak, Yakima, Walla Walla, and Eugene for the RCP 4.5 and 8.5 scenarios. The range for a given year corresponds to the 19 climate models.

Table 3 The relative fraction of time (%) spent within specific temperature intervals between September 1st and March 31st. These intervals correspond to differing effects on CP accumulation in the Dynamic Model. The results are for the RCP 8.5 scenario.

		<-2°C	-2°C-13°C	13°C-16°C	>-16°C
Omak	Historical	23.9	61.6	5.1	9.4
	RCP8.5 (2076-2099)	4.9	68.8	7.3	19
	Difference	-19	7.1	2.3	9.6
Yakima	Historical	17.6	65.8	6	10.6
	RCP8.5 (2076-2099)	4.5	65.2	9	21.2
	Difference	-13.1	-0.7	3.1	10.7
Walla Walla	Historical	9.4	71.3	7.1	12.3
	RCP8.5 (2076-2099)	1.7	61.3	11.8	25.3
	Difference	-7.7	-9.9	4.6	13
Eugene	Historical	2.1	79.7	7.5	10.7
	RCP8.5 (2076-2099)	0.3	62	14.4	23.3
	Difference	-1.8	-17.7	6.9	12.6

3.2 Timing of Accumulation of Various Chill Portions

In general, most areas other than the northern region (e.g., Omak) see a projected delay in the timing for meeting CP thresholds (Fig. 5). For the RCP 8.5 scenario and the end of the century, models consistently projected that, compared with historical timings, the most southern location (Eugene) had a one-month delay in meeting CP thresholds and a little more than a 2-week

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delay for mid 21st century projections. This delay was consistent with Huston et al. [24]. Although our magnitude of delay is lower than theirs, we are using different models. For the most northern location (Omak), models projected a delay in the timing for chilling fulfillment for the lower CP thresholds and an advancement for reaching greater CP thresholds with a reversal at thresholds around 45 CP in late December. This implies that increased exposure to temperatures optimal for chill accumulation is primarily in effect only after January for Omak. Even for central Washington State (Yakima), we can see that earlier delays are compensated later in the season with a shrinking delay. This, again, points to the wide variation in the response to warming within this relatively small PNW tree fruit production region.

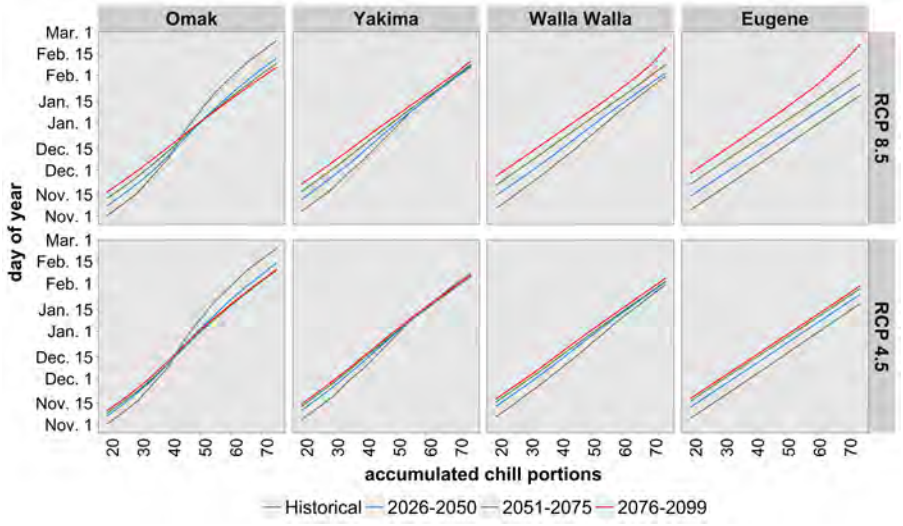

Fig. 5 Day of the Year a given range CP accumulation thresholds (20 to 75 CP) are met. The range encompasses minimum CP requirements for the range of tree fruit species and cultivars grown in the region. These are average Day of the Year values across years and averaged across the 19 climate models.

Although the entire range of chill requirements (including the high values in the range) are met by March 31st, delayed fulfillment of chill accumulation thresholds have implications through affecting the overlap between chilling and heating processing and resulting in the dynamics between these processing becoming critical for spring phenology and budbreak [23].

3.3 Overlap Between Chilling and Forcing processes

Time series of chilling accumulation and forcing accumulation processes are plotted to get a comparative sense of the timing of chilling process (when

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75% and 100% of chill accumulation are met) and when forcing accumulation starts taking off (using accumulation of 25 heat units as a threshold). Since CP requirements can widely vary across tree fruit species and cultivars, the figures are plotted for representative medium and high CP requirement varieties, with 50CP (e.g. Golden Delicious) and 74CP (e.g. Cripps Pink) requirements respectively.

Forcing can start accumulating when 75% of CP requirements are met, following the typical assumptions in chill-overlap models (e.g. [47]) of spring phenology. Historically, in the PNW, there is a gap between when forcing can start accumulating(when 75% CP is met) and when actual forcing accumulation commences after conditions are warm enough (gap between the green and purple horizontal boxes in Figures 6 and 7). With future warming, this gap shrinks as a result of delays in chill accumulation and advances in the timing of when conditions are warm enough to commence forcing accumulation. In fact, in Omak, Yakima, and Walla Walla, historically, in most years, 100% of CP requirements are met before conditions become conducive for forcing accumulation (black box compared to the purple box). Eugene is a relatively warmer area were some overlap in the timing of chill and forcing accumulation already exists. The slope values noted at the top of each figure are increasing into the future indicating that the rate of early forcing accumulation is increasing.

These results are for the RCP 8.5 scenario. Similar behaviour is exhibited under RCP 4.5 (see Supplementary Materials) although the effects are less pronounced.

Majority of tree fruit production in the PNW is in the region between Omak and Yakima. The gap between the chill accumulation phases and the start of forcing accumulation in Figures 6 and 7 indicate that in these regions, historical spring phenology and bloom are primarily driven by forcing, consistent with the description of colder regions in [23, 50]. In contrast, with warming we see an increasing overlap between timing of chilling and forcing processes. That is, there is a likely regime shift from being a region where spring phenology is primarily driven by forcing (and there is minimal or non-existent chill accumulation related production risks) to one where spring phenology is dynamically dependent on both chill and heat accumulation processes, with higher risk of issues such as non-uniform bloom and bud abscission that can result in production impacts [5]. This also means simple thermal time models will no longer be able to accurately quantify spring phenology, and chill-overlap models will be necessary. Such models do not currently exist for the PNW and decision support tools for growers [51] utilize thermal time models of forcing which have worked well for historical conditions. Development of chill-overlap models (such as [47]) and using partial least squares regression to identify chill and heat accumulation phases (such as [50, 52]) for the PNW would be critical for future decision support. These areas may also require interventions such as overhead irrigation or chemical induction of budbreak to alleviate new risks.

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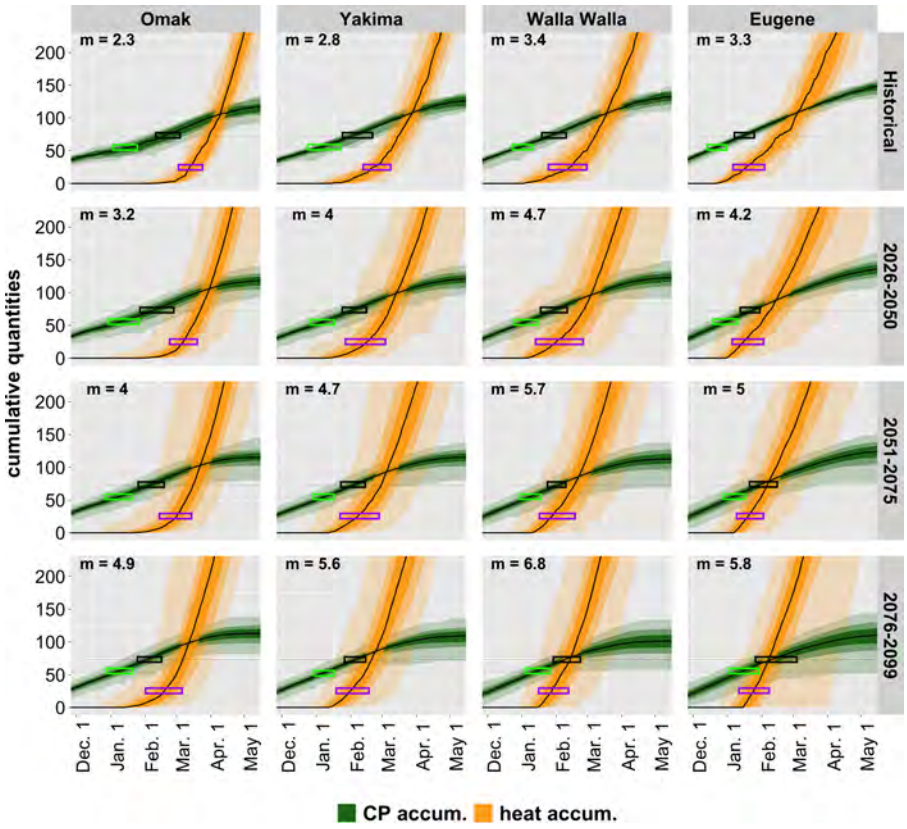

Fig. 6 This plot corresponds to RCP 8.5 for a representative high chill requirement cultivar: Cripps Pink with a minimum chill requirement of 73.3CP [49]. The green part of the figures are a time series of chill portion accumulation. The range comes from nineteen models and multiple years in the relevant time frame. The shadings correspond to 25th to 75th percentile (darkest shade), 10th to 90th percentile (lighter shade), and min to max (lightest shade) of CP accumulation. The middle black line is the median. The orange part shows heat accumulation, with similar shading ranges as described for chill accumulation. m noted in each figure is the slope of the median heat accumulation between Feb. 15 and Apr. 15 as an indicator of the rate of forcing accumulation. The heat accumulation process is allowed to begin on the day 55 CP (75% of 73.3CP) is accumulated. There are 3 horizontal boxes in these plots that shows the 10th to 90th percentile of the day of year specific events are completed. The bright green box in the green cloud corresponds to the day of the year forcing accumulation is allowed to commence (after75% of CP requirements are met). The purple box in the orange cloud corresponds to the day of the year when heat accumulation starts to take off: $y = 25$. The black box corresponds to the day of the year when full CP requirements are met; in this case 73.3CP.

4 Conclusions

The tree fruit producing areas of the Pacific Northwest US experience large spatial variations in the response of chill accumulation to climate change. Moving north, there is a general trend from decreasing chill accumulation to minimal change then to increasing chill accumulation in response to cli-

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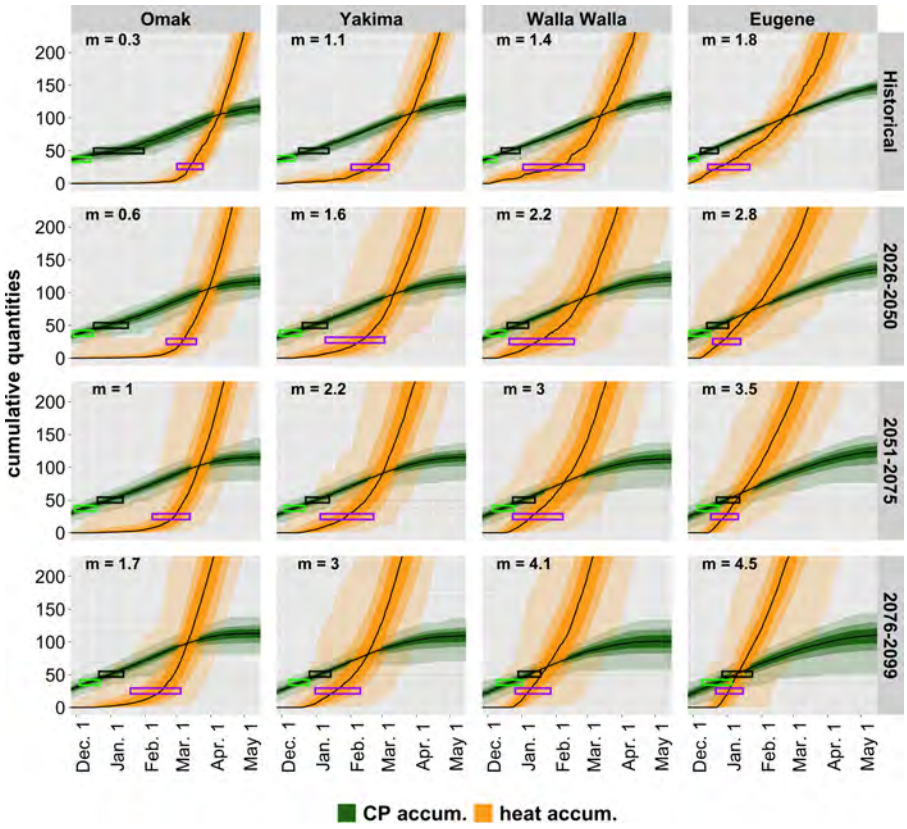

Fig. 7 This is similar to Fig. 6 except for a medium chill requirement variety (e.g. Golden Delicious with a requirement of 50CP).

mate change. The key factors contributing to differential responses within the PNW can also vary by region, with more exposure to optimal temperatures likely contributing to changes in the northern areas and chill negation due to higher temperatures contributing to projected changes in other areas.

Even with warming, temperatures continue to be generally conducive to chill accumulation. However, a combination of delayed and reduced chill accumulation along with likely advancement in forcing, will likely lead to many parts of the PNW transitioning from regimes where forcing is the primary driver for spring phenology to one where the dynamics and interplay between chilling and forcing processes becomes dominant for spring phenology. This is true for RCPs 4.5 and 8.5 and varieties with medium and high CP requirements, though more pronounced and occurring earlier for high chill requirement varieties under RCP 8.5. Even though northern Washington State has less risk of insufficient accumulation, other warmer regions of the PNW with potential future risk of insufficient chill accumulation for some cultivars will likely continue as key production regions given

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their competitive advantage in terms of faster time to market. These regions would need to plan for management strategies such as overhead irrigation for cooling, and chemical management of budbreak (with increased production costs) to address potential risks. Adaptation strategies such as overhead irrigation face other obstacles such as availability of irrigation water. Irrigation water rights typically come with a specified season of use, and if future early season evaporative cooling is outside the current permitted season of use, it would require an approval subject to examination that such a change does not adversely affect another water right holder with a higher priority to the use of water.

Significant gaps in our biological understanding of the winter dynamics and dormancy processes in tree fruit create uncertainty in quantifying the response under climate change [3,53,54]. Given the potential for introduction of production risks even in colder regions such as the PNW - one of the prominent tree fruit production regions of the US - efforts by the scientific community to address these knowledge gaps will be critical for identifying appropriate adaptation or mitigation strategies. Future modeling efforts must also account for the overlap between fulfillment of chilling requirements (breaking of endodormancy) and environmental conditions promoting budbreak (break of ecodormancy), and the dynamics and tradeoffs across these processes. It is under these conditions where risk to perennial tree fruit production exists and needs to be better understood, modeled, and projected. Given the significant spatial differences across a relatively small geographic range, it is also critical to understand, model and project these dynamics at a local landscape resolution.

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All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest The authors declare no conflict of interest.

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Data Availibility The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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5 Supplementary Material

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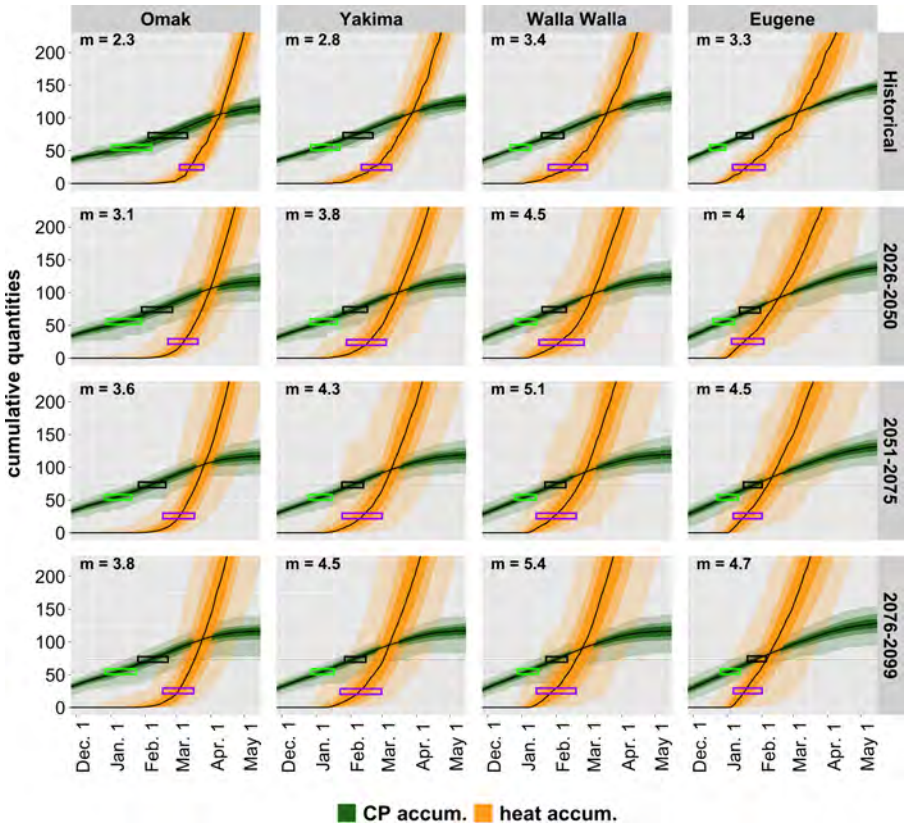

Fig. 8 This is the RCP 4.5 version of Fig. 6 for high chill requirement varieties (e.g. Cripps Pink).

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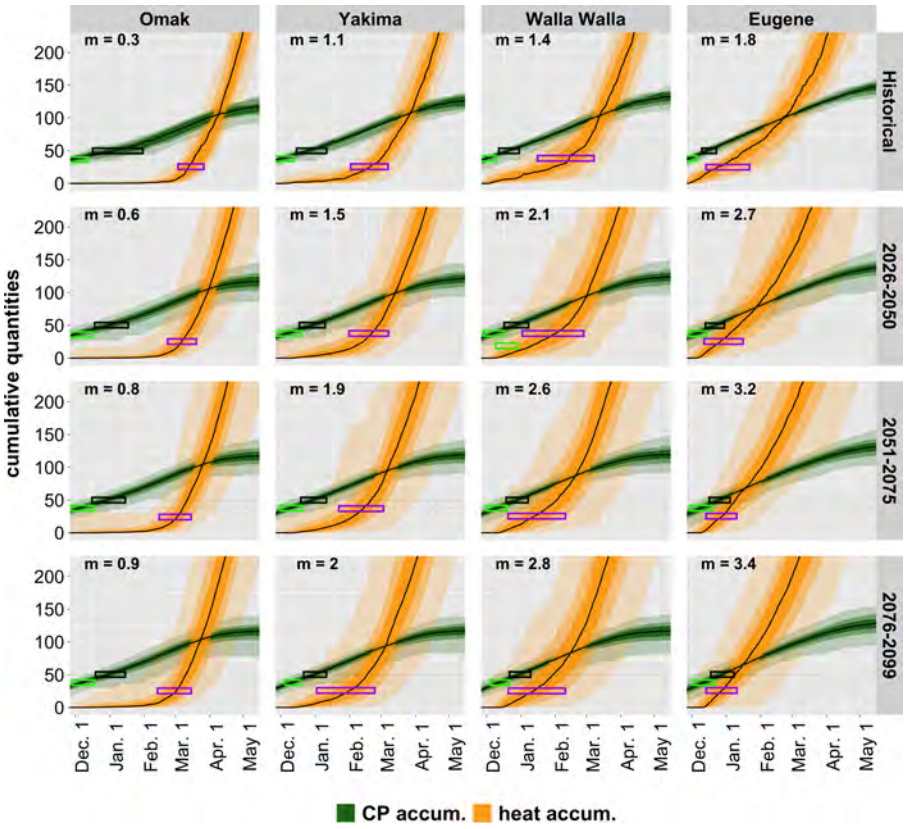

Fig. 9 This is the RCP 4.5 version of Fig. 7 for medium chill requirement varieties (e.g. Golden Delicious).

Biophysical Climate Risks and Economic Impacts for Washington State

Prepared by the

Climate Impacts Group,
University of Washington

with IMPACT Center
at Washington State University

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IMPACT Center
AT WASHINGTON STATE UNIVERSITY

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https://cig.uw.edu/projects/climate-risk-assessment/

The webtool developed for this assessment, *Climate Mapping for a Resilient Washington*, is available at:
https://cig.uw.edu/resources/analysis-tools/climate-mapping-for-a-resilient-washington/

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AT WASHINGTON STATE UNIVERSITY

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Executive Summary

The Washington State 2021-23 Operating Budget ESSB 5092 Sec 606(23)) funded the University of Washington Climate Impacts Group (CIG) to *"provide an updated climate risk assessment designed to inform future updates to the statewide climate resilience strategy."* The UW CIG, with Washington State University IMPACT Center, compiled information on two science-based elements of climate risk:

> **Biophysical Impacts:** Projections of the magnitude and timing of changes in the climate and climate-related hazards. Expected climate changes are mapped for Washington State, summarized by county, and presented in an interactive web application for local governments and state agencies, *Climate Mapping for a Resilient Washington*.
>
> **Economic Impacts:** Case studies of the economic consequences of three key biophysical impacts — extreme heat, wildfire, drought —for the economy in Washington.

This assessment of future changes in the climate and climate-related hazards, with associated economic consequences, can inform state and local plans for climate resilience and prioritization of funding for risk-reduction activities.

Purpose and Need

The current availability of information on changes in the climate and related hazards in Washington State is spotty – varying by hazard, sector, and location. The information on biophysical climate impacts and economic consequences compiled for this proviso fulfills a need for foundational, current scientific information that can be readily accessed, interpreted, and applied to plan and implement actions that enhance state and local climate resilience. Recent reports on how to further climate resilience at the state level all identified the need for technical information to support a coordinated state response to the most pressing climate hazards.

The information and products generated by this proviso aim to support several needs for updating the *2012 Washington State Integrated Climate Response Strategy*. This includes the information on climate impacts necessary to make coordinated and strategic decisions on resilience priorities and the allocation of funds for resilience Resilience actions funded under the Climate Commitment Act are most likely to successfully build resilience if they are informed by *where and when* droughts, high streamflows, sea level rise and wildfires are expected to intensify in a warming climate.

State Agency Consultation

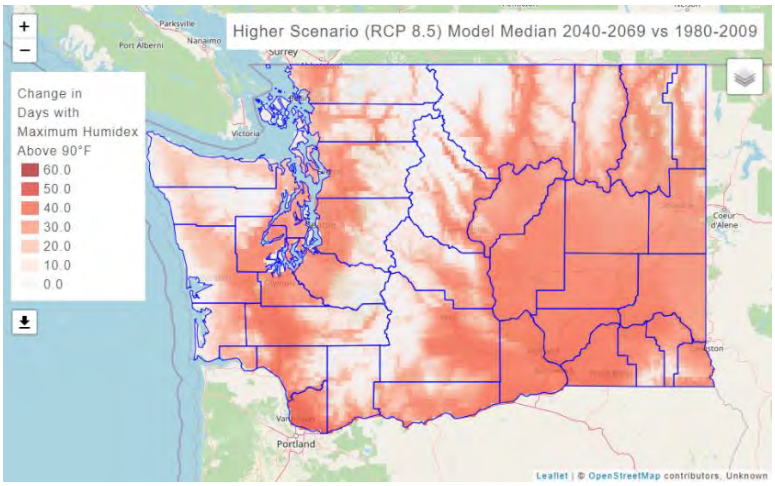
The proviso directed the UW CIG to coordinate with the office of the governor and state agencies to scope the assessment. Given the extensive work on climate resilience by state agencies in the last decade, we consulted with agency staff to determine how an assessment of biophysical climate risks would be most useful. We heard from state agency staff that information on climate impacts for local jurisdictions is an immediate need. This information can enhance local awareness of climate risks and enable local governments to effectively engage in climate resilience planning and grant opportunities at the local, state, and federal level.

Three Climate Hazard-Sector Combinations

Extreme Heat & Human Health

Biophysical Impacts: By the 2050s (2040-2069), the number of days per year with a humidex above 90°F is expected to increase across the state. A maximum daytime humidex above 90°F corresponds to higher risk of heat-related illness, hospitalization and death, but not all locations and populations will be equally exposed or susceptible. Socioeconomic factors largely determine the inequitable impact of extreme heat.

Economic Impacts: One year of heat-related activity losses results in direct losses to industry sales of over $426.1 million-$178.3 million in lost gross state product and losses of over 1,481 full-time equivalent jobs in Washington.

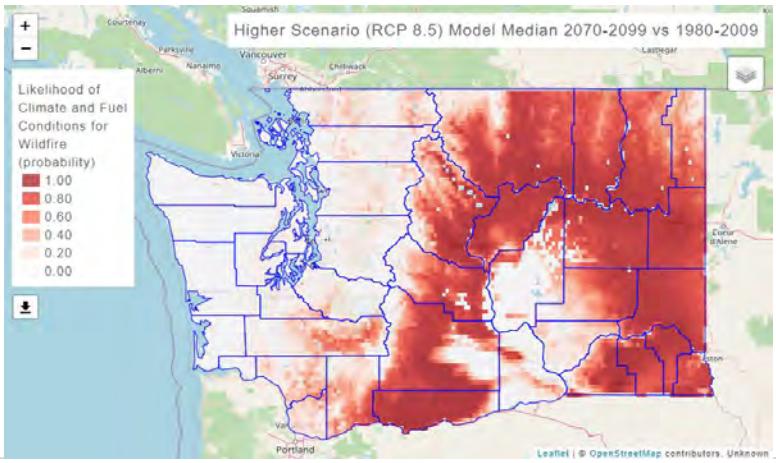


Expected change in the number of days with Humidex above 90°F across Washington State for the middle of the century (2040-2069) and under a high climate scenario (RCP 8.5). The number of days with a humidex above 90°F indicates potential for heat-related illness and death.

Wildfire & Infrastructure

Biophysical Impacts: By the end of the century (2070-2099), the likelihood of conditions that support wildfire is expected to increase in central and eastern Washington where wildfire is already most likely, as well as in western Washington, especially southwestern Washington, where current wildfire likelihood is low.

Economic Impacts: Based on an analysis of wildfire economic losses in California in 2018, if the economic losses in Washington matched those measured on a per acre basis, Washington's economic losses from direct and indirect wildfire damages would have been $49.8-$53.0 billion in 2021.

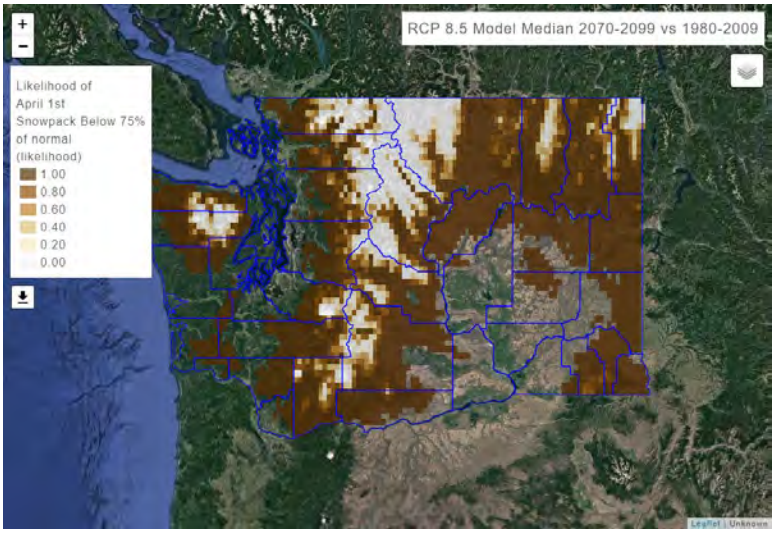


Expected likelihood of climate and fuel conditions that support wildfire across Washington State for the end of the century (2070-2099) and under a high climate scenario (RCP 8.5). The likelihood of conditions for wildfire indications potential for wildfire damage and disruption.

Drought & Agriculture

Biophysical Impacts: Climate change is expected to decrease natural water supply in Washington and increase the likelihood of drought. However, the change in likelihood of drought is difficult to model and quantify because drought depends on the complex influence of precipitation, snowpack, and streamflow on overall water supply. Drought can be declared in Washington when and where one or a combination of factors—precipitation, streamflow, snowpack—falls below 75 percent of normal and water users experience hardship. As one example of drought, many low-elevation areas in Washington that currently receive snow are expected to be more likely than not to have snowpack drought (less than 75 percent of normal April 1 snow-water equivalent) by the end of the century (2070-2099).

Economic Impacts: An assessment of the 2015 drought by the Washington State Department of Agriculture found that agricultural losses due to the 2015 drought were between $633 million and $773 million. In 2015, irrigated potato acreage in the Odessa subarea fell over 25% primarily because of the dry conditions and lack of water resources that year. A case study of potato production in the Odessa subarea shows that, with supply chain effects included, potato losses from the Odessa Subarea alone accounted for just under $377 million.



Expected likelihood of snowpack drought (less than 75 percent of normal April 1 snow-water equivalent) across Washington State for the end of the century (2070-2099) and under a high climate scenario (RCP 8.5). Snowpack drought is one indicator of drought for water supplies dependent on spring snowpack.

Applications of the Assessment and *Climate Mapping for a Resilient Washington*

Support state resilience goals and priorities by building local awareness and capacity for resilience. State agencies enable and support local climate resilience planning and implementation as one way to meet state goals for more resilient communities and natural systems in Washington. Successful implementation hinges, in part, on the capacity and awareness of local governments.

Support local governments to plan for climate resilience. The information in this assessment and *Climate Mapping for a Resilient Washington* can support local governments to plan, prepare, and act to build climate resilience. CMRW is integrated into the guidance under development by the Department of Commerce for incorporating climate resilience into local comprehensive plans. When equipped with sufficient knowledge of future climate risks, and given the resources to address them, local governments can act within their authority to build climate resilience.

Enhance the ability of local governments to secure resilience funding. Multiple state programs invest funds in local activities that contribute to climate resilience, yet local jurisdictions often lack the information and capacity to ensure that these activities adequately account for risks and incorporate resilience benefits. When local governments are better informed and equipped to understand local climate changes, they will be more likely to successfully secure state and federal funds for risk-reduction activities.

Assess critical and vulnerable components of the local economy. Information on current and future biophysical risks can be combined with an economic framework to assess the most critical and vulnerable components of a local economy. This combined information can local governments to assess the economic benefits of climate risk-reduction activities compared to no action.

Gaps and Next Steps for Statewide Climate Risk Assessment and Resilience Planning

The report, analysis, and web application completed for this proviso can be expanded to (1) include additional analysis of biophysical, economic, and other elements of climate risk assessment, and (2) enhance resilience planning at the state level.

Climate Risk Assessment

- Combine information on current and future likelihood of biophysical climate hazards.
- Enable state-level comparison of biophysical climate impacts.
- Assess other elements of climate risk: local exposure, sensitivity, and adaptation.
- Develop a database of assets at risk and estimate their economic value.
- Estimate expected economic impacts with and without adaptive interventions.

Climate Resilience Planning

- Identify sector and hazard specific strategies and actions for statewide resilience.
- Identify performance measures and mechanisms for accountability.

1. Background and Introduction: Climate Risk Assessment Proviso

The 2021-23 Operating Budget for Washington State funded the Climate Impacts Group (CIG) at the University of Washington to provide updated climate impacts risk assessment in coordination with the office of the Governor.

> ***ESSB 5092 Sec 606(23))*** *$225,000 of the general fund—state appropriation for fiscal year 2022 and $75,000 of the general fund—state appropriation for fiscal year 2023 are provided solely for the climate impacts group in the college of the environment to provide an updated climate impacts risk assessment designed to inform future updates to the statewide climate resilience strategy. The group must coordinate with the office of the governor to refine the scope of assessment. The final report and associated deliverables must be completed and submitted to the governor and appropriate committees of the legislature by December 15, 2022.*

The proviso directed the CIG to refine the scope of the assessment with the office of the Governor and complete a final report for the legislature by December 15, 2022. This report and associated appendix and online materials are the products of that proviso.

A climate risk assessment that accounts for increases in the likelihood and consequences of climate-related hazards can inform plans for climate resilience and risk reduction. This assessment is critical to minimize future impacts of climate-related hazards on the state's residents, infrastructure, economy, and natural systems. Approaches to climate risk assessment vary and continue to improve. A comprehensive, state-wide climate risk assessment, comparison and prioritization requires multiple elements to adequately assess risk, which is commonly defined as *likelihood times consequence*. Climate change is a risk multiplier that is widely expected to increase the likelihood and severity, and thus consequences, of most climate-related hazards for which the state already prepares and manages, such as extreme heat, heavy rainfall, riverine and coastal flooding, wildfire, and drought.

Climate adaptation, or resilience, is the ongoing process to anticipate, prepare, and adapt to changes in the climate and climate-related hazards to minimize negative impacts on our natural systems, infrastructure and communities and increase their ability to adapt to changing climate conditions.

Our team, University of Washington Climate Impacts Group and the Washington State University IMPACT Center, compiled information on two key elements of a climate risk assessment: the likelihood of biophysical climate impacts and the potential economic consequences of three key climate-related hazards for Washington.

1. Biophysical Climate Impacts Assessment: A statewide, sector and location-specific assessment of the biophysical impacts of climate change for which data already exist and that were relatively easy to acquire. The location of climate changes and hazards are mapped across the state. Where data were sufficient, they are presented as the

change in the likelihood or probability of climate hazards based on expected changes in the climate through the end of the 21st century.

2. Economic Climate Impacts Assessment: Case studies of the economic consequences of key biophysical impacts for which sufficient data are available. Case studies are focused on three biophysical impacts: extreme heat, wildfire, and drought. Most information on the economic impacts of climate changes and climate-related hazards is based on past events. Although limited in scope, this information can provide insights into potential future economic impacts of climate change when combined with the change in likelihood of climate-related hazards.

We focused on biophysical climate impacts and their economic consequences because these are two critical science-based elements of a climate risk assessment. These elements will most successfully help to identify and prioritize risk-reduction activities when they are combined with statewide, sector- and location-specific information on other elements of a comprehensive climate risk assessment.

Four other elements of risk include (1) the *current* likelihood and magnitude of climate-related hazards (underdevelopment by the Emergency Management Department); (2) which populations, natural systems, or assets will be more exposed to climate-related hazards; (3) which populations, natural systems and assets will be more susceptible to climate; (4) the relative level of preparedness, or resilience, of those exposed and sensitive populations, natural systems, and assets. These other elements are not covered in this report; however, we provide some direction on the types of information that can be considered at the local, state and programmatic levels to inform variation in exposure and susceptibility. In Section 7, Gaps and Next Steps, we describe how the information on biophysical and economic climate impacts can be combined with other elements of risk assessment for a holistic assessment of the state's climate risk. We also describe potential next steps towards a climate resilient Washington.

2. Purpose and Need: Assessment of Biophysical and Economic Climate Risks

The current availability of information on changes in the climate and climate-related hazards in Washington State is spotty – varying by hazard, sector, and location. Decades of climate impacts research and assessment have identified the major climate impact pathways and risks for the state[1]. However, the diversity of local impacts of a changing climate makes it challenging for state and local decision-makers to use this information to effectively plan for resilience and to strategically identify and prioritize risk-reduction activities. At both the local, programmatic level and the larger state or regional level, science-based assessment and mapping of impacts is an important way to plan and prioritize resilience actions. These data are often publicly available but difficult to access and use without substantial training and capacity.

The information on biophysical climate impacts and economic consequences to Washington compiled for this proviso fulfills a need for foundational, current scientific information that can be readily interpreted and applied to plan and implement efforts that enhance state and local climate resilience. This includes the information necessary to make coordinated and strategic decisions on resilience priorities and to allocate funds for resilience. This information is relevant and timely given the current and impending funds to support risk-reduction activities that will be generated by state and federal statutes, such as Washington's Climate Commitment Act (CCA) and the federal Inflation Reduction Act and Infrastructure Investment and Jobs Act.

2.1 Support Decisions to Allocate Climate Resilience Funding

Resilience actions funded under the CCA are most likely to successfully build resilience if they are informed by *where and when* droughts, high streamflows, sea level rise and wildfires are expected to intensify in a warming climate. Funds generated from the auction of greenhouse gas emission allowances under the CCA are to be directed at "the highest risks in the most vulnerable locations." The legislature is responsible for selecting which projects will be funded with auction proceeds, including for the natural solutions account and other programs to increase climate resilience of ecosystems and communities. The natural solutions account is expected to fund projects that protect fish and wildlife habitats, improve aquatic ecosystems and water quality, and protect against floods and wildfires. Actions may include reducing flood risk by restoring floodplains or ensuring sustainable drinking water by increasing water supply.

2.2 Support Resilience Planning and Prioritization

Recent statewide reports and interagency discussions all identified the need for actionable technical information to support a coordinated state response to the most pressing climate hazards facing the state. The need for scientific and technical information,

[1] Snover, A.K., Mauger, G.S., Whitely Binder, L.C., Krosby, M., Tohver, I. 2013. *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers.* State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle

with minimal barriers to access, has been commonly cited in recent reports on potential processes and approaches to build climate resilience in Washington. The state recently explored how to strengthen statewide coordination and prioritization of climate resilience in two reports – *Prioritizing Actions and Investments for Climate Resiliency in Washington*[2], *Climate Governance Report*[3] – and interagency discussions on updating the 2012 *Washington State Integrated Climate Response Strategy*[4].

The 2020 report, *Prioritizing Actions and Investments for Climate Resiliency in Washington*, by the Office of Financial Management (OFM) concluded that, "although Washington invests significantly in projects that contribute to climate resilience, climate resilience is often not the primary focus of such activities." The report highlighted several needs to invest in climate risk reduction to prevent future impacts and better prepare and protect communities from current and future climate-related hazards, while also creating jobs and economic benefits. The report emphasized that, although multiple state agencies plan and invest in climate resilience within their authority, these actions are underfunded and lack a coordinated approach to setting priorities. Two recommendations by OFM were to update the 2012 Integrated Climate Response Strategy and strengthen statutory requirements to incorporate climate resilience into agency projects, programs, and activities.

The 2021 report, *Climate Governance Report* by Cascadia Policy Solutions, similarly advocated for the need to coordinate the state's response and strategies for climate resilience among state agencies and with local jurisdictions. Such strategies are most likely to be successful if they are based on where and by when climate-related hazards are expected to intensify. The 2021 report by recommended (1) coordination of agency risk assessments and response plans, (2) a statewide plan that includes objectives and goals to protect and improve the resilience of ecosystems and communities with strategies to meet those objectives, and (3) coordination between agencies and local municipalities on these strategies. All of these approaches will benefit from the information on biophysical and economic impacts of climate change presented in this report.

2.3 Inform Updates to the Washington 2012 Integrated Climate Response Strategy

The information and products generated by this proviso aim to support several needs for updating the 2012 Integrated Climate Response Strategy. Any statewide climate resilience plan has a substantial legacy of state agency planning and coordination upon which it can build, while also harnessing new information on climate impacts and economic risks and ensuring that local governments and municipalities also have essential information and capacity. The *Integrated Climate Response Strategy*, led by the Department of Ecology in 2012, aimed to coordinate statewide climate resilience and create a framework to enable state agencies to prepare for and adapt to the impacts of a changing climate. At the time it was drafted, this

[2] Office of Financial Management.2020. *Prioritizing Actions and Investments for Climate Resiliency in Washington. Report to the Legislature* Ch. 357, Laws of 2020.
[3] Cascadia Policy Solutions 2021.*Climate Governance Report*
[4] Adelsman, H., & Ekrem, J. 2012. *Preparing for a changing climate: Washington State's integrated climate response strategy*. Department of Ecology, Olympia, WA.

strategy was groundbreaking for its depth and breadth of analysis, as well as its long list of contributors, which generated substantial buy-in. The strategy sparked action by agencies to plan for resilience and build the institutional capacity needed to support action. However, progress has since been slow to implement activities aimed at reducing specific climate risks and the vulnerability of Washington State's residents and economic sectors[5].

As the state explores whether and how to update the *2021 Integrated Climate Response Strategy*, critical needs include (1) the scientific basis to identify and prioritize the most pressing climate hazards, (2) a mechanism to ensure that local governments have low-barrier access to this same information so that they can comply with state regulations and requirements for resilience, and (3) an understanding of the potential economic consequences of not acting. This report and associated products compile sector- and location-specific information on the biophysical impacts, make it readily available to local governments across the state, and describe potential economic consequences of not acting to reduce three key climate hazards.

[5] Casola, J., Ziff, D. & Dolšak, N. 2018. *Are Washington State Agencies Preparing for Climate Change?* A report prepared by Climate Impacts Group, University of Washington, Seattle.

3. Consultation: Scoping the Climate Risk Assessment

The proviso directed the UW CIG to coordinate with the office of the governor to refine the scope of our assessment. After CIG identified potential elements of a comprehensive climate risk assessment with the governor's office staff, we identified the elements most useful to support prioritization of resilience funds and an update to the 2012 *Integrated Climate Response Strategy*. Staff emphasized the need for information in two areas. The first concerns how biophysical impacts of climate changes and related hazards (e.g., extreme heat, extreme precipitation, drought, wildfire) are expected to vary across the state – which areas will be affected first and worse? The second is the need for information on the economic consequences of climate impacts to compare the financial benefits and costs of risk reduction.

Given the extensive work on climate resilience by state agencies in the last decade, we consulted with agency staff to determine how an assessment of biophysical climate risks would be most useful to their efforts. We consulted with the following agencies: Washington Department of Fish and Wildlife, Department of Natural Resources, Emergency Management Department, Department of Ecology, Department of Health, Commerce Department, and the network of agency climate resilience staff through the Interagency Climate Adaptation Network. Through presentations and conversations, we scoped two forms of assessment:

> Option 1: Relative climate exposure across the state to inform statewide resilience policies and funding decisions;
>
> Option 2: Climate risk exposure of local jurisdictions to enhance awareness and capacity to respond to state and federal policies, regulations, and funding opportunities.

We heard from state agency staff that both options were desired and relevant, and that Option 2 — local government support for climate information — is the greater immediate need. State agency staff indicated that they have general knowledge of climate impacts and are more able to access existing resources than do local jurisdictions, but they often experience a critical gap in the awareness and capacity of local governments to access and apply climate information. They observed that, in local jurisdictions, planners and officials do not have equitable, inexpensive, low-barrier ways to access relevant climate information to support their efforts to plan, implement local actions, comply with state requirements, and secure state or federal funding for climate resilience. To be successful, local jurisdictions need support. Based on this consultation, we developed Option 2, an assessment of biophysical climate impacts communicated with an interactive web application, *Climate Mapping for a Resilient Washington*, directed at local jurisdictions and designed to support local awareness of climate impacts and build capacity to plan and implement risk-reduction activities.

To ensure that this product would support local governments with state planning requirements and grants related to climate resilience, we conducted a second consultation and review process to solicit feedback on an initial version of the web application. We consulted with state agencies, local governments, private consulting firms engaged in climate resilience, and the Association of Washington Cities. We incorporated their feedback into the final version of the assessment and web application.

4. Approach to Climate Risk Assessment: Biophysical and Economic Impacts

The University of Washington Climate Impacts Group and Washington State University IMPACT Center developed two science-based elements of a comprehensive climate risk assessment: biophysical climate impacts and economic impacts of climate-related hazards.

Biophysical Impacts: The UW CIG summarized projections of the magnitude and timing of changes in the climate and climate-related hazards in Washington State. In this report, we provide a high-level summary of the approach used to compile and present data on biophysical climate impacts for Washington State. Detailed results are presented in an interactive web application, *Climate Mapping for a Resilient Washington*, available online.

Economic Impacts: The WSU IMPACT Center developed a high-level summary of potential impacts to Washington's economy of three key climate-related hazards: extreme heat, wildfire, and drought. We used a case study approach focused on past impacts. In this report, we summarize the approach used for the economic assessment and key results. Additional detail and methods are in Appendix A.

4.1 Approach to Assess Biophysical Impacts of Climate Change in Washington

We compiled and curated existing data sources for projected changes in the climate and related hazards in Washington. Climate datasets include projections of precipitation and temperature, sea level rise, snowpack and natural streamflow simulated with hydrologic process models, and wildfire simulated with a fire and vegetation model. Changes are mapped across the state. Where data are sufficient, these are presented in terms of the *change in the likelihood of hazards* based on the projected climate through the end of the 21st century.

Climate data typically include projected changes in the climate for multiple future scenarios based on a set of assumptions about concentrations of greenhouse gases in the atmosphere and different global climate models. Datasets also include multiple values at different timesteps and spatial scales. Of these, we selected a subset of scenarios, time periods, and values for a suite of changes in the climate and related hazards that are common in Washington and useful for assessment and planning across multiple sectors. This subset includes changes in the climate and hazards summarized in the most recent assessments for Washington[6] and the Puget Sound region[7]. We augmented information in these assessments with more recent data and analysis when available. No new climate modeling was conducted for this assessment, but some data were analyzed to calculate seasonal values, key indicators, and changes in the likelihood of hazards in Washington. Additional details and data sources are in Appendix A.

[6] Snover, A.K., Mauger, G.S., Whitely Binder, L.C., Krosby, M., Tohver, I. 2013. *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers.* State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle

[7] Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. *State of Knowledge: Climate Change in Puget Sound.* Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle.

Climate hazards and indicators included in Climate Mapping for a Resilient Washington

Climate Hazards	Climate Indicators
Extreme Precipitation	Heavy Precipitation Magnitude (percent change) Extreme Precipitation Magnitude (percent change) 1 inch Precipitation Days (change in days) 2 inch Precipitation Days (change in days) 3 inch Precipitation Days (change in days)
Extreme Heat	Summer Maximum Temperature (change in °F) Hot Days (change in days) 90°F Maximum Humidex Days (change in days) 65°F Minimum Humidex Days (change in days) Heating Degree Days (change in degree-days) Cooling Degree Days (change in degree-days) August Stream Temperature (°F)
Drought	Total Annual Precipitation (percent change) Late Summer Precipitation (percent change) Precipitation Drought (likelihood) Warm Season Streamflow (percent change) Summer Streamflow (percent change) Duration of Low Streamflow (change in days) Low Streamflow (percent change) Streamflow Timing (ratio) Snowpack Drought (likelihood)
Flooding	Peak Streamflow (percent change) Frequency of Peak Streamflow (return interval)
Reduced Snowpack	Snowpack (percent change) Streamflow Timing (ratio)
Sea Level Rise	Likely Sea Level Rise (ft) High Sea Level Rise (ft)
Wildfire	High Fire Danger Days (change in days) Wildfire Likelihood (likelihood)

Planning sectors included in Climate Mapping for a Resilient Washington

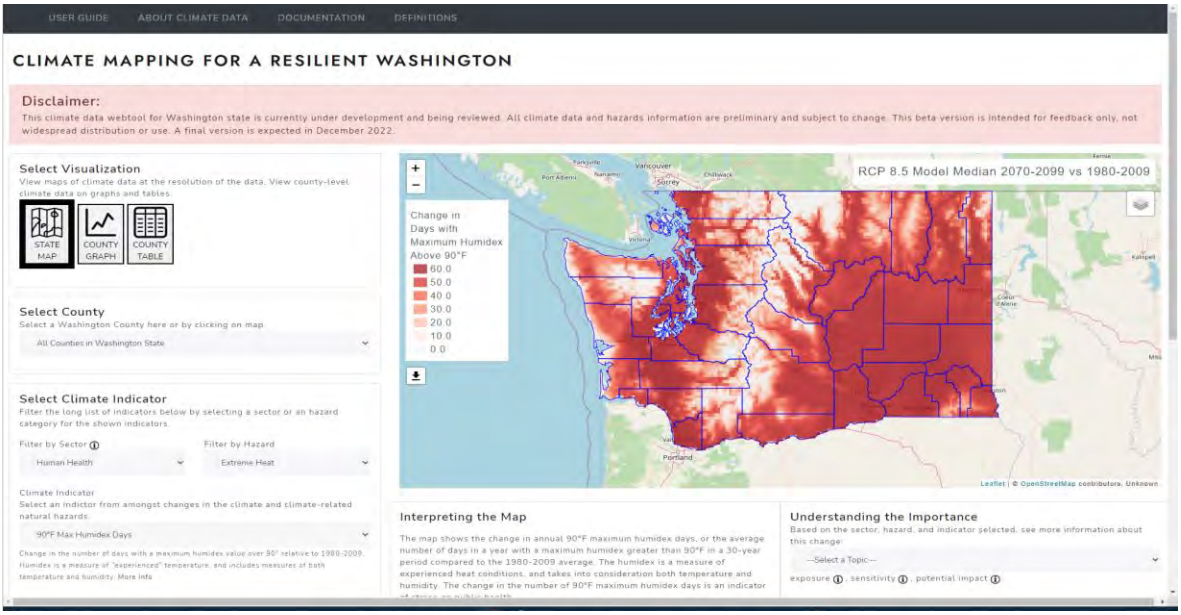
Sectors	
Agriculture	Transportation
Ecosystems	Economic Development
Human Health	Emergency Management
Buildings & Energy	Cultural Resources & Practices
Zoning & Development	Waste Management
Water Resources	

4.1.1. Climate Mapping for a Resilient Washington

Rather than list and explain the magnitude and timing of biophysical climate risks in a report, we developed an interactive web application, *Climate Mapping for a Resilient Washington*. This interactive web application compiles all such information in one place and maps climate changes and hazards across the state. Hazards are linked to sector-specific impacts, along with descriptions of the factors that affect exposure and sensitivity locally.

Although national climate resilience web applications provide similar functionality, Climate Mapping for a Resilient Washington is designed to meet the specific needs of Washingtonians by including expected changes in streamflow, snowpack, drought, and wildfire.

CMRW includes climate hazards that are critical to understand in order to manage the state's natural resources and protect residents and communities but are not commonly included in national-scale applications. National applications typically include only the indicators that are consistently available for the whole country, such as temperature and precipitation.

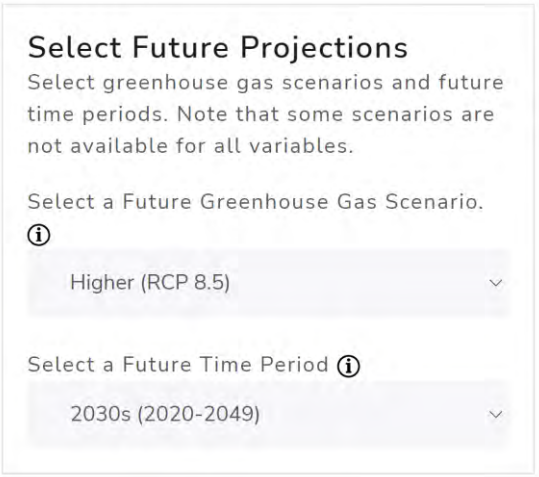


Users can filter data and customize information for their specific planning, assessment, funding and outreach applications. For each hazard-sector combination, a subset of indicators is shown that is most relevant for that sector. For example, users interested in extreme heat and human health can select from three indicators of heat effects on human health: summer maximum temperature, days above 90°F maximum humidex, and days above 65°F minimum humidex days. Users interested instead in extreme heat and impacts to the transportation sector-, will see a different indicator relevant to that sector, the number of hot days above 100°F. A description of the indicator alongside the map, explains its relevance to the sector. The sectors shown are those commonly used in local and regional planning, such as comprehensive planning.

Future Time Periods and Climate Change Scenarios

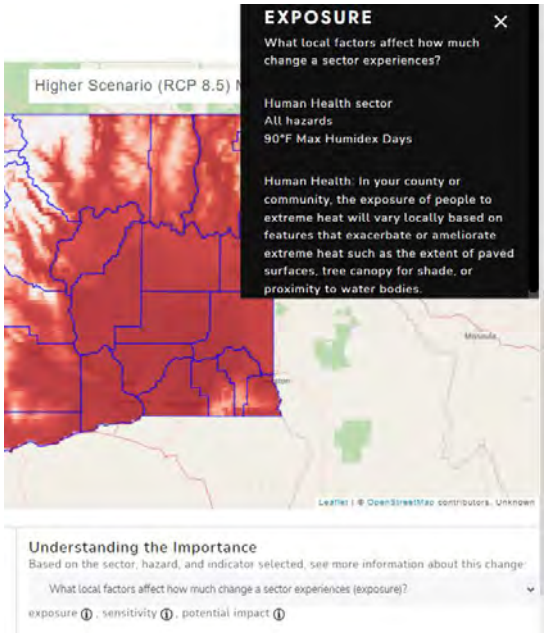
Users can filter data for the time periods that align with their planning horizon. Changes in the climate will progress over time, in most cases intensifying with more warming. Users can view changes for multiple future time periods through 2100, as consistent with their planning needs. As is standard practice in climate science, changes in the climate are summarized as the average over 30-year periods to illustrate long-term climate trends rather than short-term climatic variability. The decade labels are the center decade for each 30-year time period, for the example the 2030s refers to the 30-year period of 2020-2049.

Users can filter data for one or more climate scenarios; options vary by indicator climate indicators. Projected changes in the climate are a function of scenarios of future concentrations of greenhouse gases in the atmosphere (labeled Representative Concentration Pathways, RCPs), which are used by the international climate science community in computer models to simulate changes in the climate. Greenhouse gas scenarios are based on a standard set of assumptions about technology, humanity and policy decisions. The scenarios describe different climate futures; all are possible depending on near-term emissions.



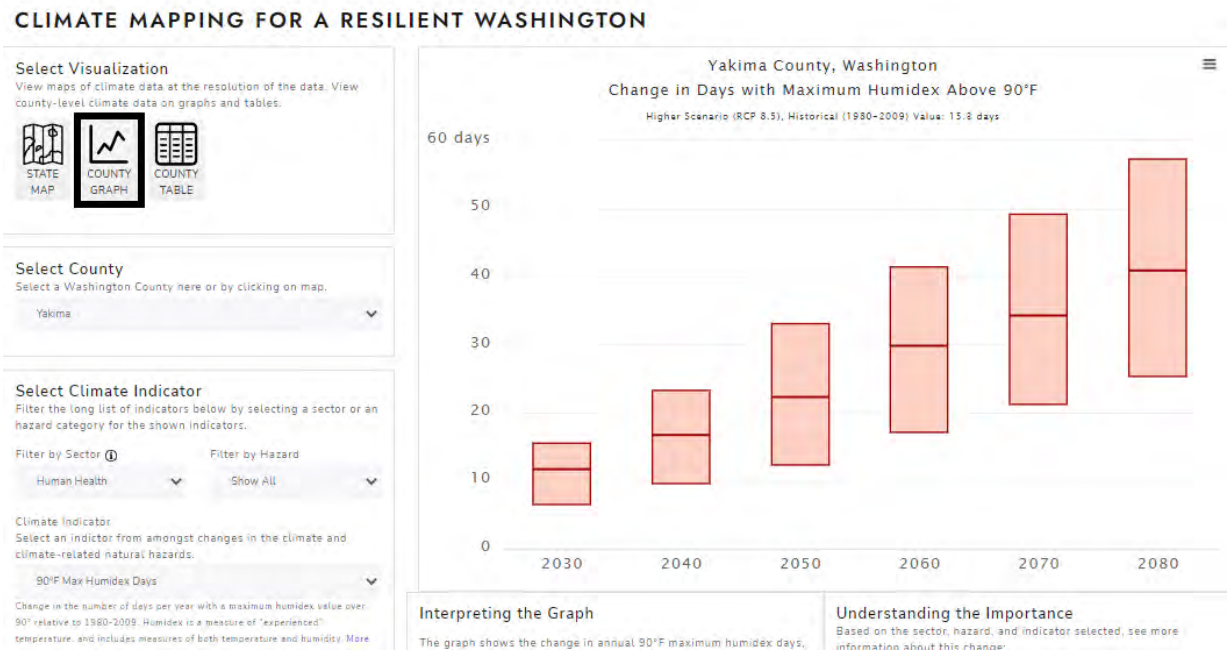
Local Variation in Exposure, Sensitivity, and Impacts

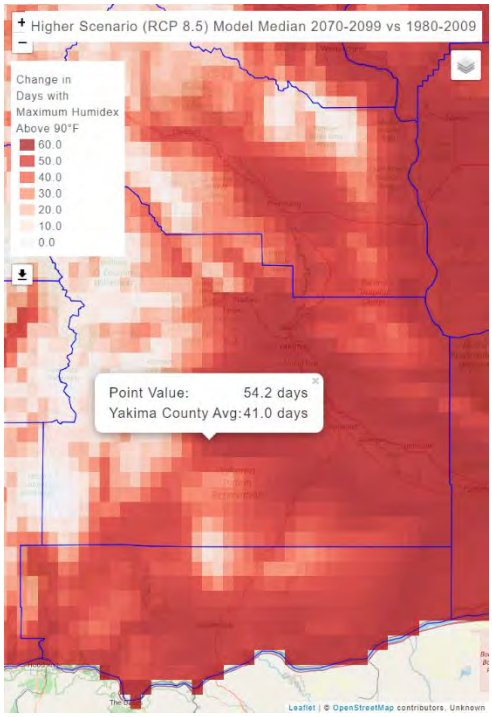
Information on biophysical climate impacts alone does not capture local variation in populations, assets, and ecosystems that will determine their vulnerability to climate hazards. At the local level, sub-populations, assets, and ecosystems will be more *exposed* to changes because of their location within a county or community. Biophysical impacts also do not capture local variation in sub-populations, assets, or ecosystems that will be more *sensitive*, or susceptible, to these changes because of factors that predispose them to climate impacts, such as pre-existing conditions and non-climatic stressors. Local information on exposure and sensitivity is a product of a climate vulnerability assessment best derived from local data, knowledge, and expertise, and it is also critical for a comprehensive risk assessment. *Climate Mapping for a Resilient Washington* guides users in the type of data and information to consider in assessing local variation in vulnerability as the first step towards a local climate vulnerability assessment.



County-level Summaries

Climate Mapping for a Resilient Washington allows users to select a county and provides a summary of changes in the climate specific to that county. Whether in Stevens, Clallam, or Yakima counties, local planners, policy-makers, and residents can all access information specific to their location. Graphs and tables with county-specific values can be downloaded and integrated into reports, plans, or presentations.





YAKIMA COUNTY
CHANGE IN DAYS WITH MAXIMUM HUMIDEX ABOVE 90°F

	MODEL MEDIAN	MODEL RANGE (10TH TO 90TH PERCENTILE)
1980-2009		
Historical Baseline	15 days	14 to 17 days
2020-2049		
Higher Scenario (RCP 8.5)	11.7 days	6.4 to 15.4 days
Lower Scenario (RCP 4.5)	9.6 days	4.3 to 14.4 days
2030-2059		
Higher Scenario (RCP 8.5)	16.8 days	9.5 to 23.2 days
Lower Scenario (RCP 4.5)	13.0 days	5.2 to 17.9 days
2040-2069		
Higher Scenario (RCP 8.5)	22.4 days	12.3 to 33.0 days
Lower Scenario (RCP 4.5)	14.4 days	7.3 to 23.8 days
2050-2079		
Higher Scenario (RCP 8.5)	29.9 days	17.0 to 41.4 days
Lower Scenario (RCP 4.5)	16.9 days	9.6 to 28.0 days
2060-2089		
Higher Scenario (RCP 8.5)	34.3 days	21.2 to 49.1 days
Lower Scenario (RCP 4.5)	19.1 days	11.2 to 31.0 days
2070-2099		
Higher Scenario (RCP 8.5)	41.0 days	25.3 to 57.2 days
Lower Scenario (RCP 4.5)	21.4 days	13.0 to 31.6 days

4.2 Approach to Assess Economic Impacts of Climate Change in Washington

As challenging as it is to determine the likelihood of biophysical impacts associated with climate change, the associated economic risks add even more complexity. When biophysical impacts occur, this leads to economic changes in quantities supplied and demanded in specific markets. In addition to immediate economic damages, climate impacts often affect transportation and supply chain networks, resulting in mid- and long-term market disruptions.

The economic framework for estimating economic disruptions due to climate hazards has largely utilized multi-disaster footprint models (MDFM), which build from the standard input-output (I-O) models similar to that developed and curated by OFM over the past several decades. Additional data and research are needed to determine the sensitivity of industrial and household activity to these changes in the climate to connect changes in the climate with the economic output variables embedded in I-O models.

We assessed the potential economic damages associated with three climate-related hazards — extreme heat, wildfire, and drought — and how they spread through an economy. We draw lessons from where risks have been realized and economic consequences have been measured. Where possible, we focus on the economic consequences of hazards in Washington. Where the economic consequences in Washington have not been measured, we use research from other regions and discuss the implications for Washington. The case studies focus on market activities and asset values to provide insight into the potential economic consequences Washington has experienced and is more likely to experience in the future. Here we introduce three case studies of three climate-related hazard and their economic consequences (Sections 4.2.1, 4.2.2, and 4.2.3). We discuss the results in Section 5.

4.2.1 Case Study: Extreme Heat and Health

There are a variety of channels by which productivity losses are generated during periods of, and around, extreme heat days. Individual productivity may decline while on the job, but absenteeism occurs as well, and is more frequent among employees receiving paid leave[8]. A simulation model was developed based on literature regarding extreme heat and economic output as measured by GDP. Industries most susceptible to extreme heat (e.g., agriculture, manufacturing, construction) are likely to see reductions in economic output of roughly 2% for each day of extreme heat[9]. Reductions in productivity account for both absenteeism and lower productivity output for employees that continue to work.[10] This results in reduced business-to-business activity in those periods. Total productivity losses do not account for the loss in human life and the non-market values of premature mortality or other non-monetary damages caused by extreme heat. Once direct industry losses are calculated they may be run through an I-O or

[8] Zivin and Neidell 2014. Temperature and the Allocation of Time: Implications for Climate Change. *Journal of Labor Economics* 32 (1): 1-26.
[9] Somanathan, E. et al. 2021. The Impact of Temperature on Productivity and Labor Supply: Evidence from Indian Manufacturing. *Journal of Political Economy* 129 (6):1797-1827.
[10] Care must be taken to ensure that overlap (co-morbidity) between the extreme heat and drought impacts are not double counted and overstate the economic impacts. In this case we are not summing the drought and extreme heat impacts, so we do not address such double counting.

MDFM, as described in the Appendix B. This modeling framework will show the reductions in variable expenses that ultimately reduce the money flowing through the supply networks in the state. All such lost economic activity may be directly tied to the extreme heat event, without which more economic activity and productivity would have happened.

4.2.2 Case Study: Wildfire

Estimates of the economic losses associated with Washington's 2021 wildfire season are derived from data collected on California's 2018 wildfire season. In 2018 approximately 2,320,567 acres of land burned in California[11]. A comprehensive economic analysis of the 2018 fire season in California is available, but no such analysis has been done for recent wildfire seasons in Washington.[12] Because of this we draw from the California research to discuss potential damages in Washington.[13] In California, 2018 was one of the worst fire seasons on record. Nearly 2% of the state was burned by over 8,500 fires. The economic analysis of the 2018 wildfires estimated capital losses (replacement costs for assets; morbidity, mortality, and health costs including lost working time and medical expenses); transportation and adaptive behaviors (e.g., traffic disturbances, lost working time from active avoidance); and all associated forward linked economic multiplier effects.

Based on measures of capital asset losses (not including the lost timber), healthcare costs, and indirect costs, total damages to California in 2018 amounted to $148.5 billion. Only 27% of this amount came from direct capital losses, with healthcare and indirect costs contributing 31.5% and 41.5%, respectively. Capital costs did not account for natural resources losses, which would have been substantial and contributed to forward linked losses for the agricultural and timber processing industries. Thus, the $148.5 billion likely understates the true impacts of the 2018 wildfires. The total damage estimate of $148.5 billion combined with a total area burned of 1.9 million acres leads to a damage estimate of roughly $78,158 per acre. Although there are differences between California and Washington, the per acre damages can be used to estimate wildfire damages in Washington in 2021 based on the total area burned.

4.2.3 Case Study: Water Shortage and Potato Production

We conducted a case study of the water shortage and drought conditions of 2015 specifically on the potato production and processing sectors of the Odessa Subarea in Washington. We used an Input-Output model, similar to that developed and housed at OFM,[14] to determine the total regional economic losses from the reductions in value produced. Potatoes are one of nature's water balloons, so without available moisture and excessively dry conditions, yields and quality are greatly reduced. Losses in potato production and processing in 2015 are calculated as the difference between the decade average yields and the 2015 yields. We attribute most of that difference to the absence of quality irrigation water and the absence of the moisture in the soil

[11] Wildland Fire Emissions Inventory System https://wfeis.mtri.org/stats
[12] Wang, D et al. 2021. Economic footprint of California Wildfires in 2018. Nature Sustainability. 4:252-260.
[13] Similarities between home value distributions and the state forests are unlikely, i.e., harvest rates, forest density, timber mix, etc. Forest fires have disparate impacts compared with grassland or shrubland fires.
[14] The Washington Input-Output Model available from Office of Financial Management at https://ofm.wa.gov/washington-data-research/economy-and-labor-force/washington-input-output-model

and atmosphere. Yield losses reduced spending throughout the potato value chain. The analysis captured the total lost activity throughout those value chains, including the lost income to households. Industries such as chemical and fertilizer manufacturers, retail trade, and transportation were all damaged by the reductions in farm income. Households within the supply chain had less income and prices for processed potatoes rose. Extreme heat was not considered as a factor leading to yield loss and there is some overlap between the drought and the extreme heat experienced that year. Appropriate measures are needed in future analysis to ensure that comorbidity issues do not result in double counting of economic impacts and modeling can isolate the portion of yield loss due to drought vs. extreme heat.

5. Results Three Climate Hazard-Sector Combinations: Extreme Heat and Human Health, Wildfire and Infrastructure, and Drought and Agriculture

5.1 Extreme Heat and Human Health in Washington

Three separate sources of information about extreme heat risk to human health and response options can be combined for a holistic approach to risk assessment and resilience planning. These sources are expected changes in extreme heat (discussed in Section 5.1.1), economic impacts (5.1.2), and a problem-oriented evaluation of variation in exposure, sensitivity, and capacity to adapt (5.1.3)[15].

5.1.1 Expected Changes in Extreme Heat

Both average temperatures and extreme high temperatures are expected to increase across the state, with potential consequences for human health and well-being. Not all locations and populations will be equally exposed or susceptible to this hazard. Without sufficient efforts to adapt, extreme heat is expected to increase the risk of heat-related illness and other severe health complications that can lead to hospitalization and death. For example, in King County when daily maximum or minimum temperatures reach or exceed the historical 99th percentile[16], risk of death increases 10 percent, hospitalizations rise 2 percent, and calls for emergency services increase up to 14 percent.

Extreme heat can be characterized in several ways. One of the most effective predictors of extreme heat risk for people is humidex, an index that measures the combined effects of temperature and humidity. A maximum daytime humidex above 90°F and a maximum nighttime humidex above 65°F corresponds to higher risk of heat-related illness, hospitalization and death. Nighttime high events are currently increasing more than daytime high events in the Pacific Northwest[17] and this can be especially harmful to human health in regions with limited experience with warm nights and few households with indoor air conditioning.

More extreme heat due to climate change is only one factor that affects the exposure of local populations to heat. Local conditions within a county or community will further intensify or ease the exposure of certain areas and populations to extreme heat. Examples include the amplifying effects of paved surfaces and urban heat islands[18] or the cooling effects of water bodies and tree canopy cover. The sensitivity, or susceptibility, of populations within a community or county will also depend on physiological tolerances and aggravating circumstances.

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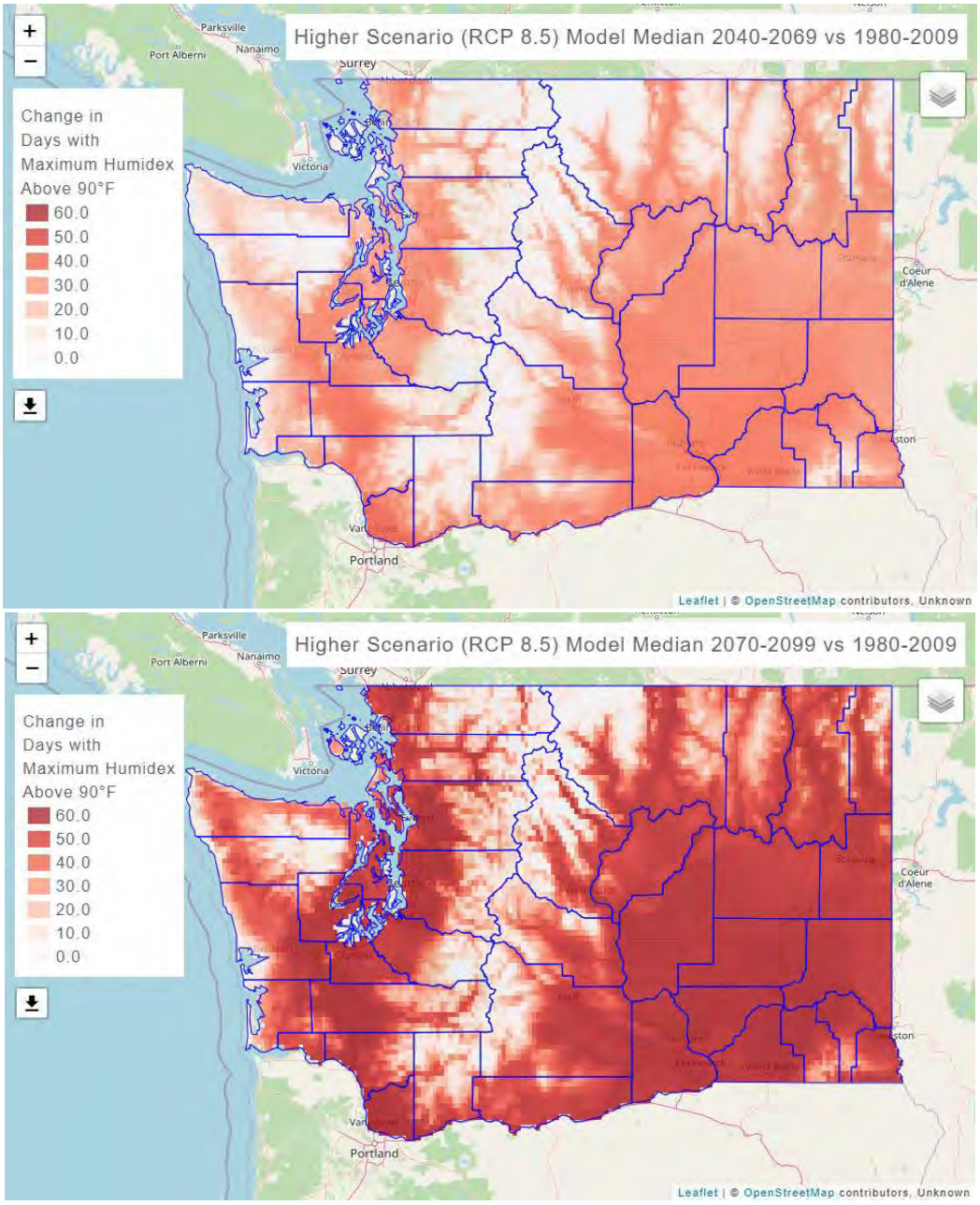
[15] Additional information on this available at https://cig.uw.edu/projects/a-problem-oriented-approach-to-washington-states-climate-response-strategy/

[16] A 99th percentile heat day in King County, based on observations between 1980 and 2010, is a day when the humidex exceeds 97°F (36.1°C). A humidex of 36.1°C is roughly equivalent to 81°F and roughly 70% relative humidity–the average humidity in Seattle in August–or 97°F with 30% relative humidity–the relative humidity recorded throughout western Washington during the 2021 heat wave.

[17] Bumbaco, K.A.et al.2013. History of Pacific Northwest Heat Waves: Synoptic Pattern and Trends. *Journal of Applied Meteorology and Climatology*. 52 (7) 1618-1631.

[18] Areas that lack vegetation and have a concentration of development are considered urban heat islands because they become relatively hotter than outlying areas. The urban heat island effect can increase temperatures 1-7°F during the day and 2-5°F at night relative to adjacent rural areas.

By the 2050s (2040-2069), the number of days per year with a humidex above 90°F is expected to increase across the state and in some regions more than others[19]. Lower elevations in the Puget Sound region and eastern Washington are expected to be more exposed to extreme heat than on the outer coast and higher elevation areas. By the 2080s (2070-2099 average compared to 1980-2009), extreme heat will intensify and the differences between a higher (RCP 8.5) and lower (RCP 4.5, not shown) scenario are expected to be more apparent.

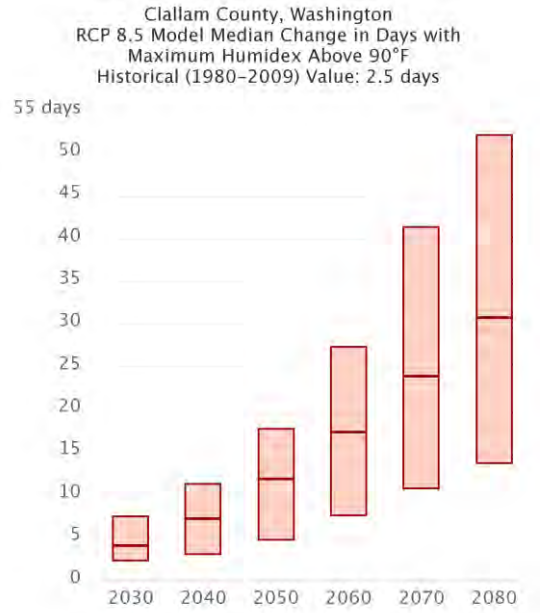


[19] Abatzoglou J.T. and Brown T.J. 2012. A comparison of statistical downscaling methods suited for wildfire applications. *International Journal of Climatology*. 32: 772-780.

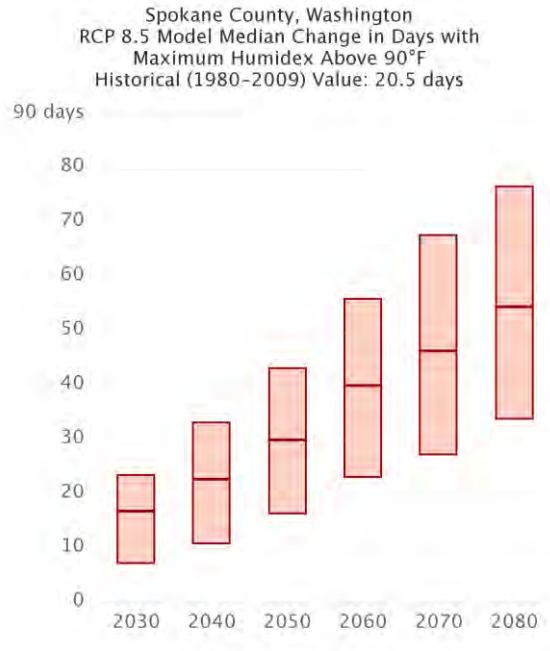
County-Level Variation in Extreme Heat Exposure

Exposure to extreme heat varies across the state. County-level summaries from *Climate Mapping for a Resilience Washington* show local changes that can help planners and decision makers understand vulnerability and prioritize climate hazards. Counties along the outer coast, for example, will have more moderate increases in extreme heat.

Counties in western Washington currently have few days per year with a maximum humidex over 90°F. They are expected to have large increases in the number of days above this threshold as the climate warms, especially for a higher climate scenario (RCP 8.5). For example, on average, Clallam County historically (1980-2009), has had only 2.5 days per year above a humidex of 90°F, but the county is expected to increase to 30.8 (range 13.7-52.1) such days by the end of the century (2070-2099) for a high scenario (RCP 8.5). Although this number of high humidex days will remain well below the number of high humidex days for counties in central and eastern Washington, residents in western Washington are less adapted to heat and are therefore at greater risk of impacts to human health.



Counties in eastern Washington currently have many more days per year with a maximum humidex above 90°F compared to counties in western Washington. This number of days is expected to increase to almost the full length of the summer season. For example, by the end of the century (2070-2099), Spokane County's days above a 90°F humidex are expected to increase from 20.5 days per year (historical average, 1980-2009) to 54.7 (range 33.9-76.8) days for a high climate scenario (RCP 8.5). Values are shown for the median and the range (10^{th}-90^{th} percentile) of multiple climate models although there is a range in the magnitude of changes that models project, all models show the same direction of change, an increase.



5.1.2 Economic Impacts of Extreme Heat for Human Health

Washington State currently supports over 4.4 million jobs and over $609 billion in gross state product annually. Based on model simulation results, one year of heat-related activity losses results in direct losses to industry sales of over $426.1 million-$178.3 million in lost gross state product and losses of over 1,481 full-time equivalent jobs. These losses are only the direct effects of extreme heat on human productivity; other direct losses (e.g., in agricultural yields and premature mortality) are not captured in these figures. Thus, these results represent a lower-bound estimate of the potential GDP impacts of excess heat.

The economic impacts of extreme heat on human activity do not stop with direct effects. Reduced output and gross state product result in lower business and employee income. Lower business income, in turn, reduces business-to-business transactions, which reduces demand throughout the state's supply networks, slows port and transportation activity, and reduces the income to all vendors of the directly affected industries. Total reduced sales from these losses are over $175.8 million: $111.4 million in GSP reduction and 941 fewer FTE jobs. Total expected losses from this source of economic damage are outlined below. Of the results reported, total losses to the state from reduced business activity represents $15.3 million. This does not include reduced household tax receipts, social insurance taxes, or corporate and excise taxes.

Summary of simulated economic losses from heat induced productivity losses in Washington

	Sales	GSP	Income	Jobs
Direct	-$426,195,401	-$178,300,903	-$115,017,720	-1,487
Indirect	-$158,470,052	-$86,824,700	-$53,853,030	-676
Induced	-$175,884,255	-$111,469,037	-$60,595,758	-941
Total	**-$760,549,708**	**-$376,594,641**	**-$229,466,509**	**-3,104**

5.1.3 Strategies and Actions: Extreme Heat and Human Health

Certain populations are more vulnerable to extreme heat than others, a fact that is masked by population-wide health statistics. Vulnerability to extreme heat is a function of a person's physiological sensitivity to extreme heat, the duration and intensity of their exposure, and their capacity to adapt to or avoid heat stress. Some populations are more sensitive to heat-related hospitalization and death. These include older adults and infants, people with pre-existing medical conditions (e.g., cardiovascular disease, kidney disease, respiratory disease), people who are unable to care for themselves, are socially isolated or bedridden, or those living or working in an urban heat island. Households without access to air conditioning (AC) or public cooling facilities, such as cooling centers, splash pads, or parks will also be more sensitive to exposure to extreme heat.

Socioeconomic factors largely determine the inequitable impact of extreme heat. Pollution contributing to heat-sensitive medical conditions, and urban heat islands that amplify heat exposure, are not evenly distributed across a metropolitan area. These inequities are closely linked to the state's legacy of racially discriminatory housing policies and decades of disinvestment. Neighborhoods that were formerly redlined generally have more air pollution, fewer trees, and an abundance of heat-absorbing artificial surfaces, causing urban heat islands that contribute to physiological maladies linked to a higher risk of death during heat waves.

The responses of state and local agencies to health risks from extreme heat have been largely opportunistic and limited in scope. As examples: the Washington State Department of Labor & Industries has expanded heat safety standards for outdoor workers, requiring more rest during hot days; the Department of Social and Health Services has issued guidance to its providers to closely monitor residents for signs of heat-related illness during heat waves; and King County has prioritized the protection and expansion of urban tree canopy and greenspace in the areas of greatest need. These measures illustrate the diverse actors and strategies for reducing heat-related illness and death. However, the death toll directly caused by the heat wave in 2021, 95 heat-related deaths in one week, illustrates the significance of heat-related illness and death. Without further adaptation, health impacts, especially for certain sensitive populations, will continue and worsen from climate change.

Multiple factors drive heat-related hospitalizations and death: sensitivity, exposure, and inadequate capacity to adapt. Framing the problem of managing effects of extreme heat on health to include these factors enables a thorough identification of strategies and actions that reduce these drivers of vulnerability. We present a subset of adaptation actions for human health and extreme heat to illustrate potential adaptive strategies across the four phases of emergency management: mitigation, preparedness, response, and recovery. A portfolio of policies—not a single, uniform solution—will most effectively reduce the risk of vulnerable populations to heat-related illness and death. A portfolio approach also provides critical redundancy in support systems, which can save a life during a heat emergency.

Heat-related adaptation actions at different phases of emergency management in response to factors contributing to vulnerability to extreme heat

	Mitigation	Preparedness	Response	Recovery
Sensitivity	Address external factors driving preexisting conditions such as cardiovascular, kidney, and respiratory disease (e.g., air pollution, lead poisoning) Discourage unhealthy behaviors around diet and nutrition (e.g., foods high in sodium, fat, and sugar)	Expand informed consent to include heat sensitivity among individuals taking medications that affect the body's ability to maintain homeostasis Use community- based networks to monitor vulnerable individuals and households Train social workers and direct care workers on how to spot and treat HRI	Increase EMS staffing during heat events to respond to increased calls for help Increase the number of ventilators and other life-saving interventions available for healthcare workers	Increase access to healthcare to identify/address illnesses and heat-contributing causes of death (e.g., medical screening and physiological monitoring)
Exposure	Increase shade and vegetation in urban heat islands through building codes, land use planning, or urban forestry initiatives Increase use of cool surfaces in urban heat islands to increase albedo effect of pavement and rooftops	Improve outreach and culturally specific communication to neighborhoods within urban heat island Mandate cooling periods for workers; encourage beneficial behavioral strategies, such as hydration and rest	Deploy infrastructure, such as splash pads or misters for localized cooling Improve use of cooling centers by addressing issues with access, misinformation, and stigma	Use surveillance data to improve/refine heat response plans (e.g., health sensitivity-vulnerability maps, EMS call data) Apply for FEMA funding, such as Public Assistance or Hazard Mitigation Grant Program to reimburse emergency protective measures and/or finance future heat mitigation projects
Adaptive Capacity	Leverage flexible funding assistance programs to improve access/utilization of residential AC, e.g., LIHEAP, Community Development Block Grant Program, 1115 Medicaid waivers. Encourage diversification and growth of summer season electric generation to improve reliability of grid	Partner with property holders that have large, indoor spaces with working AC (e.g., malls, churches) Increase touch points in communicating how to diagnose onset of HRI and ways of reducing heat stress, such as increasing hydration, reducing physical exertion, avoiding sun exposure, and cooling the neck Integrate acclimatization into occupational heat safety rules	Open cooling centers; extend hours of existing public facilities with AC, such as libraries Improve access and safety at beaches and swimming pools Deploy mobile teams to distribute water and cooling accessories or provide transportation to cooling centers	Bolster energy-assistance programs to help vulnerable populations pay higher utility bills resulting from running AC during instances of extreme heat

5.2 Wildfire Likelihood and Infrastructure in Washington

5.2.1 Expected Increases in the Likelihood of Wildfire

Climate change is expected to increase both the length of the fire season[20], and the frequency and area burned by wildfires in Washington[21]. Higher temperatures and drier conditions in summer reduce the moisture in live and dead vegetation (e.g., fuel), creating conditions that enable fires to burn more easily and spread more quickly over larger areas. Fires may also burn with greater intensity and more severely in ecosystems where these climate conditions are combined with management practices that have increased the amount of vegetation, such as exclusion of small, low-severity fires or the introduction of flammable invasive plant species.

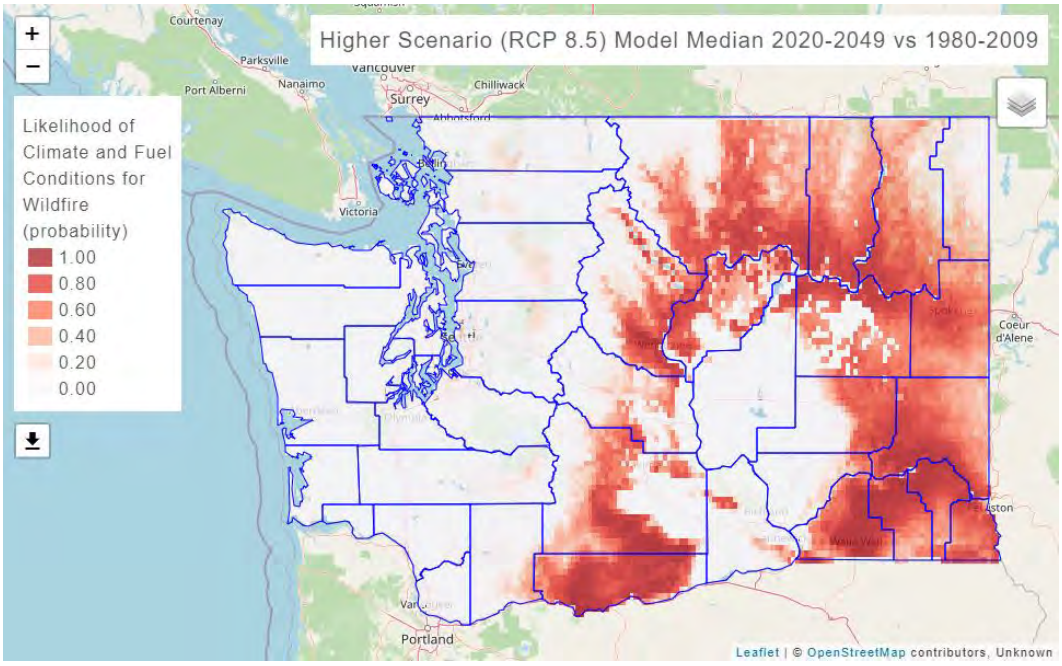
Wildfire is a critical component of most ecosystems in Washington. Characteristic fires provide ecological benefits (e.g., reduce fuels, create wildlife habitat, and enable regeneration of certain plant species), but large and uncharacteristically intense wildfires that burn into communities in the wildland-urban interface (WUI)[22] can cause significant economic losses at the state and local level, ecological consequences, and be harmful, even fatal, for humans. Wildfires of the last decade have also highlighted that nowhere in Washington is immune to poor air quality from wildfire smoke.

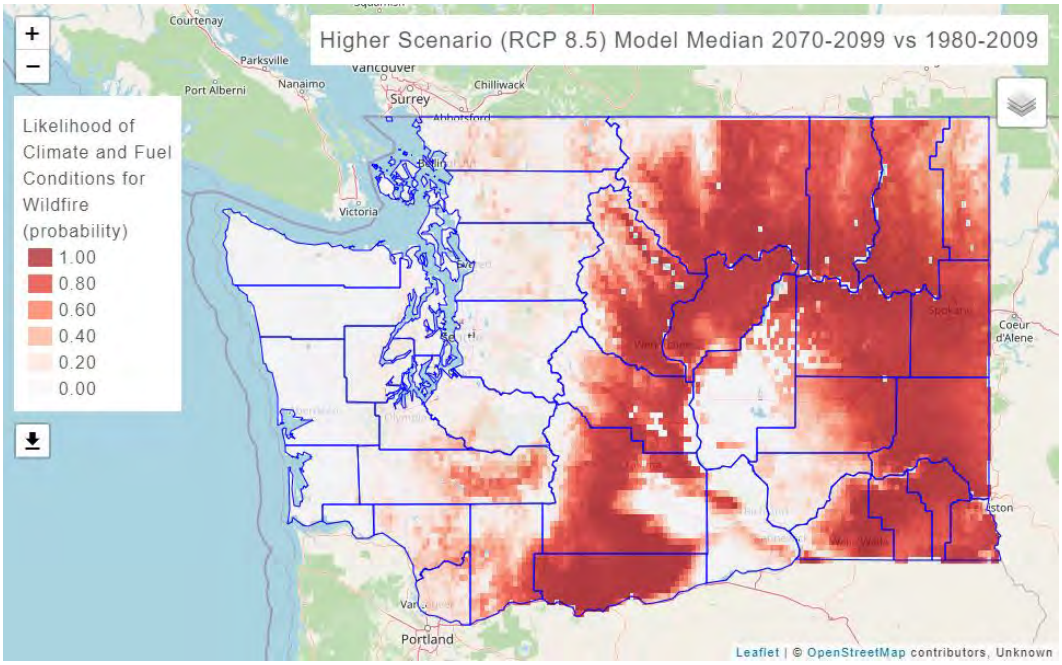
Similar to extreme heat, not all locations and sub-populations in the state will be equally exposed to a higher likelihood of wildfire in a warming climate. Infrastructure and people located in the WUI are a greatest risk. An often-overlooked contributor to increasing wildfire risk in Washington is the expansion of the WUI. From 2000 to 2010, Washington saw a 14 percent increase in the total WUI area. Many people building and moving into the WUI may be unaware of current or future wildfire risk.

Not all subpopulations or infrastructure in the WUI and exposed to a high likelihood of wildfire will be equally susceptible to the impacts of wildfire. For example, non-English speaking populations may have less access to resources and information related to wildfire preparedness or evacuation. Low-income populations and those with substandard housing may have fewer resources or less access to resources to help recover after a wildfire. Outdoor workers in the agriculture, construction, and recreation sectors may be more susceptible to wildfire smoke. Similarly, inherent characteristics of infrastructure, such as the materials that make up buildings and energy infrastructure, can make it more or less susceptible to fire.

[20] Jolly, M. W. et al., 2015. Climate-induced variations in global wildfire danger from 1979 to 2013. Natural Communications. 6: 7537.
[21] Sheehan, T., D. Bachelet, K. Ferschweiler. 2015. Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures. Ecological Modeling. 317:16-29
[22] The wildland-urban interface (WUI) are areas where wildlands and structures meet or intermingle. It refers to proximity of structures and natural ecosystems (e.g., forests) and does not indicate risk.

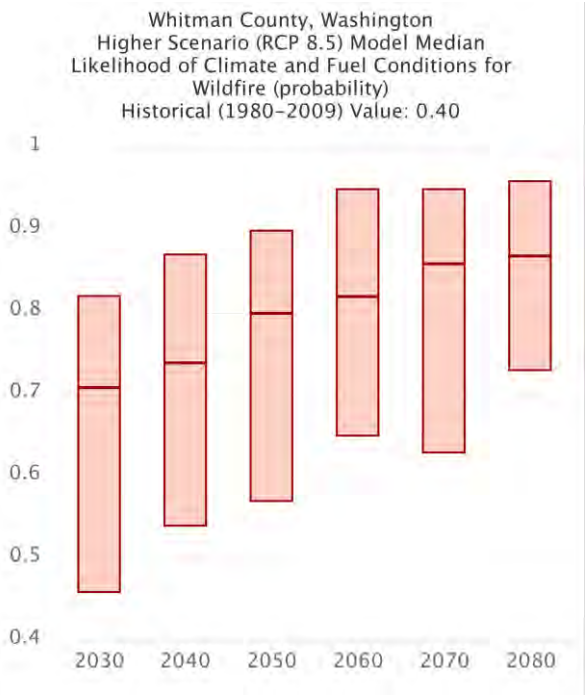
By the 2050s (2040-2069), the likelihood of climate and fuel conditions that can support wildfire in any year are expected to increase throughout much of the state. The likelihood of wildfire conditions is expected to initially increase in central and eastern Washington, consistent with where wildfire is already most likely. By the end of the century (2070-2099 average compared to 1980-2009 average), the likelihood of conditions that support wildfire is expected to increase more in those areas, as well as in western Washington, especially southwestern Washington where current wildfire likelihood is low.



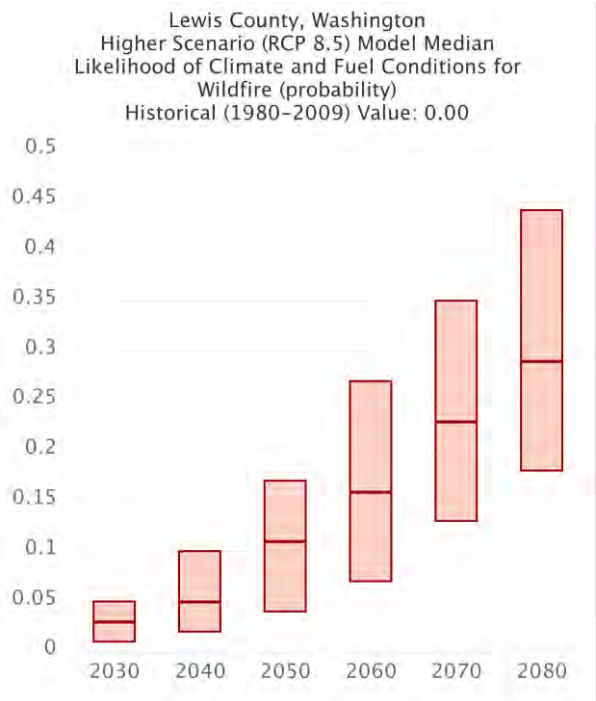


County-Level Variation in the Expected Change in Wildfire Likelihood

Many counties in eastern Washington already have a high likelihood of climate and vegetation conditions that can support wildfire in any one year. That likelihood is expected to further increase with drier conditions. For example, on average, Whitman County has 0.40 probability historically (1980-2009) that conditions in a year will enable wildfire. The probability of wildfire conditions there is expected to increase to 0.87 (range 0.73-0.96) for a high (RCP 8.5) scenario by the end of the century (2070-2099). The expected change in wildfire probability is similar for a lower scenario (RCP 4.5) not shown.



In contrast, counties in western Washington generally have a much lower likelihood of climate and fuel conditions that can support wildfire in any given year. For example, on average, Lewis County historically (1980-2009) has had a less than 0.01 probability that conditions in any one year will be sufficient for wildfire. The probability of wildfire conditions there is expected to increase to 0.29 (range 0.18-0.44) for a high (RCP 8.5) scenario by the end of the century (2070-2099). The expected change in wildfire probability is generally lower and has a larger range for a lower climate scenario (RCP 4.5) not shown but is still expected to increase.



5.2.2. Economic Impacts of Wildfire

Wildfires pose multiple economic risks including lost timber value, home destruction and reduced property values, transportation disruptions, and increased carbon emissions. In 2021 634,567 acres burned in Washington. Based on the analysis of wildfire economic losses in California, if the economic losses in Washington matched those measured in California on a per acre basis, Washington's economic losses from direct and indirect damages would have been $49.8-$53.0 billion in 2021.

These damages do not account for the lost timber assets (i.e., the stock of trees in our forests). The fire damage on the asset value of the forests creates no new activity or asset value in other segments of the economy, thus representing an almost entirely negative economic change. The forests represent a "savings account" that timber companies can draw from in the future, but wildfire acts as a withdrawal since timber can no longer be harvested except in the immediate case of salvage logging in some areas. At an estimated $0.55 per cubic foot of timber or $467 in lost asset value per acre, Washington lost $226 million to $314.9 million in timber values during the 2021 growing season. In addition to direct losses, a more thorough accounting would also measure the losses in forestry and agricultural output. Lost hours worked, increased transportation disruptions, and mortality and morbidity should all be quantified as part of the economic costs associated with wildfires. The true results of fire damage in Washington require comprehensive knowledge of what land types and forest resources, as well as health risks and capital assets, were affected. The severity of economic damages will be directly linked to the frequency and severity of wildfires.

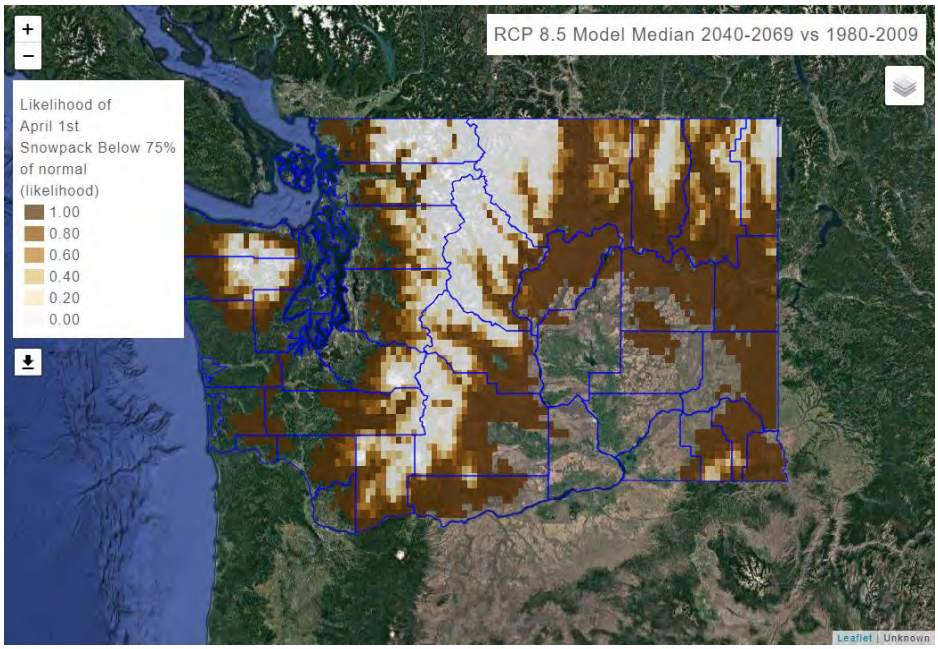
5.3. Drought and Agriculture in Washington

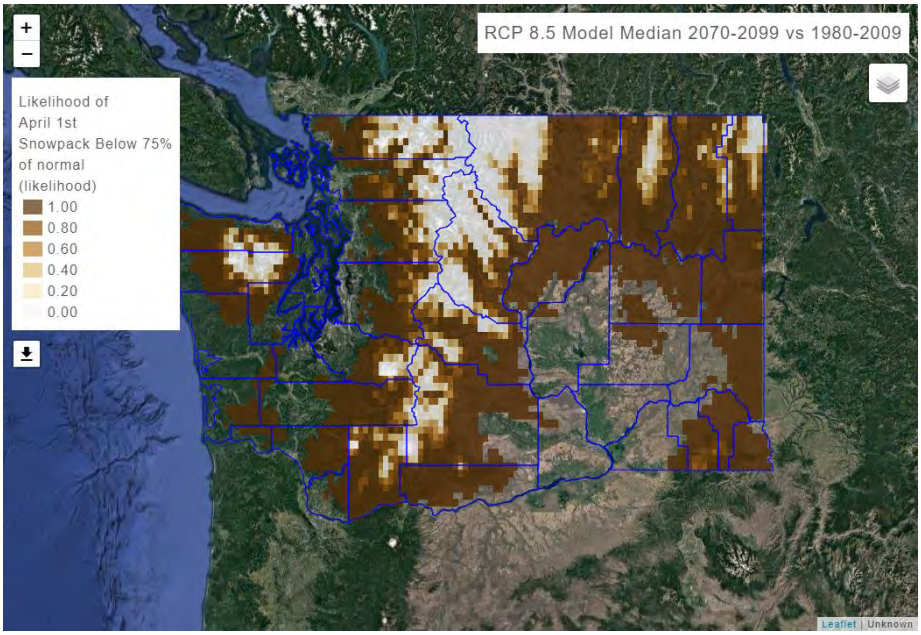
5.3.1 Expected Increases in the Likelihood of Drought

Climate change is expected to increase drought in Washington. However, the change in likelihood of drought is difficult to model and quantify because drought depends on the complex influence of precipitation, snowpack, and streamflow on overall water supply. Natural water supply in Washington is expected to decrease with warming. Rising temperatures, leading to declining snowpack, and combined with less precipitation in summer, are expected to reduce natural water supply. The likelihood of drought in any one year is expected to increase, especially as it relates to the amount of snowpack available to contribute to water supply. However, drought not only means drier conditions; it also requires that someone or something is negatively affected by a lack of water (i.e. hardship). In Washington, the legal definition of drought is based on water availability, which captures these criteria. A drought is declared when water supply is expected to fall below 75 percent of normal *and* water users in an area will probably incur hardship because of the lack of water.

Drought can be declared when one or a combination of factors—precipitation, streamflow, snowpack—falls below 75 percent of normal and hardship occurs. *Climate Mapping for a Resilient Washington* presents multiple indicators of drought, because different indicators are relevant for water supply in different areas. For example, snowpack is critical for water supply in areas dependent on surface water coming from mid to high elevations, but it is less relevant in areas that depend on groundwater. Consistent with Washington's legal definition of drought, drought indicators (e.g. snowpack and precipitation) are presented as the likelihood of being below 75 percent of normal.

By mid-century (2040-2069), many low-elevation areas in Washington that currently receive snow are more likely to have snowpack drought (less than 75 percent of the 1980-2009 average April 1 snow-water equivalent)[23]. By the end of the century (2070-2099), the area with high likelihood of snowpack drought is expected to expand upward in elevation. Only the highest elevations of the Cascade and Olympic Mountains will continue to have a low likelihood of snowpack drought, especially for a high (RCP 8.5) scenario.

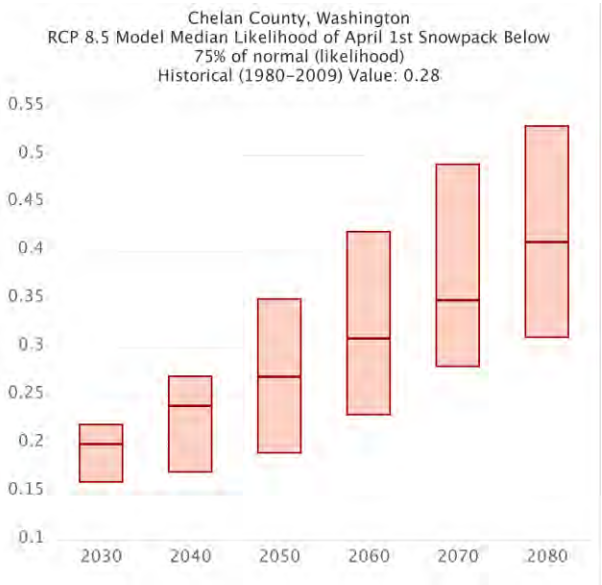




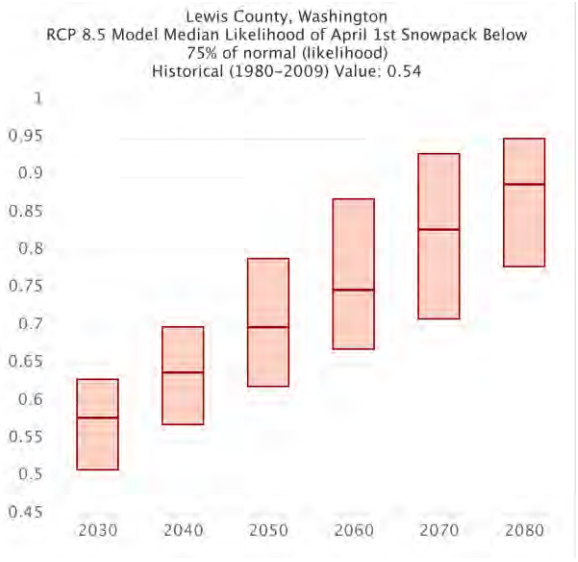
[23] Chegwidden, O. S., B. Nijssen, D. E. Rupp, P. W. Mote, 2017: Hydrologic Response of the Columbia River System to Climate Change [Data set].

County Level Variation in the Expected Likelihood of Snowpack Drought

The likelihood of snowpack drought will also increase in counties with substantial area at higher elevations, such as Chelan County, but this likelihood is not expected to increase as much as in lower elevation counties to the west. In Chelan County the likelihood of snowpack drought is expected to increase from 0.28 historically (1980-2009), to 0.41 (range 0.31-0.53) for a high (RCP 8.5) scenario by the end of the century (2070-2099).



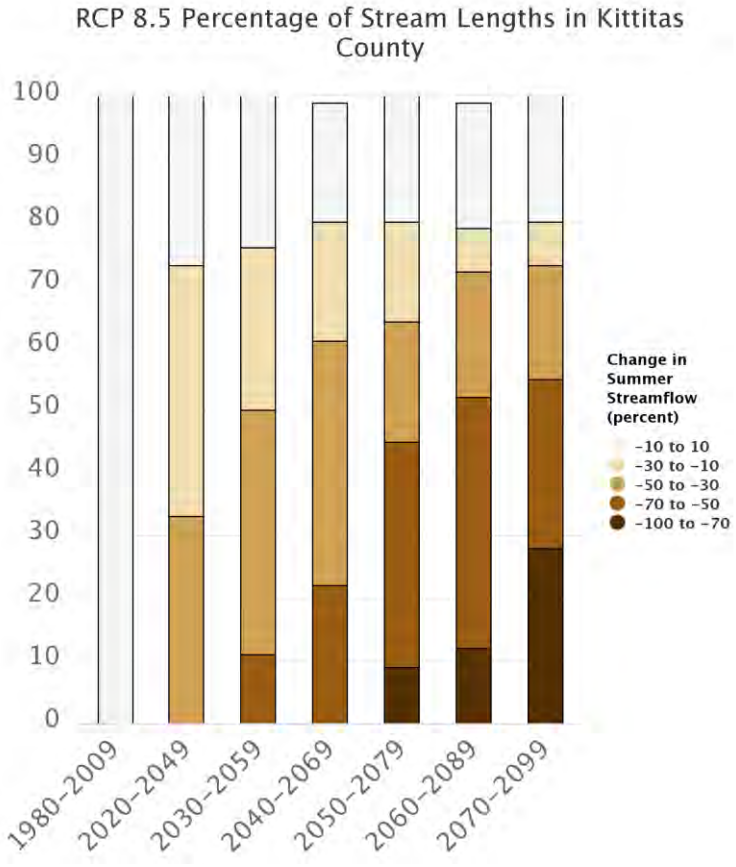
Counties with a higher likelihood of snowpack drought in the future are those on the west slope of the Cascade and Olympic Mountains with substantial areas of low-elevation foothills, such as Lewis County. By the end of the century (2070-2099), the likelihood of snowpack drought In Lewis County will increase from 0.54 historically (1980-2009) to 0.89 (range 0.78-0.95) for a high (RCP 8.5) scenario.



County Level Variation in the Expected Changes in Natural Summer Streamflow

By mid-century (2040-2069), natural summer streamflow is expected to decrease for most streams in Washington, especially streams that flow from higher elevations in western and northeastern Washington[24]. By the end of the century, summer streamflow is expected to further decrease across the state, with decreases in natural summer streamflows of over 70 percent in many areas.

In counties with many streams supplied by melting snowpack from the Olympic and southern Cascade mountains, natural summer streamflow will decline through the end of the century. For example, for over half the streams in Kittitas County, natural summer streamflow is expected to decrease by 50 percent or more by the end of the century (2040-2069) relative to historical (1980-2009 average) flows for a high scenario (RCP 8.5). Similar changes are expected for a lower scenario (not shown).



[24] Chegwidden, O. S., B. Nijssen, D. E. Rupp, P. W. Mote. 2017. Hydrologic Response of the Columbia River System to Climate Change [Data set]. Zenodo.

5.3.2. Economic Impacts of Water Shortage on Potato Production in Odessa Subarea

Washington State Department of Agriculture 2015 Drought Assessment

2015 was one of the driest years in Washington's history, which prompted the Department of Ecology to request a full study of the drought by Washington State Department of Agriculture's (WSDA) Natural Resources Assessment Section (NRAS). The stated objective was "to assess the gross value of lost production, as well as some additional expenses growers incurred due to the drought." Net and indirect impacts of drought were not part of the department's stated objective, nor was distinguishing between the drought and the extreme heat events that occurred that year.

The WSDA evaluated different hydrological regions in the state and broke down their analysis by primary commodity, capturing over 77% of agricultural acreage in Washington. They found that agricultural losses due to the 2015 drought were between $633 million and $773 million. However, because agriculture is part of a broader food supply chain, the economic consequences of these direct effects were not fully monetized.

Potato Case Study

This case study shows that, with supply chain effects, potato losses from the Odessa Subarea alone accounted for just under $377 million. The Odessa Subarea underlies Adams, Franklin, Grant, and Lincoln counties in east-central Washington. This area of Washington is extremely dry and relies on subsurface water. This area boasts the highest potato yields in the United States, but it is dependent on irrigation. In 2005, the Odessa Subarea had 35,600 acres in potato production. In 2015, irrigated potato acreage in the subarea fell more than 25% to 26,519 acres, primarily because of the dry conditions and lack of water resources in that year.
Even with poor water supply and reduced acreage, growers in the subarea produced over 943,000 tons of potatoes. The Odessa Subarea is 132.4 times more concentrated in potato production than the average region in the United States. The region has a strong comparative advantage in potato production, but only insofar as it has access to water.

Concentration of potato production value in the Odessa Subarea

Region	Potato Production (Sales in thousands)	Total Regional (Sales in thousands)	Concentration
Four-county region (Adams, Franklin, Grant, Lincoln)	$201,293	$6,023,766	132.4
Washington State	$771,210	$362,656,959	8.4
United States	$3,750,246	$14,863,510,830	1.0

Source: USDA NASS Quick Stats, Emsi, and author's calculations

The costs of losing potato production in the Odessa Subarea would exceed $37 million, and about 1,100 jobs would no longer be supported. The long-term impacts may extend even further if potato processing plants reduced their output. Under this scenario, total reductions in regional output would exceed $138 million, with a loss of nearly 3,000 jobs. These losses may seem minor relative to the entire economy, but they reflect only the losses from potato outputs. The real costs of losing water in the Odessa Subarea would also affect forage producers, specialty crop producers (e.g., mint, pepper, onion, carrot), and wine grape growers. Even the few wheat producers who do irrigate their crops would be under pressure.

Range of economic losses to the four-county region from losing potato production

	Sales	Value added	Income	Jobs
Direct effect	($111,384)	($27,240)	($27,853)	(933)
Multiplier effects	($22,489)	($10,121)	($7,899)	(229)
Total effects	($133,873)	($37,361)	($35,752)	(1,162)

Source: Emsi 2017.1 and author's calculations

Range of economic losses to the four-county region from losing potato production and processing

	Sales	Value added	Income	Jobs
Direct effect	($387,024)	($76,828)	($61,070)	(1,229)
Multiplier effects	($219,573)	($61,371)	($53,036)	(1,576)
Total impacts	($606,596)	($138,200)	($114,106)	(2,805)

Source: Emsi 2017.1 and author's calculations

6. Applications of the Assessment and Mapping of Climate Hazards

Although climate change is a global phenomenon, building climate resilience is best accomplished at the state and local level. State government is critical to increasing climate resilience. It provides guidance, regulations, funding, a technical assistance and approves local plans, while enabling coordination and consistency with state goals and priorities. However, action by local governments and communities will be essential to implement state resilience goals. Local communities have substantial and specific knowledge about the particular susceptibility of populations, assets, and infrastructure. When equipped with sufficient knowledge of future climate risks, and given the resources to address them, local governments can act within their authority to build resilience in response to local conditions.

At the CIG, local governments and consultants frequently contact us to assist with access, interpretation, and application of scientific and technical information on expected changes in the climate and related hazards. Although we strive to meet demand one-on-one, our capacity is limited. A single web application can never meet the needs of all users – training and technical support will continue to be necessary – but *Climate Mapping for a Resilient Washington* fills a critical gap in the demand for local information to support climate resilience plans.

Climate Mapping for a Resilient Washington enhances statewide capacity to build climate resilience by enabling all jurisdictions to equitably access a common set of climate hazard data with minimal barriers

6.1 Support State Resilience Goals and Priorities through Local Capacity Building

Several state agencies are exploring pathways to support local climate resilience planning and implementation to meet state goals for more resilient communities and natural systems. Many mechanisms to build resilience (e.g., permitting, land use planning, building codes, zoning, emergency response) are decided at the local level. Collectively, these local actions can contribute substantially to statewide resilience goals. Successful implementation hinges, in part, on the capacity and awareness of local governments. *Climate Mapping for a Resilient Washington* will add knowledge at a local scale and build capacity for local planners and government officials to plan for climate resilience. Local-scale information also enhances motivation to develop and ownership of the responses.

Data and information in *Climate Mapping for a Resilient Washington* offers multiple ways to support local governments to plan, prepare, and act to build climate resilience. Customized maps, graphs, and tables that depict changes in the climate and related hazards can be used by local governments to:

- Facilitate external and internal education, training, outreach, and communications.
- Support the development of local climate resilience, adaptation, or action plans.
- Enable more effective collaboration with state agencies on climate resilience goals.

- Enhance knowledge and capacity to consider climate resilience in state and federally required plans and programs, such as the comprehensive plan, water system plans, hazard mitigation plans, watershed plans and the shoreline master program.

6.2 Support Local Governments to Plan for Climate Resilience in Comprehensive Plans

A near-term application of this assessment and Climate Mapping for a Resilient Washington is climate resilience elements of comprehensive guidance for which is currently under development by the Washington State Department of Commerce. Commerce is developing guidance and a model element to assist cities and counties to incorporate climate resilience into comprehensive plans. While developing *CMRW*, we worked directly with Commerce to connect the web application, and the data it includes, with their draft guidance for the climate resilience element and menu of example goals and policies. By either using guidance developed by Commerce or developing their own process, cities and counties can voluntarily integrate resilience goals and policies into comprehensive plans. The CMRW webtool is integrated into the draft planning guidance by Commerce and includes sectors and hazards that are relevant for comprehensive planning. The pilot program led by Commerce will test the web application for its effectiveness in supporting the comprehensive planning process.

6.3 Enhance the Ability of Local Governments to Secure Resilience Funding

Multiple state programs invest funds in local activities that contribute to climate resilience and risk reduction, yet local jurisdictions often lack the information and capacity to ensure that these activities adequately account for risks and incorporate resilience benefits. When local governments are better informed and equipped to understand local climate changes and their potential impacts, they will be more likely to successfully consider climate resilience in projects and secure state and federal resilience funding. For example, the Recreation and Conservation Office (RCO) invests public funds through local projects to support objectives for public benefit, such as salmon and orca recovery, wildlife conservation, and outdoor recreation opportunities. The RCO recognizes not only the risk that climate change poses to many of their investments, but also the opportunities that these investments present to increase the climate resilience of Washington's communities and natural systems. Through such programs, RCO and other state grant administrators encourage project sponsors to consider both the potential impacts of climate hazards on projects and the benefits of projects for risk reduction. This is most likely to succeed if project sponsors have locally relevant information that can inform grant proposals and project designs. Similarly federal grants are opportunities for local jurisdictions to secure funds for climate resilience projects.

6.4 Assess Critical and Vulnerable Components of the Local Economy

Information on current and future biophysical risks can be combined with an economic framework to assess the most critical and vulnerable components of a local economy. This combined information can enable decision-makers to assess the economic benefits of climate risk-reduction activities. Particular assets may have more critical economic value to one community, but other assets are more critical to others. Information on which assets are more important to the economy of the state will allow prioritization of those assets at various levels of

government and ultimately allow those communities to recover from climate events quicker and with less economic disruption. The framework and data from such economic analyses are designed to help make the economy more resilient to biophysical impacts when they happen.

7. Gaps and Next Steps: Statewide Climate Risk Assessment and Resilience

The report, analysis, and web application completed for this proviso can be expanded to include additional analysis and curation of information to support state and local climate resilience planning and risk reduction. Gaps and next steps are described below related to three areas of additional work: (1) analysis of biophysical and economic climate risks, (2) other elements of climate risk assessment, and (3) enhanced resilience planning at the state level.

7.1 Combine Information on Current and Future Likelihood of Climate Hazards

A comprehensive climate risk assessment could be developed that combines information on the *future* likelihood with the *current* likelihood of climate hazards. The assessment of biophysical climate risks completed for this proviso focuses on the *future change* in the likelihood and magnitude of climate hazards. It may be important to prioritize risk reduction in areas where hazards now are unlikely, but may substantially increase in the future, because these areas may be less adapted to and prepared for the hazard. Conversely, risk reduction may be a priority in areas where hazard likelihood is *already high*, despite little change in future if these areas are not now sufficiently prepared. A constructive approach to risk assessment is to combine future changes in the likelihood of hazards with current likelihood of hazards as described in hazard profiles for the State Hazard Mitigation Plan[25]. To support this, some changes in future hazards not currently quantified as change in likelihood could be quantified this way with additional analysis. For example, sea level rise information can be converted to the change in the likelihood of coastal storms. Likelihood is useful for informing risk assessment and prioritization for climate resilience, similar to how it is commonly used in hazard mitigation plans.

7.2 Enable State-level Comparison of Biophysical Climate Impacts

***Climate Mapping for a Resilient Washington* targets information for local jurisdictions, but with little effort, it could be tailored to also include more functionality for statewide comparison of climate hazards and indicators.** Through the scoping and feedback phase, we heard from multiple potential users that the following additional functionality would be useful:

- Present county-level information in a format that enables easier comparison and ranking among counties.
- Develop regional (e.g., eastern and western Washington) summaries of hazards to inform resilience plans at these levels.

[25] 2018 State Enhanced Hazard Mitigation Core Plan https://mil.wa.gov/enhanced-hazard-mitigation-plan

- Add climate indicators and hazard summaries for regulatory planning areas and watersheds to support state agency resilience efforts.

7.3 Assess Other Elements of Climate Risk: Local Exposure, Sensitivity, and Adaptation

Local exposure: A comprehensive risk assessment would include statewide, sector- and location-specific information about the populations, natural systems and assets exposed to hazards. *Climate Mapping for a Resilient Washington* guides local governments and planners on the type of information to consider in order to determine where people and resources will be most exposed to hazards, such as current flood zones or designated wildland-urban interface, but that information is not integrated into the web tool. Similar to climate exposure, data on current local hazard exposure could be compiled and curated. These data are also inconsistent and vary by hazard, sector, and location. It is this local exposure that creates sufficient granularity to inform where risk reduction should be prioritized at the local scale. Local variation in climate change alone is insufficient to inform priorities at this scale.

Sensitivity: CMRW also does not include information on the factors that predispose certain populations, assets, or natural systems to be more susceptible, or sensitive, to the hazards. Factors that affect sensitivity differ among sectors and hazards, and could be compiled to highlight communities or systems more at risk because of their particular sensitivities, as in the example of subpopulation sensitivity to extreme heat. The *Washington Environmental Health Disparities Map*[26] or the *Climate Health and Risk Tool* (CHaRT) under development by the UW Center for Health and the Global Environment (UW CHanGE)[27] are potential sources of information on sensitive subpopulations. CHaRT allows users to visualize the health risk associated with climate hazards, such as extreme heat, across communities in Washington State. CHaRT provides information about risk levels at a neighborhood level and information related to the underlying drivers of that risk, including information about the population at risk and factors that affect population vulnerability in a given location.

Capacity to Adapt: Even where communities or assets are particularly exposed and sensitive, they still may not warrant the highest priority for risk reduction if substantial resources are already allocated to the need. Statewide, sector- and location-specific information about the relative level of preparedness and resilience locally is another element of a comprehensive climate risk assessment which can help ensure that resources reach the places with the greatest need, rather than those that already have substantial resources and capacity. Capacity to adapt will greatly influence who is affected and where resilience can be implemented. For example, an area with high likelihood of current and future flooding, but also significant resources dedicated to flood protection infrastructure and response through existing programs, is unlikely to be a high priority candidate for future resilience funding.

[26] Washington Tracking Network, Washington Environmental Health Disparities Map. Department of Health https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

[27] CHaRT is in the final stages of development, will be released in early 2023, and will be available on the website of the UW Center for Health and the Global Environment (UW CHanGE) https://deohs.washington.edu/change/.

7.4 Develop a Database of Assets at Risk

Develop a database of all county level human, physical, and natural resource assets (market and non-market values) at risk from climate change. The database could include

- Public land and natural resource assets (e.g., forestry data from the US Forest Services Forest Inventory and Analysis program
- Agricultural production values by commodity (USDA NASS, USDA ERS)
- Private assets (e.g., housing and commercial property assets and industry production)
- Labor and human capital assets (as discussed in section 5.1.2)
- Non-market values (e.g., salmonid habitats, wilderness assets, statistical value of life)

Where data do not exist, survey and statistical assessments may be needed. In the 2015 assessment of drought effects on agriculture, the Washington State Department of Agriculture and the Washington State Academy of Science made a similar recommendation "…In addition, now is the time to develop a robust plan for continued data collection. Required data and strategies for collection and ongoing analysis need to be identified in order to give Washington State the ability to assist growers and plan for a future that will include increased incidence of severe weather events such as the 2015 drought."[28]

7.5 Estimate the Value of Assets at Risk

Once assets at risk are comprehensively identified and accounted for, models could be constructed and designed to assess the value of those assets. Prices of assets are dynamic and thus the value of our regional economy is in constant flux. Calculating and maintaining estimates of the value of assets goes beyond multiplying consumer prices by asset volumes. For example, greater distance to market often leads to an asset becoming less valuable. Human capital assets generate different values in different locations. The structure for valuing the assets needs to rest on a framework that can be easily updated (e.g., via a dashboard) as value determinants adjust to market conditions. This process should be based on research and model designs that have been developed and deployed in the scientific literature. This process will be difficult and time-intensive because precedents need to be carefully identified and reviewed before implementation. Doing this for the first time will result in "bugs" in the system that will require refinement over time. As processes change data are not comparable year-over-year. A set of base metrics that are comparable will be needed so that economic variables can be scaled for time series comparisons. The results of this process will be new datasets for the state and county economies. This datasets alone will be a helpful resource for local leaders as they develop climate resiliency strategies.

7.6 Estimate Expected Economic Impacts With and Without Adaptive Interventions

Adapt the Washington-Idaho Computable General Equilibrium (WAID-CGE) model to assess economic impacts with and without adaptive interventions and implementation of climate resilience strategies. This model is based on Washington Social Accounting Matrices and allows assessment of the household welfare effects of specific adaptive interventions. It has

[28] Washington Dept. of Agriculture. 2017. 2015 Drought and Agriculture. https://drought.unl.edu/archive/assessments/WashingtonState-2015.pdf

been used to assess the economic effects of revenue neutral carbon taxes,[29] biofuel policies,[30] etc. This model compares adaptive interventions on an economic basis, a step that is necessary to ensure that the intervention is not more costly than the climate impact itself.

7.7 Identify Sector and Hazard Specific Strategies and Actions for Statewide Resilience

Updates to the 2012 Integrated Climate Response Strategy could benefit from an assessment of potential strategies and actions that focus on specific sector-hazard combinations and highlight coordination across agencies and among levels of government. The problem-oriented analysis described for extreme heat and human health (Section 5.1.3) is one way to identify resilience gaps and a suite of strategies and actions. This approach makes it possible to address the highest risks, for the most vulnerable populations, in the most exposed locations. Commonly cited barriers to climate resilience are often institutional, such as inadequate institutional support, overlapping or confusing mandates and authorities, and limited financial or human capacity. To address these institutional barriers requires both problem-oriented assessment of current barriers and opportunities for resilience strategies and actions. The problem-oriented analysis relies on a combination of stakeholder interviews and a literature review, and it uses methodologies from policy sciences to synthesize contextual scientific, economic and demographic information about a specific hazard into a condensed description of the problem.

7.7 Identify Performance Measures and Mechanisms for Accountability

Performance metrics could be developed to track the effectiveness of resilience actions for multiple aspects of vulnerability. The 2012 Integrated Climate Response Strategy did not include performance measures for building resilience or mechanisms for accountability —that is, who is expected to do what by when. Going forward, a problem-oriented analysis of specific hazard-sector combinations could highlight multiple aspects of vulnerability, including the exposure to climate hazards, inherent factors that lead to greater susceptibility, and factors that limit the potential for populations, species, or natural systems to adapt. For example, in the case of extreme heat and public health, certain subpopulations are more sensitive as a result of particular chronic medical conditions. Services like cooling centers or energy assistance programs could evaluate their effectiveness by surveying their end users on issues pertaining to accessibility, communication strategies, and accommodations for populations at greater risk.

[29] Galinato et al., 2015. How Does Washington State Initiative 732 Impact the Agriculture and Forestry Sectors? *Western Economic Forum* 14: 2
[30] McCullough et al., 2011. Economic and Environmental Impacts of Washington State Biofuel Policy Alternatives. *Journal of Agricultural and Resource* Economics. 36: 3

Appendix A: Data Types and Sources in Climate Mapping for a Resilient Washington

Climate Change or Natural Hazard	Data Source	Native Resolution	Citation
Total Annual Precipitation Late Summer Precipitation Precipitation Drought Heavy Precipitation Magnitude Extreme Precipitation Magnitude 1 inch Precipitation Days 2 inch Precipitation Days 3 inch Precipitation Days	Dynamically Downscaled Hydroclimate Projections: WRF model	12km x 12km	Salathé, E.P., Leung, L.R., Qian, Y., Zhang, Y. 2010. *Regional climate model projections for the State of Washington*. Climatic Change 102(1-2): 51-75. https://doi.org/10.1007/s10584-010-9849-y
Warm Season Streamflow Summer Streamflow Duration of of Low Streamflow Low Streamflow Streamflow Timing Peak Streamflow Frequency of Peak Streamflow Snowpack Snowpack Drought	Re-routed RMJOCII – public data source pending.	0.0625° x 00.625° for SWE data, 11723 segments for streamflow data	Chegwidden, O. S., B. Nijssen, D. E. Rupp, P. W. Mote. 2017. *Hydrologic Response of the Columbia River System to Climate Change* [Data set]. Zenodo. doi:10.5281/zenodo.854763.
Likely Sea Level Rise High Sea Level Rise	PROJECTED SEA LEVEL RISE FOR WASHINGTON STATE – A 2018 ASSESSMENT	171 coastal segments	Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. 2018. *Projected Sea Level Rise for Washington State – A 2018 Assessment*. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, University of Oregon, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project. updated 07/2019.
Summer Maximum Temperature Hot Days 90°F Maximum Humidex Days 65° Minimum Humidex Days Heating Degree Days Cooling Degree Days High Fire Danger Days	MACAv2-METDATA	4km x 4km	Abatzoglou J.T. and Brown T.J. *A comparison of statistical downscaling methods suited for wildfire applications.* 2012. Int. J. Climatol., 32: 772-780. https://doi.org/10.1002/joc.2312
August Stream Temperature	NorWeST Summer Stream	N/A	Isaak, D., S. Wenger, E. Peterson, J. Ver Hoef, D. Nagel, C. Luce, S. Hostetler, J. Dunham, B. Roper, S. Wollrab,

	Temperature Model		G. Chandler, D. Horan, S. Parkes-Payne. 2017. *The NorWeST summer stream temperature model and scenarios for the western U.S.: A crowd-sourced database and new geospatial tools foster a user community and predict broad climate warming of rivers and streams.* Water Resources Research, 53: 9181-9205. https://doi.org/10.1002/2017WR020969.
Wildfire Likelihood	Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures	0.0417° x 0.0417°	Sheehan, T., D. Bachelet, K. Ferschweiler. 2015. *Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures.* Ecological Modelling. 317. 16-29. 10.1016/j.ecolmodel.2015.08.023.
Potential Impacts for all climate changes and natural hazards.	State of Knowledge: Climate Change in the Puget Sound Preparing for a Changing Climate Washington State's whear		Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. *State of Knowledge: Climate Change in Puget Sound.* Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. https://doi.org/10.7915/CIG93777D Adelsman, H., & Ekrem, J. 2012. *Preparing for a changing climate: Washington State's integrated climate response*

	Response Strategy		*strategy.* Department of Ecology, Olympia, WA.
	Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers		Snover, A.K., Mauger, G.S., Whitely Binder, L.C., Krosby, M., Tohver, I. 2013. *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers*. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle.

The rise in climate change-induced federal fishery disasters in the United States

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ABSTRACT

Commercial, recreational, and indigenous fisheries are critical to coastal economies and communities in the United States. For over three decades, the federal government has formally recognized the impact of fishery disasters via federal declarations. Despite these impacts, national syntheses of the dynamics, impacts, and causes of fishery disasters are lacking. We developed a nationwide Federal Fishery Disaster database using National Oceanic and Atmospheric Administration (NOAA) fishery disaster declarations and fishery revenue data. From 1989-2020, there were 71 federally approved fishery disasters (eleven are pending), which spanned every federal fisheries management region and coastal state in the country. To date, we estimate fishery disasters resulted in $2B (2019 USD) in Congressional allocations, and an additional, conservative estimate of $3.2B (2019 USD) in direct revenue loss. Despite this scale of impact, the disaster assistance process is largely ad hoc and lacks sufficient detail to properly assess allocation fairness and benefit. Nonetheless, fishery disasters increased in frequency over time, and the causes of disasters included a broad range of anthropogenic and environmental factors, with a recent shift to disasters now almost exclusively caused by extreme environmental events (e.g., marine heatwaves, hurricanes, and harmful algal blooms). Nationwide, 84.5% of fishery disasters were either partially or entirely attributed to extreme environmental events. As climate change drives higher rates of such extreme events, and as natural disaster assistance requests reach an all-time high, the federal system for fisheries disaster declaration and mitigation must evolve in order to effectively protect both fisheries sustainability and societal benefit.

Subjects Aquaculture, Fisheries and Fish Science, Science Policy, Coupled Natural and Human Systems, Climate Change Biology
Keywords Extreme environmental events, Fishing communities, Marine heatwaves, Fisheries economics, Federal fishery disasters, Climate ready fisheries management

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INTRODUCTION

Marine fisheries represent an important part of the United States (US) economy, employment, and food security, generating $244B in annual revenue, providing 1.7M part- and full-time jobs (*NOAA, 2020a*), and supporting a centuries-long history of community, cultural, and indigenous heritage. While overcapitalization, data limitations, and mismanagement have led to historical fishery declines, more recent fisheries science and management advancements have been achieved nationwide (*Methot Jr et al., 2013*; *National Research Council, 2014*; *NOAA, 2016*), including improved stock status of US federally managed fisheries and rebuilding of overfished species (*NOAA, 2020b*). However, climate change and extreme environmental events (e.g., marine heatwaves) are adding significant challenges to an already underfunded and overburdened fisheries management system (*Hoegh-Guldberg & Bruno, 2010*; *Di Lorenzo & Mantua, 2016*; *Wernberg et al., 2016*; *Free et al., 2019*; *Belhabib et al., 2018*), threatening both national food security and the balance between healthy economies and ecosystems (*Ding et al., 2017*). The COVID-19 pandemic has also added a new suite of impacts (*Bennett et al., 2020*), leading to the highest annual number of natural disasters declared in 2020 in the history of the Federal Emergency Management Agency (*FEMA, 2020*).

Recent improvements in our understanding of linkages between fisheries, ecosystems, climate, communities, and economies indicate that disaster impacts can have rapid and lasting effects (*Hoegh-Guldberg & Bruno, 2010*; *Wernberg et al., 2016*). When US fisheries are impacted beyond federally designated economic thresholds, the US Secretary of Commerce can formally declare a Federal Fishery Disaster (*Upton, 2019*), which results in financial compensation for impacted fishing communities. Fishery disaster determinations represent a federal response to anthropogenic and/or environmental impacts that spread throughout entire fisheries supply chains, from the resource itself, to fishing communities, families, and to associated fishing, seafood, clothing/equipment, marine, manufacturing, and hospitality industries (*Upton, 2019*; *Oliver, 2019*). Fishery disaster declarations are also largely reactive by design, meaning that when disaster assistance is requested (let alone disbursed), the disaster impacts have already been realized.

Fishery disasters are approved on a case-by-case basis by the US Secretary of Commerce under the jurisdiction of sec312(a) and 315 of the Magnuson-Stevens Fishery Conservation and Management Act (MSA; 16 U.S.C. §1861(a) and §1864,), as well as sec308(b and d) of the Interjurisdictional Fisheries Act (IFA; 16 U.S.C. §4107). Fishery disaster requests are typically filed by either state governor(s) or elected or duly appointed representative(s) of affected indigenous fishing communities. For a disaster request to be approved, three fundamental criteria must be met: (1) there must be an identified state, federal, or Native American fishery resource disaster associated with either species population decline or loss of fishing infrastructure, (2) it must have an "allowable cause" (*Upton, 2019*), and (3) there must be economic impact resulting from the disaster. If it is concluded that a fishery disaster occurred, then the economic data are analyzed to determine whether the disaster led to a commercial fishery failure. Commercial fishery failures are declared if revenue losses are greater than 80% relative to the mean annual revenue over the most recent five-year period

(*Upton, 2019*; *Oliver, 2019*). Revenue losses of less than 35% are generally not eligible for assistance, and losses between 35–80% receive further evaluation. An additional federal designation, a catastrophic regional fishery disaster, may also be declared if the following criteria are met: (1) if either a commercial fishery failure or fishery resource disaster are declared by the US Secretary of Commerce, (2) if the event affects more than one state or fishery managed by a regional council or Interstate Fishery Commission (IFC), and (3) if the event results in economic losses to coastal or fishing communities (*Upton, 2019*). If a commercial fishery failure is determined, the US Congress may appropriate assistance funds to the impacted states or communities. These groups must then create a spending plan that is reviewed by the National Oceanic and Atmospheric Administration (NOAA) before assistance is administered. Under the MSA, the federal government cannot allocate greater than 75% of the cost of assistance activities toward individual disaster assistance, with the remaining 25% typically covered by state or regional entities. The complexity of the process and administrative steps required often result in disbursement of funds occurring years after the disaster occurred (*Upton, 2019*; *Oliver, 2019*).

Federal Fishery Disaster review and assistance implementation timelines follow a six-step process: (1) disaster event, (2) request for assistance, (3) analysis and determination, (4) appropriation, (5) allocation, and (6) a grant out for assistance (Fig. 1). Disaster assistance can be structured in numerous ways, generally with fishing communities as the primary intended beneficiaries. Assistance can be appropriated by US Congress and routed through IFCs or individual states, and then allocated directly to fishers and fishing communities through grants, job training, cooperative agreements, contracts, or low-interest loans (*Upton, 2019*). Assistance can also be administered in a more proactive context to fisheries science or management programs, including data collection, compensated reduction in capacity, or resource restoration projects. This administrative process can be contentious since federal decision-making may be unclear, data driving disaster determinations are not publicly reported, impacted individuals or entities may be difficult to identify, and the degree of economic impacts may be difficult to quantify.

The thirty-year history and national scale of fishery disasters in the US indicate a clear need for a nationwide synthesis that can allow fisheries scientists, managers, and policymakers to advance a more adaptive fisheries management approach in a new disaster-specific context. To date, federal fisheries science and management have focused largely on reducing the number of stocks that are overfished or experiencing overfishing. Meanwhile, US Federal Fishery Disasters have been processed on a case-by-case basis with a lack of peer-reviewed science dedicated to comprehensive learning across all disasters. Our aim was to produce a national synthesis that answers how the frequency and causes of disasters have changed since the inception of the assistance program, and to estimate the economic impacts of disasters at both national and regional scales. This will not only inform disaster-related fishery management and policy decisions, but it will expand on our understanding that overfished/overfishing stock metrics, such as the NOAA Fish Stock Sustainability Index (FSSI), should be the primary metric with which we evaluate national fishery management success. To illustrate the scale and trends of disasters and their associated economic impacts, we developed a national and regional database of all

Figure 1 **Federal fishery disaster request, determination, and administration process.** Agency seals represent institutional involvement during each step of the disaster assistance process. Time periods in parentheses represent the mean (±SD) duration required for each step to occur. While the total implementation time is known (shown after step 6), some individual time steps do not have associated duration information.

Full-size DOI: 10.7717/peerj.11186/fig-1

Federal Fishery Disasters in the US and synthesized the associated spatial and temporal data reported in US federal disaster records. We used the frequency of disasters and common details across federal disaster requests and approvals to analyze temporal trends and to create a standardized metric for annual and region-specific disaster impacts. We estimated economic impacts based on Congressional allocations for disaster assistance as well as direct fishing revenue loss using NOAA and state-level landings and revenue data. In so doing, we highlight a recent shift in disaster frequency and causes; we discuss inefficiencies in the request, determination, and implementation processes; and we open a discussion for more proactive solutions to managing fishery disasters. This is especially critical when federal disaster assistance requests reached an all-time high (*FEMA, 2020*), and when climate change impacts are emerging as a significant threat to coastal fisheries, communities, economies, and ecosystems (*Hoegh-Guldberg & Bruno, 2010*; *Pecl et al., 2017*; *Lotze et al., 2019*).

MATERIALS & METHODS

We developed a US Federal Fishery Disaster database separated by federal management regions (Fig. 2) using the NOAA Fishery Disaster Assistance online portal produced by the Office of Sustainable Fisheries (*NOAA, 2020c*). In this portal, fishery disaster determinations were listed with specific disaster information, including (when available) the assistance request letter, federal decision letter, press release, and funding authority. Most disaster records included the affected state(s), year(s), fishery(ies), federal management region, specific area, individual requestor(s), request date and letter, determination status, press release, determination authority and letter, funding authority, cause of the disaster, and appropriation amount. These records, combined with state and federal landings and revenue data, were used to examine trends in disaster frequency and impacts, causes of

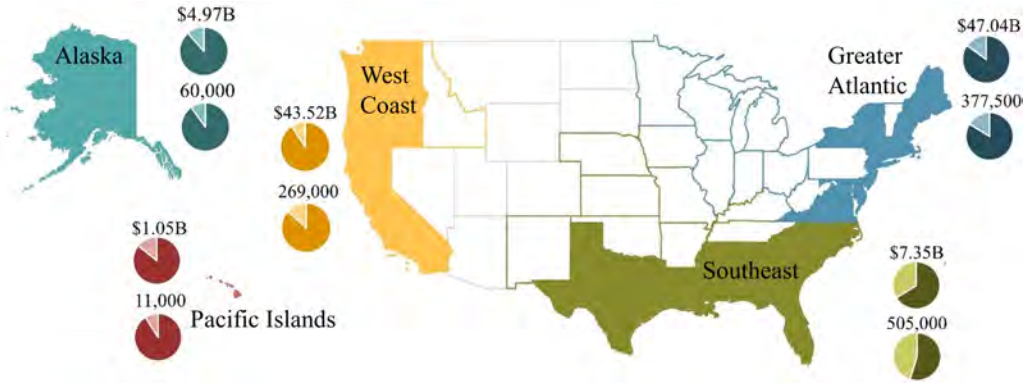

Figure 2 Five US federal fisheries management regions (Alaska, West Coast, Pacific Islands, Greater Atlantic, and Southeast) represented in the fishery disaster database. In each region, pie charts represent annual commercial and recreational fisheries sales impacts (top pie chart) and total number of jobs (bottom pie chart) to illustrate regional contributions to the US economy. The dark shaded region in each pie chart represents commercial fishery values, and the light shaded region represents recreational fishery values (source: *NOAA, 2020a*).

Full-size DOI: 10.7717/peerj.11186/fig-2

disasters, federal funding allocation, and direct revenue impacts. We carried out all statistical analyses in the statistical software environment R. All Federal Fishery Disaster data used in these analyses are available at https://www.fisheries.noaa.gov/national/funding-and-financial-services/fishery-disaster-determinations, and all fishery landings and revenue data are available via the NOAA Fisheries One Stop Shop (FOSS) website (*NOAA, 2020d*). All code for the analyses are available in the following GitHub repository: https://github.com/vrsaccomanno/federal-fish-disasters.git.

We assessed evidence for change in disaster frequency across the 30-year time series in two ways: (1) we assessed trends in the frequency of disaster determinations per year (each of which may specify multi-year disasters; e.g., a disaster declared in 2002 may specify disaster impact years 1999-2002), and (2) we assessed trends in the number of disasters per year. In both cases, we fit the following Poisson regression generalized linear model (GLM) with a log link, and scaled (Z-scored) year as a fixed continuous effect to model the count of disaster determinations or ongoing disasters per year. Given that the mean and variance for both response variables are approximately equivalent, we feel the assumption of Poisson distributed data is appropriate (we note, however, that findings from a negative binomial instance of the same models were essentially identical). The frequency of disasters will likely vary by management zone (Alaska, Greater Atlantic, Pacific Islands, Southeast, West Coast) in part because different regions are more likely to experience different types of disasters (e.g., hurricanes are not likely to impact the West Coast and Alaska regions). To address the potential for non-independence between zones, we also fit the following Poisson generalized linear mixed models (GLMM) with a fixed continuous effect of year (again, scaled) and random categorical effects of management zones, using the *glmer* function in the R library lme4 (*Bates et al., 2015*). Model formulations for both the GLM and GLMM models, including parameter estimates, are provided in Table 1.

Table 1 Mixed and fixed effects formulations and parameter estimates for models of disasteroccurrence and causes across years. Note that prior to model fitting, we transformed the vector of years into Z-scores in order to aid parameter estimation (subtracted all years by the mean of years, then divided by the standard deviation of years). The model formulation column reflects model specification in the R programming environment. In each of the parameter columns (Intercept and Year Effect) we report mean estimates with standard errors in parentheses. For the Year Effect parameter (parameter of interest) we report *p*-values. The RE Variance column reports the model estimated random effects variance, when appropriate. The final column reports Akaike information criterion (AIC) values for each model instance.

Response	Model method	Model formulation	Intercept(s)	Year effect	RE variance	AIC
Disaster Determinations	Poisson GLMM	~Determination.Year + (1|Management.Zone)	−0.36 (0.14)	0.42 (0.12), $p < 0.0008$	0.014	226.4
Disaster Determinations	Poisson GLM	~Determination.Year	0.94 (0.13)	0.38 (0.13), $p < 0.003$	NA	113.7
Ongoing Disasters	Poisson GLMM	~Impact.Year + (1|Management.Zone)	−0.36 (0.14)	0.26 (0.10), $p < 0.01$	0.01	259.2
Ongoing Disasters	Poisson GLM	~Impact.Year	0.94 (0.13)	0.38 (0.11), $p < 0.0003$	NA	121.3
Disaster Cause	Ordinal logistic GLMM	~Determination.Year + (1|Management.Zone)	NAnthropogenic|Combination of Both: -2.1 (0.54) Combination of Both|Environmental: -0.28 (0.45)	0.94 (0.27), $p < 0.0006$	0.51	130.1
Disaster Cause	Ordinal logistic GLM	~Determination.Year	Anthropogenic|Combination of Both: -1.94 (0.36) Combination of Both|Environmental: -0.281 (0.26)	0.87 (0.25), $p < 0.0004$	NA	130.5

Fishery disaster causes were assigned based on information provided in formal federal declarations, request letters, determination letters, press releases, federal fisheries reports, and/or primary literature sources. These causes, such as Harmful Algal Blooms (HABs), hurricanes, warming events, or oil spills, were then condensed into three ordered categories: environmental, combination of environmental and anthropogenic, and anthropogenic. Disasters resulting from hurricanes or HABs were labeled as environmental, but disasters resulting from overfishing or oil spills were labeled as anthropogenic. Because the publicly reported federal disaster declarations did not often include a cited rationale for cause determinations, with many causes labeled arbitrarily as 'natural disaster of unknown causes,' we used peer-reviewed fisheries literature and federal fisheries reports as additional sources for cause classifications. This allowed a more detailed understanding and documentation of the causes of each disaster. For example, causes of West Coast salmon fishery disasters were typically classified as a combination of both environmental (e.g., drought or warming) and anthropogenic (e.g., overfishing, habitat loss, fish passage barriers) factors due to the wide variety of well documented impacts on salmon stocks in each case. Once causes were assigned, disaster records were then separated by cause, year, and management region to highlight not only reasons why disasters are occurring, but also whether the reasons behind them are changing over time. To assess trends in the frequency of these categorical assignment through time, we performed an ordinal logistic regression with the category of each disaster as the response, and year as a fixed continuous effect. As above, we also fit a mixed effects ordinal logistic regression with fixed effect of year and random effects of management zone. We fit the fixed effects model using the *polr* function in the R library MASS (*Ripley et al., 2013*), and the mixed effect model using the *clmm2* function in the R library ordinal (*Christensen, 2019*).

Economic impact associated with each fishery disaster was measured using the federal assistance dollar amount allocated by Congress, as well as estimates of the direct fishing revenue impact. All dollar amounts were converted from nominal to real dollars (2019 USD) using an inflation multiplier from the US Bureau of Labor Statistics CPI inflation Calculator for the year in which the disaster occurred (*U.S. Bureau of Labor Statistics, 2020*). The federal assistance amount was sourced from the NOAA Fishery Disaster Assistance online portal, although federal disaster number 19 had an allocation amount that was not reported. The request letter for this particular disaster cited economic impacts of $53.8–94.2M in 2019 USD, and given government policy that the federal share cannot exceed 75% of a disaster request, this request equates to a maximum federal allocation of approximately $40.4–70.7M. Therefore, to estimate the total dollar amount allocated by Congress from 1994-2020, we combined the federal allocation amounts from the 65 known cases reported on the portal, the overall amount that was Congressionally approved for all disasters in aggregate in 2019 and 2020, and the estimate from the single unknown case (disaster number 19, Table S1).

To estimate the direct revenue impact associated with each fishery disaster—defined as revenue loss associated only with changes in landings and not throughout the supply chain—we evaluated each determination in accordance with NOAA Fisheries policy guidance on economic thresholds required for a successful determination (*Denit, 2018*);

the difference in revenue of the impacted fishery during the disaster year(s) relative to the previous five-year average was calculated to produce revenue loss estimates. While revenue loss data were not explicitly reported in the federal disaster records, we were able to collect landings and nominal revenue data for each disaster using the NOAA Fisheries One-Stop Shop (FOSS) online database in most cases (*NOAA, 2020d*). When an approved disaster required finer spatial resolution landings and revenue data (e.g., if the fishery/area affected was smaller than the state-level scale), state landings sources were used to isolate regional-level data when possible. There were several disasters where landings and revenue data for the appropriate spatial scale (e.g., a regional bay) and/or management entity (e.g., tribal) were not obtainable; in these instances, the next best viable data source was used when available and the revenue impact estimate of the disaster was assigned a confidence level (i.e., low, medium, high) based on how well the landings and revenue data reflected the spatial scale of - and management entity impacted by - the disaster (Table S1). There were eight disasters in which viable data were completely unobtainable; these disasters are demarcated with "N/A" in the Net Revenue Change column in Table S1.

Direct revenue data were obtainable for 63 of the 71 approved fishery disasters. Changes in revenue in multi-year disasters—as reported on NOAA's online portal (*NOAA, 2020e*)—were evaluated on an annual basis relative to the corresponding previous five-year average; while direct revenue data were obtainable for 63 disasters, calculating revenue loss for each disaster year resulted in more than 63 disaster years due to the handful of multi-year disasters ($n = 79$). Non-parametric bootstrapping techniques were used to estimate the sampling distribution of the median direct revenue impact and associated measures of uncertainty because the obtained revenue impact estimates were non-normally distributed (a Shapiro–Wilk test showed a significant departure form normality, $W = 0.71$, $p < 0.001$) . For each sample statistic, 100,000 replications were performed using the "Boot" package in R programming language (*Davison & Hinkley, 1997*; *Canty & Ripley, 2019*; *R Core Team, 2019*).

RESULTS

There were 96 Federal Fishery Disaster assistance requests filed in the US since 1994 (as of Oct 2020), spanning the impact period from 1989–2019, during which time 71 disasters were federally approved (Table S1). Congressional allocations and direct revenue loss data were available for 65 and 63 of the 71 approved disasters, respectively. The available data allowed estimates of the missing Congressional allocation values (see Supplementary Methods) and subsequent analyses of economic impact. Federal disaster records also allowed analyses of disaster frequency and causes of disasters.

Economic impact

For the purposes of this study, all economic estimates are reflected in 2019 USD, with eleven 2020 assistance requests still pending. The total amount allocated by Congress throughout the entire federal disaster assistance program from 1994–2020 was over $1.99B (Table 2). This does not include six approved disasters with unreported federal assistance amounts, and it also does not include amounts that are still being

Table 2 Total U.S. Congressional fishery disaster assistance (2019 USD) by cause and by federalfisheries management region. One additional disaster had an allocation amount that was not reported, but the request letter cited economic impacts of $53.8-94.2M. Anthropogenic causes include pollution and overfishing; environmental causes include marine heatwaves, harmful algal blooms, hurricanes, extreme drought, etc.; and a combination includes both anthropogenic and environmental causes. Examples of fisheries being impacted by a combination of causes can be found in some Pacific northwest salmon fishery disasters, which were caused by low returns that resulted from marine heatwaves, drought, disease, habitat impacts, mismanagement, and overfishing.

Cause	Alaska	Greater Atlantic	Pacific Islands	Southeast	West Coast	To be determined	Total
Anthropogenic	$82,000,000	$132,996,669		$30,940,000	$7,600,000		$253,536,669
Environmental	$174,292,189	$41,572,622	$1,140,000	$505,938,343	$170,723,211		$893,666,365
Combination of Both	$75,588,349	$36,600,000		$37,098,200	$281,802,589		$431,089,138
To be determined						$414,103,069	$414,103,069
Total	$331,880,538	$211,169,291	$1,140,000	$573,976,543	$460,125,800	$414,103,069	$1,992,395,241

determined for five disasters that were approved in 2019, as well as eleven disaster requests from 2019 and 2020 that have not yet been approved. However, a total of $165M was Congressionally appropriated for the 2019 fiscal year. In 2020, US Congress used the Coronavirus Aid, Relief, and Economic Security Act (CARES Act: https://www.fisheries.noaa.gov/national/noaa-fisheries-coronavirus-covid-19-update) to approve the allocation of an additional $300M for fisheries as a result of the ongoing COVID-19 pandemic.

Total assistance allocations were highly variable across space and time (i.e., no apparent trend), and ranged from $0–$300M annually (mean of $73.8M ± $96.1M SD). The Southeast Region (http://www.fisheries.noaa.gov/regions) obtained the most assistance since the inception of the program ($574M, 36.4% of overall determined funding), followed by the West Coast ($460M, 29.2%), Alaska ($332M, 21.0%), Greater Atlantic ($211M, 13.4%), and Pacific Islands ($1M, 0.1%). Overall, the entire western US (Alaska, West Coast, and Pacific Islands combined) accounted for 50.3% of all approved US disaster allocations (excluding pending disasters), while the Southeast and Greater Atlantic Regions accounted for 49.7% of allocations (Table 2).

We generated direct revenue loss estimates—defined as revenue loss associated only with changes in landings—for 63 of the 71 approved fishery disasters, which amounted to over $3.2B in revenue loss from 1994–2019, with additional significant revenue losses anticipated in 2020 due to the ongoing COVID-19 pandemic. These estimates were non-normally distributed, motivating the use of non-parametric statistical techniques. The median percent change in revenue during a disaster relative to the mean annual revenue over the preceding five-year period was −38.3 (IQR range = −70.4 –−1.3) across the 63 disasters for which data were attainable (Table S1). We also found that 12 of the 63 disasters showed a net *increase* in revenue in the year(s) of the disaster reported on the online portal. Omitting these 12 cases (to reflect total revenue losses that occurred) results in a median percent change in revenue of −60.6 (IQR range = −74.1 –−24.8). The median revenue loss in a disaster year was −$3.5M ($n = 79$), with a bootstrapped 95% confidence interval of [−$5.6 M –$4.8 M] ($n = 100,000$ bootstrap samples) across the 63 disasters for which data were attainable. Omitting the 12 cases where revenue

increased results in a median revenue loss in a disaster year of −$11.6M ($n = 62$), with a bootstrapped 95% confidence interval of [−$18.7 M −−$7.6 M] ($n = 100{,}000$ bootstrap samples). The Alaska Region accounted for 66.2% of the revenue impact overall, followed by the West Coast Region (18.1%), Southeast Region (10.7%), Greater Atlantic (5.1%), and Pacific Islands (<0.01%) (see GitHub repository for code specific to revenue loss estimates: https://github.com/vrsaccomanno/federal-fish-disasters.git).

Disaster trends

All statistical models (GitHub repository: https://github.com/vrsaccomanno/federal-fish-disasters.git) strongly indicate that disasters are increasing over time (i.e., that the number of disaster declarations and number of disasters per year have both increased; Table 1), even with eleven disasters during the 2017–2020 period that are still pending review (Fig. 3). The mixed effects models converged but with much larger AIC scores than counterpart fixed effects only models, indicating a poor model fit (Table 1). Moreover, the similarity in the estimated fixed year effect coefficients in both the mixed and fixed effects models (Table 1) suggests the mixed effects formulation is inconsequential to our findings.

It is possible that auto-correlation could manifest in the generative processes underlying our time-ordered data. That is, the underlying causes of disasters such as climate driven storm events or mis-management may carry momentum through time. Such a lack of independence between data points would violate the assumptions of the statistical methods we applied. However, we found no evidence of this based on an analysis of autocovariance in the residuals of the linear model regressing the number of disasters across years. In fact, the correlation at lag 1 (adjacent residuals) was ∼0, and no lag regardless of size had a correlation of >|0.-2| (https://github.com/vrsaccomanno/federal-fish-disasters.git). We are therefore confident that the statistical findings from our GLM models are robust.

Fishery disasters impacted every federal fisheries management region, and every coastal state in the U.S., as well as the US Virgin Islands, Puerto Rico, and American Samoa. Impacts were largely to commercial and recreational groundfish, commercial nearshore invertebrates, and commercial and Native American salmon fisheries, although several assistance requests and determinations simply stated only that ‘‘multiple fisheries’’ were impacted. Regional trends in disaster frequency showed a distinct shift from disasters across all regions between 1994–2015 to disasters occurring almost entirely in the West Coast and Southeast management regions from 2017–2019. The West Coast management region had the highest share of approved disasters (28/71), followed by the Southeast (18/71), Alaska (14/71), Greater Atlantic (10/41), and Pacific Islands (1/71) regions. Overall, the entire western US (including one approved disaster in the Pacific Islands) accounted for 60.6% of all approved US disasters, while the Gulf Coast and east coast accounted for 39.4% of approved disasters.

Disaster causes

Since the 1990s, the predominant cause of fisheries disasters has shifted from anthropogenic to environmental in nature, with extreme environmental events reflecting 95.3% of the revenue loss during the most recent years (2014–2019), increasing from 38.5% during

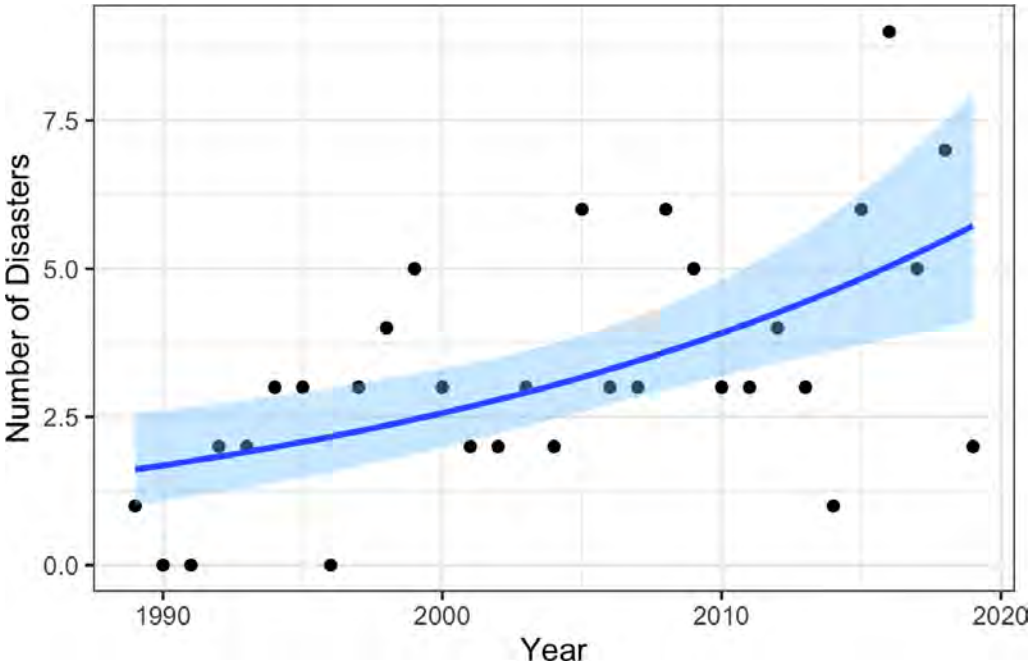

Figure 3 **Model estimated change in the number of fishery disasters by impact year.** The dark blue line represents the maximum likelihood fit (fixed effect of year; 4th row, Table 1), while the light blue shaded regions represent the 95% confidence intervals.

Full-size DOI: 10.7717/peerj.11186/fig-3

the first five years (1994–1998). Disaster causes were aggregated into three condensed categories: anthropogenic, environmental, or a combination of both. Marine heatwaves accounted for the most disasters overall, followed by hurricanes, overfishing, low returns (multiple Pacific salmon species), and HABs. Disasters caused by "low returns" in salmon fisheries were typically due to a combination of anthropogenic and environmental factors. Both the fixed and random effects logistic regression models performed similarly in terms of AIC scores (Table 1), with both showing significant time trends in the cause of disasters (Fig. 4). Regionally, marine heatwaves and HABs were often attributed to disasters in the both the West Coast and the New England / Greater Atlantic Regions, while hurricanes represented the primary cause of disasters in the Southeast Region. The majority of disasters with Congressional allocations were attributed to environmental causes ($894M, 56.6% of total determined allocations), followed by a combination of both ($431M, 27.3%), and lastly, anthropogenic causes ($254M, 16.1%; Table 2). There were no apparent trends in Congressional allocations by cause or region, although extreme environmental events were either partially or fully attributed to 84% of all Congressional allocations. In terms of revenue loss to fisheries, anthropogenic causes led to $1.8B (56.4%) in losses, although this was almost entirely driven by overfishing in the Alaska snow crab fishery (four federally approved disasters in total). Environmental causes resulted in an additional $900M (27.9%) in losses, and $505M (15.7%) in losses were attributed to a combination of anthropogenic and environmental causes (Table 3).

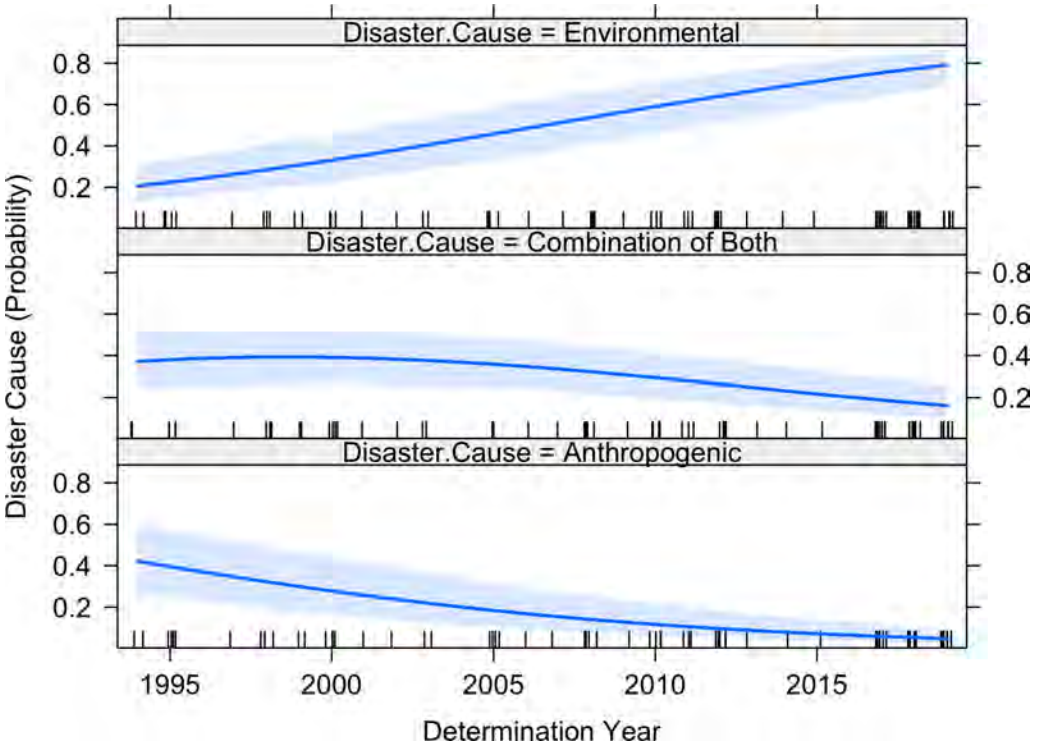

Figure 4 **Model estimated change in the probability that a given disaster has roots in anthropogenic causes, environmental/anthropogenic combined causes, or environmental causes.** The dark blue center lines represent the maximum likelihood fit, while the light blue shaded regions represent the 95% confidence intervals. The rug plot (tick marks, jittered around each year) at the bottom of each panel represents the number of declared disasters (of any cause) per year.

Full-size DOI: 10.7717/peerj.11186/fig-4

Table 3 **Total revenue losses (2019 USD) by cause and by federal fisheries management region during disaster years.**

Cause	Alaska	Greater Atlantic	Pacific Island	Southeast	West Coast	Total
Anthropogenic	$1,629,023,913	$156,252,205		$19,344,227	$16,669,638	$1,821,289,983
Environmental	$460,804,419	$7,525,113	$244,000	$319,003,223	$112,420,965	$899,997,721
Combination of Both	$46,055,192			$5,326,946	$453,935,310	$505,317,448
Total	$2,135,883,525	$163,777,318	$244,000	$343,674,396	$583,025,913	$3,226,605,152

Federal timelines

The average time to fully process a disaster declaration was approximately 2.1 years (± 1.4 years SD), with a maximum total process time of six years, and one disaster request from 2005 that remains undetermined. The time period from the disaster occurrence to the formal assistance request filing averaged 6.4 months (± 12.0 months SD), with 66.2% of requests being filed within 1 year after the disaster, and 87.7% filed within 2 years after the disaster. Once the request was filed, determination time (time between steps 2 and 3 of the 6-step process) lasted as long as 4.0 years (mean of 8.3 ± 8.7 months SD). One disaster approval occurred 92 days before the request was formally filed (disaster number 29: Hurricane Katrina).

DISCUSSION

Federal Fisheries Disasters have generated large, yet remarkably variable revenue impacts throughout the US during the last three decades, and the frequency of disasters is increasing over time. In turn, the US government has spent billions of dollars to mitigate these impacts. In the early days of fishery disaster determinations, these impacts were largely due to mixed factors and relatively poor fisheries management. Fortunately, such direct anthropogenic causes of disasters appear to be on the wane as fisheries management improves (e.g., *Marshall et al., 2019*; *Hilborn et al., 2020*; *NOAA, 2020b*). However, environmentally-driven fishery disasters are clearly on the rise, fueled by extreme environmental events that occur as symptoms of a changing climate (*Cheung & Frölicher, 2020*; *Jacox et al., 2020*; *Laufkötter, Frölicher & Zscheischler, 2020*). For example, the US west coast marine heat wave event of 2013–2016 (e.g., the warm 'blob') produced a broad range of coastwide impacts (*Cavole et al., 2016*), including several approved Federal Fishery Disasters (e.g., *Holland & Leonard, 2020*). In total, these marine heatwaves were the dominant environmental cause of Federal Fishery Disasters nationwide in the 30-year time series, followed by hurricanes and HABs, but almost all marine heatwave events occurred only in the recent 2013–2020 period. This recent emergence of marine heatwaves, which occurred on both the east and west coasts of the U.S., thus accounted for much of the increasing trend in fishery disasters. Taken together, our findings suggest that not only are fisheries disasters on the rise, but the linkage between climate change, marine heatwaves (*Frölicher, Fischer & Gruber, 2018*; *Oliver et al., 2018*; *Holbrook et al., 2019*), and now Federal Fishery Disasters is becoming increasingly clear, and the causes of fishery disasters are shifting from those with conventional management solutions, to those that require more pro-active and climate-ready policies (*Pinsky & Mantua, 2014*). Similar temporal shifts in impact causes were documented for animal mass mortality events, which included both marine and terrestrial species (*Fey et al., 2015*). This shift toward increased impacts due extreme environmental events is also consistent with numerous studies documenting unprecedented and accelerating oceanographic, ecosystem, and fisheries changes during the same time period (*Bond et al., 2015*; *Peterson, Robert & Bond, 2015*; *Ritzman et al., 2018*; *Thompson, 2018*; *Arafeh-Dalmau et al., 2019*; *Piatt et al., 2020*; *Santora et al., 2020*).

Despite the multi-billion dollar economic impacts, we are likely underestimating the true magnitude of the economic effects of Federal Fishery Disasters. First, our economic analyses only include estimates for 63 of the 71 approved fishery disasters due to data limitations, and there are still eleven pending disaster requests that were also not included in the analysis. Second, our analyses represent fisheries that were formally included in federal assistance requests, but there may be impacted fisheries/communities that never applied for assistance. Third, our revenue impact estimates only included losses during the disaster year(s) as reported on the online portal, not potential losses in subsequent years due to delayed impacts. Fourth, our impact analyses were based on the NOAA disaster determination model that uses direct commercial fishing revenue as the primary impact metric, but indirect economic losses across supply chains are undoubtedly larger (*Holland & Leonard, 2020*). In addition, direct and indirect revenue contributions from recreational

fisheries, which generate $68B in national annual sales (NOAA, 2018), were not included in our economic impact analyses due to data limitations. Fifth, because disaster requests and approvals often take years to process and publicly report, there will likely be disaster requests added to the most recent 2018-2020 period, meaning that our results may represent a conservative estimate of increasing trends over time and economic impacts during these recent years. Finally, our study only focused on economic impact estimates, but fishery disasters also reflect impacted ecosystems, communities, and cultures that were not the focus of our analyses (e.g., *Smith & Gilden, 2000*). These represent critical components of the overall impact from fishery disasters that should be a focus of future science and policy engagements.

The magnitude of economic impacts of fishery disasters is clearly a problem, but the lack of standardized reporting with sufficient detail in disaster requests and determinations creates significant challenges for implementing solutions. For example, the median revenue loss across all approved disasters (38.3% loss) was notably less than the 80% threshold that triggers federal determination of a commercial fishery failure, and is just above the 35% threshold that allows further review according to federal guidelines. We also identified 12 cases of federally approved disasters in which fishery-specific direct revenue actually increased during the disaster year relative to the previous 5-year average, a surprising finding given that an increase in revenue in a disaster year does not meet NOAA Fisheries policy guidance on economic thresholds required for a successful determination (we omitted these cases from our impact estimates under the rationale that gains in one fishery do not erase losses sustained in another). Our conservative estimates of economic impacts may not be capturing the full scale of impact, but the consistency in the economic metric used between our study and the federal determination process suggests a need for improved economic data collection and federal reporting. Improved reporting would also provide critically needed clarification about specifically which fisheries are impacted. For example, fishery disasters ranged in spatial scale from individual rivers to multiple states; they might impact only one Native American community or several; and they might affect only one fishery or virtually every fishery in a state or region. Enumerating disaster impact by specific fisheries is thus problematic because information about which species, fisheries, and communities were affected was not always provided in federal disaster assistance requests and determinations. These details could facilitate improved estimations of impact, more transparency when and where the Secretary of Commerce determines there are special circumstances that may justify using a lower threshold of percent revenue loss in disaster determinations, and a more streamlined and transparent process for estimating and allocating assistance to the most heavily impacted fisheries and fishing communities.

Problems also exist with assistance processing lags and opaque determination process. Across all Federal Fishery Disaster declarations, total federal process duration (Fig. 1, duration between steps one and six) averaged 2.1 years, ranging from zero to six years after the disaster event. Such delayed response times are likely due both to the complex determination and allocation process, and the burden of increasing disaster assistance request rates. The administrative process can also be contentious because federal assistance timelines can significantly lag impact events, federal decision-making is often unclear

(or undocumented), impacted individuals or entities may be difficult to identify, and the degree of economic impacts may be difficult to quantify (*Upton, 2019*). A more detailed accounting of determinations could address these issues, and reveal aspects of the determination process that are leading to such highly variable response times.

The federal response to the growing impacts of fishery disasters clearly needs reform, but the lack of standardized reporting in Federal Fishery Disaster requests and determinations makes identifying solutions difficult. Our finding that many of the published determinations failed to list the specific commercial fishery(ies) used to make the determination is problematic. While disasters ranged in scale from individual fish stocks and fisheries to multiple states and fishing communities, the details provided in determination documents do not reflect the complexity of disaster impacts. Transparent, detailed, and mechanistic descriptions of economic impact determinations are necessary for the Secretary of Commerce to determine if there are special circumstances that may justify using a lower threshold of percent revenue loss in Federal Fishery Disaster determinations. To achieve this, public reporting of a full economic impact assessment in each fishery would undoubtedly cause prohibitive slowing of the disaster assistance process, but publicly reporting the data that are already behind each disaster determination would achieve a greater level of transparency and impact detail while adding little to the process and timeline. In addition, there is need for a more streamlined, fair, and transparent process for allocating assistance (*Oliver, 2019*; *Upton, 2019*). While compensation of fishing communities is the ultimate goal of disaster assistance, we found that approximately 40% of federal determinations failed to identify the specific fishery(ies) impacted by the disaster, making any future efforts to accountability in assistance allocation difficult, if not impossible.

This study represents a national-scale view of fishery disasters, a problem that has worsened over time, and has cascading socioeconomic impacts to society. This study also highlights a clear need for consideration of ecosystem and cultural impacts of fishery disasters that were not the focus of this study. For example, Native American fisheries represent a far more extensive history of coastal harvest and culture than commercial or recreational fisheries, illustrating the intimate connection possible between nature and people that span millennia. However, in three decades, 29 federally approved (and four pending) disasters have impacted salmon fisheries in the Pacific northwest (*Smith & Gilden, 2000*). Over half of these requests came from Native American communities that have been intimately connected with salmon populations for generations, yet limited syntheses of disaster impacts to indigenous communities are available. Knowledge of the disruptions in such cultural relationships should be a necessary part of efforts to mitigate the totality of fishery disaster impacts, yet such considerations are not currently part of the Federal Fishery Disaster determination process.

As currently structured, the legal framework for declaring Federal Fishery Disasters can depend on a range of economic impact metrics that typically go unreported in disaster determinations, but Congressional appropriations depend on demonstrating a direct loss of revenue to commercial fisheries. However, there is no question that the broader market and non-market value of fisheries losses grossly outweigh the direct revenue loss

(*Holland & Leonard, 2020*; *Seung, 2017*). These additional impacts encapsulate fisheries supply chains, cultural values, and non-commercial impacts. The fact that the existing legal mechanisms for fishery disaster assistance hinge largely on direct revenue loss may explain why many declared Federal Fishery Disasters fail to meet the defined economic loss thresholds (e.g., in some disasters, revenue actually increased); it is likely lawmakers are making a good-faith effort to account for the true breadth of economic and societal loss stemming from disaster. However, the lack of a codified mechanism for doing so contributes to inaccurate accounting of financial assistance.

CONCLUSIONS

As disaster impacts to fishing communities worsen via increased disaster frequencies, federal response times to mitigate these impacts continue to lag by years in most cases (*Upton, 2019*). Developing proactive, rather than reactive, mitigation strategies may partially address this problem. Recent shifts in the causes of fishery disasters toward extreme environmental events suggest a need to explore incentive structures for linking disaster assistance with proactive climate-ready fisheries management (*Pinsky & Mantua, 2014*). Regional fishery disaster vulnerability assessments (*Badjeck et al., 2013*), ecosystem-based fishery management approaches (*Holsman et al., 2020*), responsive harvest control rules (*Kritzer et al., 2019*), and accounting for climate-related shifts in fisheries productivity/distributions (*Free et al., 2020*) may all be useful in guiding science and management efforts toward this end. Industry insurance mechanisms, such as those trialed in west coast salmon fisheries, might also mitigate future extreme event scenarios by providing timely assistance to those in greatest need, as well as incentivized support for climate-ready fisheries management goals (*Mumford et al., 2009*).

There has never been a better time to identify and implement more effective government response to disasters. The COVID-19 pandemic has added a new layer of impacts across virtually every sector of the global economy, including fisheries (*Bennett et al., 2020*). By September 2020, the US had already reached a record annual number of natural disasters declared (56% of which were linked to COVID-19 at the time of submission) by FEMA in the history of US natural disaster declarations (1953-2020). In the fisheries sector, the seafood industry landscape has been severely impacted, with entire fleets tied to the docks, and fisheries market closures occurring around the world (*Bennett et al., 2020*). The pandemic has led to an unprecedented need for federal assistance across a significant portion of the US economy, including $300M approved for fishery disasters in 2020 as part of the Coronavirus Aid, Relief, and Economic Security Act (CARES Act). The scale of need for federal assistance this year highlights the critical importance of preventing and mitigating disasters with climate-ready management models, maximizing efficiency in the federal assistance process, and increasing the impact of every federal dollar spent during these extreme and uncertain circumstances.

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ADDITIONAL INFORMATION AND DECLARATIONS

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Competing Interests

The authors declare there are no competing interests.

Author Contributions

- Lyall Bellquist conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the paper, and approved the final draft.
- Vienna Saccomanno and Brice X. Semmens performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the paper, and approved the final draft.
- Mary Gleason and Jono Wilson conceived and designed the experiments, authored or reviewed drafts of the paper, and approved the final draft.

Data Availability

The following information was supplied regarding data availability:

All federally-declared fishery disaster data used in these analyses are available at NOAA: https://www.fisheries.noaa.gov/national/funding-and-financial-services/fishery-disaster-determinations

All code and fishery landings and revenue data are available in Github: https://github.com/vrsaccomanno/federal-fish-disasters.git

Data was taken from the NOAA Fisheries One Stop Shop (FOSS) website: https://foss.nmfs.noaa.gov

Fishery disaster trend analyses were performed using the data available as a Supplemental File.

Supplemental Information

Supplemental information for this article can be found online at http://dx.doi.org/10.7717/peerj.11186#supplemental-information.

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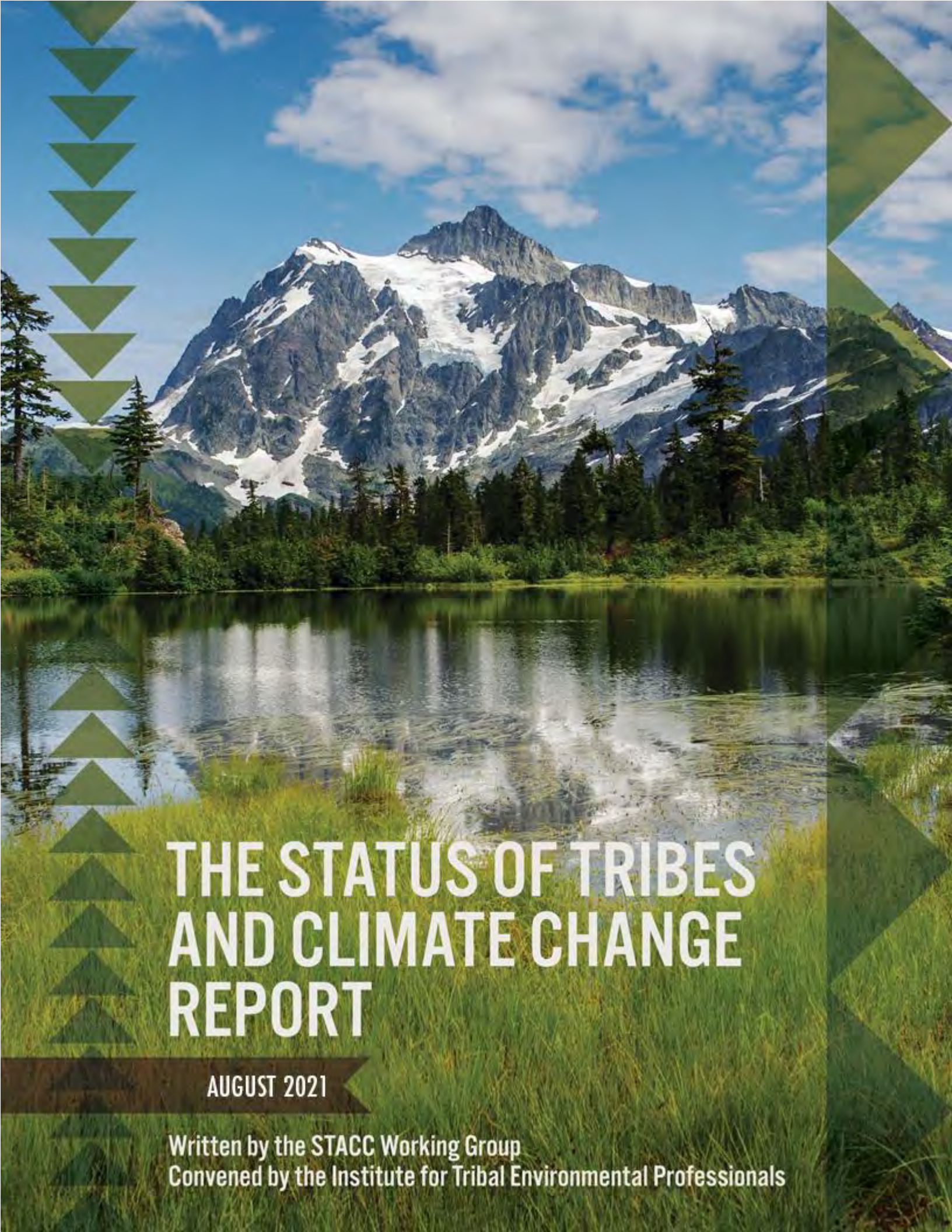

THE STATUS OF TRIBES AND CLIMATE CHANGE REPORT

AUGUST 2021

Written by the STACC Working Group
Convened by the Institute for Tribal Environmental Professionals

Cover photo: Mt. Shuksan, Washington

We acknowledge all Indigenous peoples across Turtle Island who have inhabited the lands, currently known as the United States of America, since time immemorial. We honor their past, present, and future knowledges, cultures, and lifeways for tending and preserving Mother Earth. We extend gratitude to and honor all our human and nonhuman relatives and the land, plants, waters, and air. We honor and recognize all voices of our Sisters, Brothers, Leadership, Elders, and Youth fighting for the next Seven Generations.

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EXECUTIVE SUMMARY

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The climate is changing. Global air temperatures are rising, as are sea levels throughout most of the U.S. Heavy rainfall is increasing in intensity and frequency. Atlantic hurricane intensity is on the rise, and the number of large forest fires in the western U.S. and Alaska is increasing and is exacerbated by drought and heat. In Alaska and the Arctic, sea ice is declining, permafrost is thawing, and warming is more than twice the global average (Walsh et al., 2014; Hayhoe et al., 2018; USGCRP, 2017).

Given close relationships with the natural world stemming from deep spiritual and cultural connections and subsistence lifeways, Indigenous peoples are on the frontlines of those experiencing and adapting to climate change. Indigenous peoples possess incredible resiliency and innovation, borne from Indigenous knowledges, worldviews, and countless generations of connection to place (Ford et al., 2020). At the same time, climate change impacts for many Tribal communities are already severe (such as shifts in/loss of key cultural species and land loss due to erosion, flooding, and permafrost thaw), and the challenges they face responding to impacts are daunting (such as lack of funding and technical resources and legacies from colonialism and discrimination). The time to act is now, and the way to act is together: in community, taking care of one another and all our relations.

What Is the Status of Tribes and Climate Change (STACC) Report?

The *Status of Tribes and Climate Change (STACC) Report* seeks to uplift and honor the voices of Indigenous peoples across the U.S. to increase understanding of Tribal lifeways, cultures, and worldviews; the climate change impacts Tribes are experiencing; the solutions they are implementing; and ways that all of us can support Tribes in adapting to our changing world. Given this, the STACC Report was written for diverse audiences, including Tribal managers, leaders, and community members; the authors of future National Climate Assessments; federal and state agencies and decision-makers; and nongovernmental organizations. Over 90 authors representing diverse entities and perspectives contributed to this report, including the authors of 34 personal narratives and author teams who wrote topic reviews using elements from their own experiences and knowledge as well as information from the most current peer-reviewed literature. The development of the STACC Report was coordinated by the Institute for Tribal Environmental Professionals (ITEP), which was established in 1992 at Northern Arizona University with a cooperative agreement with the Bureau of Indian Affairs' Tribal Climate Resilience Program. ITEP is honored to have worked with these authors, who together, along with the Steering Committee, form the STACC Working Group.

Why This Report Was Created

The Indigenous peoples of North America have seen many hardships, including legacies of colonialism, forced assimilation, intergenerational trauma, upheaval and repression of Native economic systems, and the loss of ancestral lands, languages, natural resources, and traditions. Due to colonialization and subsequent land dispossession, social exclusion, and discrimination, researchers have identified Indigenous peoples globally and in the U.S. as populations "at-risk" to environmental change (Ford et al., 2020; Nakashima et al., 2018). Tribes have, however, continually proven to be resilient and innovative, which is evident in their creating adaptation and mitigation plans and continuing to rely on traditional knowledges to inform actions and strategies. This resiliency and adaptation dates back thousands of years and holds true in today's changing climate.

As numerous Indigenous persons would attest to, the close relationship that Tribes have with their lands, waters, resources, and heritage includes a responsibility to one another, to all relations, and to the past and future generations of human and nonhuman relatives alike. It embodies the need to care for and respect the needs of all things and recognizes the responsibility to honor the wisdom of their ancestors and carefully consider the consequences of their decisions and actions for future generations. This may lead Tribal members to ask: what does it mean to be a good ancestor?

Due in part to these worldviews that are tightly interwoven with many compounding dimensions, Tribal experiences with climate change can make Indigenous peoples particularly vulnerable to cascading and disproportionate impacts, while their responses simultaneously support Tribal resilience to those impacts and are discussed throughout the STACC Report.

While Tribes cannot be thought of as one monolithic group, diverse Indigenous persons are in dialogue about synergies that exist among their worldviews. Numerous Indigenous persons have articulated that their worldviews understand all things as an interconnected whole, as shown in Figure 1, the *Indigenous Holistic Worldview Illustration*. There is inherent difficulty in writing a report that includes sectoral chapters about impacts experienced by Indigenous peoples that also reflects the interconnected nature of those experiences. However, as Figure 1 shows, each topic is interwoven with the others and all the systems of the world. (See *Introduction* for further discussion of Figure 1.)

Although Indigenous peoples have been involved in various scientific reports related to climate change (see Ch. 1), a gap exists in the published literature of a holistic, in-depth review of the unique experiences of and threats to Tribes, in particular with first-hand experiences described. The STACC Report aims to fill this gap as well as provide recommendations for decision-makers and others supporting Tribal efforts.

Understanding Tribal Sovereignty

In order to effectively support Tribes in their efforts to address climate change, it is vital to understand Tribal sovereignty, self-determination, the federal trust responsibility, and consultation requirements within the government-to-government relationship. Tribal sovereignty is the inherent right of American Indians and Alaska Natives to govern themselves, and any decisions that could impact their property or

citizens must be made with their participation and consent (NCSL, 2013; USDOI Frequently Asked Questions, n.d.). Similar to states, Tribes "possess the right to form their own governments; to make and enforce laws, both civil and criminal; to tax; to establish and determine membership (i.e., tribal citizenship); [and] to license and regulate activities within their jurisdiction…" (USDOI Frequently Asked Questions, n.d.). The Indian Self-Determination and Education Assistance Act of 1975 articulates a

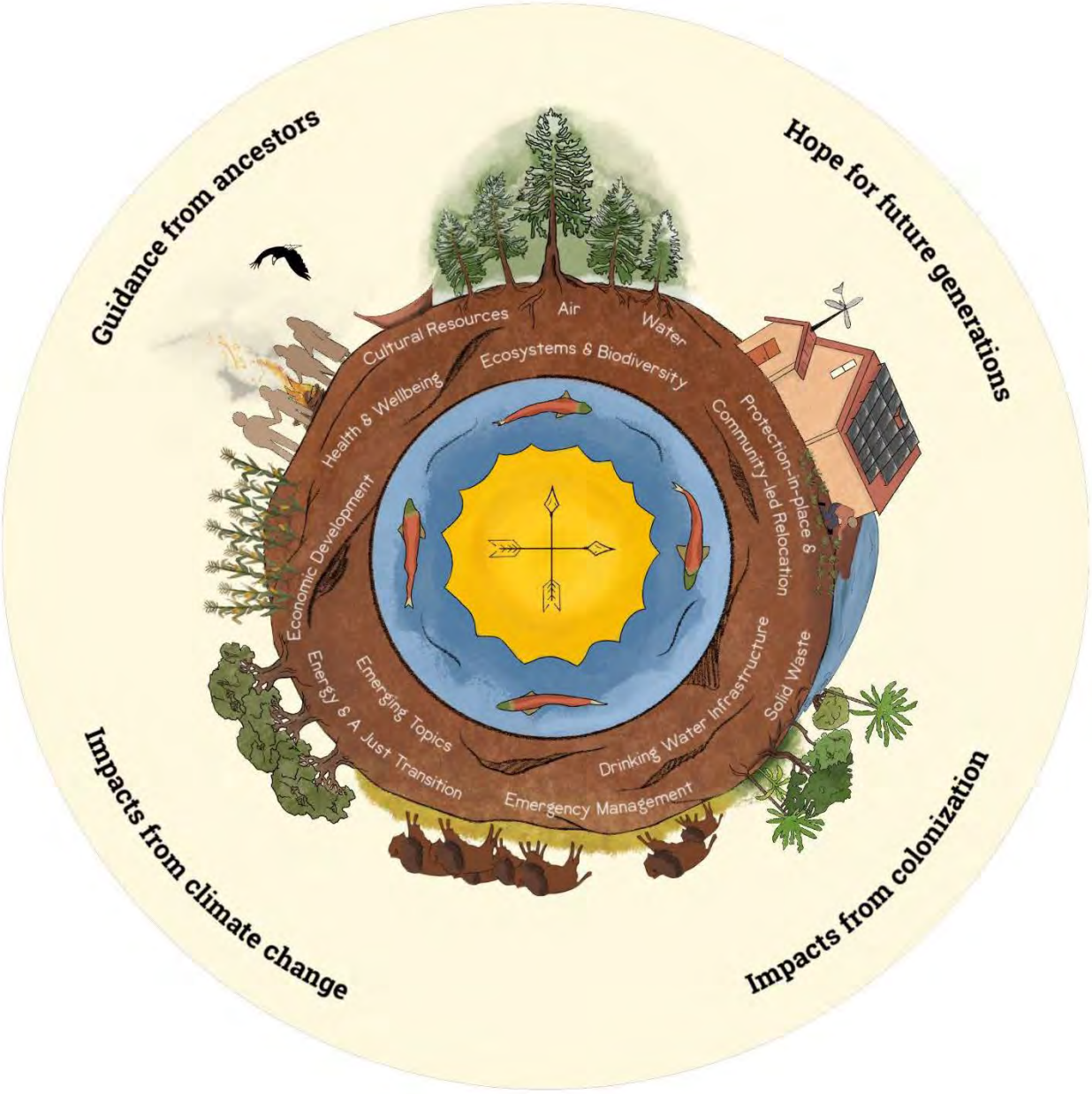

Figure 1. The Indigenous Holistic Worldview Illustration visually depicts the interconnected way in which many Indigenous peoples experience the world and includes factors that influence the natural world. The various topics that the STACC Report addresses are included in the roots to demonstrate that while the Report is divided into independent chapters, the topics are, in reality, part of an interdependent whole. This illustration's shape resembles a turtle in reference to Turtle Island, as some of the creation stories of Indigenous peoples of North America include a turtle, which can be thought of as either the continent of North America or as the entire Earth, depending on the storyteller. Illustration design: Coral Avery and Molly Tankersley

pathway for Tribal control, responsibility, and autonomy over programs and services usually administered by the Bureau of Indian Affairs (USDOI Self-Determination, n.d.; USDOI Frequently Asked Questions, n.d). The federal trust responsibility addresses the reality that Tribal nations ceded their homelands in exchange for the guarantee of protection of their rights to self-government and lands and to provide for federal assistance (NCAI Tribal Governance, n.d.). The government-to-government (or nation-to-nation) relationship is a fundamental principle of the federal trust responsibility (NCAI State/Tribal Relations, n.d.), and government-to-government consultation must occur from the beginning stages of all decision-making that could potentially impact Tribes.

Executive Order 13175, which was established in 2000, "reaffirms the Federal government's commitment to tribal sovereignty, self-determination, and self-government. Its purpose is to ensure that all Executive departments and agencies consult with Indian tribes and respect tribal sovereignty as they develop policy on issues that impact Indian communities" (DOE, 2000). This executive order was reaffirmed by the Biden administration on January 26, 2021. Sovereignty is an inherent right of Tribes, and the onus is on the federal government to ensure that right and government-to-government consultation are upheld. It is important to note that not all Indigenous groups/peoples have federal recognition, which limits their access to federal resources and impacts their ability to address climate change.

Chapter Number	**Chapter Title**
Chapter 1	History of Indigenous Peoples in National Climate Assessments
Chapter 2	Worldviews, Knowledges, & Social Impacts
Chapter 3	Actionable Science & Collaborative Climate Planning
Chapter 4	Ecosystems & Biodiversity
Chapter 4.1	Air
Chapter 4.2	Water
Chapter 4.2.1	Drinking Water Infrastructure
Chapter 5	Health & Wellbeing
Chapter 6	Economic Development: Renewables, Sustainable Economies, & Carbon Offsets
Chapter 7	Energy & a Just Transition
Chapter 8	Cultural Resources
Chapter 9	Emergency Management
Chapter 10	Protection-in-Place & Community-Led Relocation
Chapter 11	Solid Waste
Chapter 12	Emerging Topics

Table 1. Chapter numbers and titles for easy reference and an overview of the Report layout.

Interwoven Key Messages & Recommendations

The full list of Key Messages & Recommendations can be found within each chapter and in the Conclusion. Much like the interwoven nature of all the topics addressed in this report, the key messages and recommendations are interdependent and can be distilled into two themes: ***Respect and uphold Tribal sovereignty and self-determination*** and ***Integrate holistic responses in line with Tribal values***.

Key Message & Recommendation: Respect and Uphold Tribal Sovereignty and Self-Determination

Tribal sovereignty and self-determination help to counteract historical trauma, disproportionate climate change impacts, and vulnerability and are strong themes in the Recommendations across all chapters. The remedial dynamic of recognizing and respecting the pre-existing right of self-determination of Tribes should be acknowledged. Each chapter identifies key ways to promote Tribal sovereignty, including, but not limited to, the following actions and examples:

Engage Tribes early and often in decision-making processes (Chs. 3 and 10). Many federal programs and policies affecting Tribes have been designed without meaningful Tribal participation. Tribes should be central to such decision-making. Engaging Tribes early and often helps to ensure that programs developed are accessible to Tribal communities and that Tribal concerns, values, and priorities are included in decisions such as those about land or water management, the development of regulations, choices about what science questions to pursue, and more. One best "early and often" engagement practice is to establish Tribal partnerships before developing project proposals. Building relationships with Tribal leaders, managers, and community members is key to ensuring respectful dialogue and that intentions are trustworthy.

Increase co-management of natural resources. Co-management of natural resources involves cross-jurisdictional, cooperative, participatory collaboration in decision-making, planning, and enforcement (Ch. 3), and contributes to strengthening of food security and the realization of food sovereignty (Ch. 5). As the Kootenai Tribe of Idaho describes in their narrative in Ch. 4.1, their state-Tribal partnership improved monitoring capabilities during the 2020 wildfire smoke season.

Respect, include, and protect Indigenous and traditional knowledges in climate change actions. Such knowledges are a fundamental and interwoven part of Indigenous cultures and are important for understanding and responding to changes that are occurring. For instance, during climatic and other disruptions such as wildfires, extreme weather, and the COVID-19 pandemic, when access to commercial foods may be cut off, traditional hunting, fishing, and gathering methods form a source of local resilience. In addition to the information in Chs. 2, 3, 4, 5, and 12, a resource for better understanding this concept is the *Guidelines for Considering Traditional Knowledges in Climate Change Initiatives*.[1] As described in the Guidelines, Tribes must be able to choose to share or not share traditional knowledges with others.

Provide adequate funding for climate change adaptation (Chs. 4–12 and Appendix A). Inadequate funding remains one of the greatest barriers for Tribes to plan for and adapt to climate change, as well as to mitigate climate change through greenhouse gas reductions and developing a zero-carbon economy (Chs. 4.2.1, 6, 7, and 12). For example, across the U.S., Tribal communities are experiencing land loss due to erosion, flooding, and permafrost thaw (Chs. 4 and 10). Nationwide, at least $6.2 billion is needed over the next 50 years to protect, replace, and move existing Tribal infrastructure. This amount includes at least $175 million needed annually nationwide over the next ten years (Ch. 10).

[1] Guidelines for Considering Traditional Knowledges in Climate Change Initiatives: https://climatetkw.wordpress.com/about/

Increase coordination among federal programs so that financial and technical resources are more easily accessed by Tribes and are used more efficiently. When accessing climate change adaptation resources, Tribes may face hurdles navigating a federal system in which funding and technical expertise are dispersed across multiple departments and programs, each with differing and sometimes complicated processes for accessing resources (Ch. 4.2.1, 9, and 10). For example, programs that provide funding to construct public drinking water systems are located within seven different federal agencies, and there is no lead federal agency or program to help communities facing relocation (Ch. 4.2.1 and 10).

Build and retain capacity within Tribes to manage and adapt their resources and infrastructure to climate change through passing down of knowledge between elders and youth, workforce development, professional training to increase technical and managerial expertise, and the equitable and ethical use of Indigenous knowledges and Western science (see Chs. 3, 4.2.1, 5, 7, and 12). Tribal Colleges and Universities, for example, are important institutions for students to transition from education to their careers as professionals; on-the-job training programs allow for the application of emerging technologies such as those in energy generation; and hiring community members first ensures the local community will benefit. Workforce development can transcend inequity issues, contribute to strong economies, and help maintain cultural integrity. Federal responses should integrate support for these local capacity-building and retention efforts.

Provide Tribally-focused data, resources, and actionable science to support Tribal decision-making (Chs. 3 and 6 and Appendix B). Climate change occurs globally but is experienced locally in a variety of ways. Climate change data that is more local and integrated with local observations and knowledge can be more relevant for planning and actions. The University of Washington's *Tribal Climate Tool*,[2] for instance, provides Pacific Northwest Tribes with reservation-specific climate change data. Actionable science helps people make better decisions about things they care about and should start off with the question, "What does this community value?" This is aided by engaging Tribes early and often (see above).

Support the planning and implementation of Tribally-led solutions to Tribally-identified needs (Chs. 4.1 and 12 and Appendix A). Due to colonization, Tribes have had decisions about their futures imposed on them from outside entities. A key element of Tribal sovereignty involves Tribes identifying their own needs and priorities and leading their own responses and actions. The Climate Science Alliance's Tribal Working Group is one example of successfully building, supporting, and accelerating Tribal resilience in a Tribally-led environment in which the planning and implementation aspects are fully supported (narrative, Ch. 12). Another example is described by the Nottawaseppi Huron Band of the Potawatomi in Ch. 4.1: they had concerns about air pollution from area sources, which led to them directing their resources to strategically install PurpleAir monitors and develop an Environmental Dashboard to help protect the health of their Tribal members.

Key Message & Recommendation: Integrate Holistic Responses in Line with Tribal Values

As described above, Tribal worldviews, experiences, and responses embody interconnectedness. Cascading impacts from, and holistic and interconnected responses to, climate change are addressed throughout the STACC Report and include actionable steps such as:

When developing climate change solutions, recognize the interconnectedness of systems and consider strategies that achieve multiple objectives (see Chs. 4.2 and 5). Ocean acidification and harmful algae events negatively affect Indigenous food systems and security, human health, and local economies. Solutions like clam gardens—essentially, rock walls in bays or inlets that increase shellfish productivity—are an integrated response to multiple climate change impacts (e.g., rising tides, food security, and ocean acidification) and draw upon traditional knowledges. Exerting economic sovereignty through sustainable enterprise development is another strategy Tribes use to address system interconnectedness and achieve multiple objectives (see Ch. 6). Additionally, rising air temperatures and increasing drought may stress native vegetation, leaving plants more vulnerable to insect outbreaks and providing greater opportunities for invasive plants to become established. Large-scale, uncharacteristically high-severity wildfires that could contribute to ecosystem conversion may continue to increase. Cultural burning is a stewardship practice that can enhance ecosystem resilience to climate change and achieve multiple objectives by promoting drought-tolerant and fire-adapted vegetation species; inhibiting insect pests that affect foods such as nuts, seeds, and berries; mitigating large-scale detrimental fires; and promoting the growth of basket-weaving materials and medicinal and food species. By working with the fire regimes of native and nonnative vegetation, cultural burning can also inhibit the establishment of invasive plants. Momentum is gaining for the use of this multifaceted strategy as recognition of the benefits of cultural burning spreads beyond Tribal communities, scientific understanding of the role that fire plays in ecosystems builds, and legal policies that limit cultural burns shift (Chs. 4, 4.1, 5, 8, and 12.)

Increase partnerships across jurisdictional boundaries and at different scales and integrate climate change considerations into ongoing planning and implementation processes (Chs. 3, 4.2, 6, 9, and 12). Climate change impacts are often interconnected and complex, sometimes crossing jurisdictional lines. Integrating climate change into ongoing planning and implementation, along with collaborative responses at larger geographic scales, has the potential to be more cost-efficient, more inclusive with respect to decision-making, and less time-consuming and to lead to actions that are more sustainable in the long term. Ch. 12 describes how Tribes are participating in a variety of cross-boundary, collaborative projects, including the Rio Grande Water Fund hosted by The Nature Conservancy. The Fund supports large-scale forest restoration by a variety of entities in the aftermath of an extensive wildfire to ensure a clean water supply for the region's people and wildlife, both now and in the future. Examples of plans in which climate change can be considered as one factor among many include: FEMA Tribal Hazard Mitigation Plans; EPA Tribal Environmental Plans; Land/Resource Management Plans; Community Comprehensive Plans; and BIA forest, wildland fire, irrigation, fish and wildlife, agricultural, and integrated resource management plans.

Implement climate adaptation strategies that are proactive versus solely reactive (Chs. 4.2, 4.2.1, and 11). In contrast to reactive responses, proactive strategies anticipate future scenarios and plan

for problems that may occur before they take place, helping to minimize harm. Climate-resilient drinking water systems, for example, provide reliable service with limited disruptions and/or harm in the face of changing environmental conditions and extreme climate events. If disruptions occur, systems can recover quickly. Infrastructure deficiencies provide opportunities to install new infrastructure in climate-resilient ways that can help decrease emergencies. System upgrades provide occasions to improve the climate resiliency of existing infrastructure.

Connect solutions to Tribal values and priorities, and recognize the tangible and intangible significance of climate change impacts. Tribes may have different views than their non-Tribal counterparts with respect to what they value and prioritize, and not all resources have tangible value or risk of loss (Ch. 8). Ch. 5 describes how the Swinomish Indian Tribal Community, for instance, developed Indigenous Health Indicators (IHIs) that contrast somewhat with a more western view of health. The indicators include community connection, cultural use, education, natural resource security, self-determination, and resilience. The Swinomish Tribal government used these IHIs to prioritize and make decisions about how to use limited time and resources to address sea level rise and storm surge impacts to key first foods habitats.

Support Tribes' just transitions away from fossil fuels. Tribal self-determination means that decisions made by individual Tribes will vary, but a just transition away from fossil fuels and towards renewable energy will ensure that regenerative and sustainable economies are a part of the restoration of Indigenous peoples' lifeways (Chs. 6 and 7). Some Tribal economies are dependent on fossil fuels, which is an unsustainable economic model, and the burning of fossil fuels is ultimately driving climate change. The Hopi Tribe's economy has depended on coal for 50 years, and the closure of the area's coal mine was a devastating loss. The Tribe is working towards transitioning to renewable energy development to improve the health of the community while also creating new revenue and jobs (narrative, Ch. 7).

The 2021 STACC Report is the first of its kind. Future STACC Reports will seek to identify new topics and developments important to Tribes and current topics that this edition did not cover. The authors of future Reports will also continue to strive to integrate topics holistically.

Building on the successes of Tribes and individuals who have dedicated their lives to elevating Indigenous peoples' concerns and implementing the changes imperative to improving their lives, the 2021 STACC Report demonstrates the unique climate change impacts experienced by Tribes and the many ways they are responding. Gaining an understanding of Tribal worldviews, traditional knowledges, and the increased impacts that many Tribal communities face may lead to improved responses to climate change in the U.S. and greater environmental and social justice for the original peoples of this land. When we recognize we are not separate from our natural environment and value justice, equity, and respect for all our relations, we may collectively achieve a society in which all can thrive.

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NOTES ON TERMINOLOGY

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The terminology employed throughout the *Status of Tribes and Climate Change Report* reflects an effort to emphasize the importance of the meanings of Indigenous concepts, worldviews, knowledge, and languages. In some cases, there are straightforward words that can be used whose meanings correspond appropriately with Indigenous meanings. In other cases, readers have to exercise a respectful interpretation that there may be few if any appropriate English language words that correspond appropriately with Indigenous meanings. Some of the authors of the Indigenous peoples sections and chapter of the NCA4 developed a document titled *Indigenous Peoples Terminology for the Fourth National Climate Assessment*,[2] where they thoughtfully laid out definitions of terms. While, for the most part, the terminology used in this Report is in alignment with the definitions in the NCA4 terminology document, there are a few slight differences. Readers of the Report should expect to see diverse choices made about terminology. The rule used in the Report is to use terminology consistent with the best expression of information about Indigenous understanding, experience, and goals with respect to climate change. The authors collaborated with one another to determine what choices would be made about terminology. While the following list is not exhaustive, key terminology and stylistic choices are as follows:

Indigenous peoples: The term "Indigenous peoples" is used to be inclusive of self-determining societies whose political and cultural foundations pre-exist the formation of the United States, regardless of their recognition status by the United States government. "Indigenous peoples" includes the 574 federally recognized Tribes as of 2020, Native Hawaiians, state-recognized Tribes, and unrecognized Tribes and peoples. More specific terms will be used where the particular government, legal, cultural, or diplomatic situation is being referenced. Indigenous peoples' self-determination can be best respected by using terminology that acknowledges Indigenous governance systems. Indigenous peoples are not stakeholders, but self-governing and sovereign societies. The authors of the Report must rely on general words like "culture" or "knowledge" to stand in for complex, place-based institutions and scientific traditions, which can fail to convey the diversity of Indigenous peoples' lifeways and social structures. In some parts of the Report, the authors are deliberate to use words such as "some" or "diverse" to convey differences across Indigenous peoples.

Terms such as Tribe, Tribal, Tribal peoples, Tribal communities, and Indigenous peoples are all used throughout the Report, as appropriate to the context. The term "Alaska Natives" is a formal, legal, and functional term used specifically to refer to the Indigenous peoples of Alaska.

[2] Indigenous Peoples Terminology for the Fourth National Climate Assessment: http://www7.nau.edu/itep/main/tcc/docs/resources/Indigenous Peoples Terminology for NCA4_final.pdf

Capitalization choices: Consistent with some academic and international conventions, there will be capitalization of the words "Indigenous" and "Tribe/Tribal." It is important to be aware that there is no universal or widely accepted rule about capitalization. Different authoritative sources on grammar and style—whether from professional societies, style guides, political agencies, or international organizations—offer different and incongruent guidance. The decisions about capitalization in this Report reflect the will of the authors and steering committee who sought to focus on being respectful of Indigenous self-determination and being vigilant about past and continuing textual assumptions that can marginalize Indigenous peoples' presence.

In this Report, the terms "Indigenous" and "Tribe/Tribal" are being used to denote specific meanings of Indigeneity tied to government, culture, and diplomacy. For this reason, the Report is conveying to the reader meanings that actually do fulfill a certain conventional wisdom about when to capitalize. There may be some isolated instances in the Report when capitalization may not be respectful or conventional, which the Report's lead authors took responsibility in evaluating. In cases of the terms "Indigenous peoples" and "Tribal nations," the rule followed in the Report is not to capitalize "peoples" or "nations," unless a particular usage is conventional in some context. One example of an exception is the use of the term "First Nations" in Canada, which almost always capitalizes "Nations."

Terminology related to ecosystems and climate change: Indigenous peoples' knowledge systems have developed different concepts for understanding ecosystems, biodiversity, and climate change. Yet given the dominance of the English language, Indigenous persons have had to find ways to communicate collaboratively in English with non-Indigenous persons. Indigenous leaders, knowledge keepers, and scholars have expressed concern that some English-language concepts do not give sufficient awareness or respect to how Indigenous peoples understand relationships with the environment, especially when considering Indigenous conceptions of cosmology, kinship, and responsibility. Terms or phrases like "ecosystem services," "biota," or "invasive species" are important examples. These terms or phrases can connote instrumental, physical, and transactional relationships with species and aspects of the environment, but exclude relationships that carry important connotations regarding obligations and responsibilities for caretaking and kinship that are fundamental within many Indigenous peoples' cosmologies, worldviews, and cultures. The authors took seriously the problem of navigating the dominance of the English language and how such dominance affects Indigenous expression.

The Report does, in places, use more Indigenous-inspired conventions in English, where appropriate. For example, instead of "ecosystem services," some parts of the Report discuss responsibilities connecting diverse species in mutually beneficial relationships. Instead of using scientific names for individual species, some authors may use common names for ease of understanding by Indigenous peoples. At the same time, some of these English-language terms are best preserved to protect the scientific integrity of the terminology within particular literature. In other cases, Indigenous peoples have used these terms to enhance communication within multicultural exchanges of information. In some parts of the Report, "knowledge" is pluralized as "knowledges" to reflect the diversity of knowledge within Indigenous peoples and across them.

Certain Indigenous individuals and cultures refer to living entities as beings, and their use of this term may apply to or encompass humans, plants, animals, or even microorganisms. Additional context may be provided as far as, for example, whether beings are welcomed or unwelcomed (e.g., pathogens) or whether they have long been present in Indigenous communities or areas or whether they are newly arrived (invasive).

Some Suggested Reading with Connections to Choices on Terminology

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ACRONYMS USED IN THIS REPORT

ACS	U.S. Census Bureau's American Community Survey
AF	Acre Feet
AI/AN	American Indians and Alaska Natives
AIHEC	American Indian Higher Education Consortium
ANCSA	Alaska Native Claims Settlement Act
ANTHC	Alaska Native Tribal Health Consortium
AOS	Arctic Observing Summit
AP	Adaptation Plan
APHIS	Animal and Plant Health Inspection Service
AQP	Air Quality Program
ASPIRE	Advancing Science Partnerships for Indoor Reductions of Smoke Exposures
ATNI	Affiliated Tribes of Northwest Indians
BGA	Blue-Green Algae
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practices
BOD	Biological Oxygen Demand
BRFO	Blue River Foundation of Oklahoma
CAA	Clean Air Act
CAKE	Climate Adaptation Knowledge Exchange
CASC	Climate Adaptation Science Center
CCHRC	Cold Climate Housing Research Center
CDC	Centers for Disease Control and Prevention
CFLRP	Collaborative Forest Landscape Restoration Program
cfs	Cubic Feet per Second
CJRF	Climate Justice Resilience Fund
CNRA	Chickasaw National Recreation Area
CPN	Citizen Potawatomi Nation
CRCCS	Cultural Resources Climate Change Strategy
CRS	Congressional Research Service
CRWU	Creating Resilient Water Utilities
CSA	Climate Science Alliance
CSKT	Confederated Salish and Kootenai Tribes
CSZ	Cascadia Subduction Zone
CTKW	Climate and Traditional Knowledges Workgroup
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	Department of Energy
DOI	Department of Interior
EAB	Emerald Ash Borer
ECHO	Enforcement Compliance History Online
EEOP	Environmental Education Outreach Program
EI	Emissions Inventory
EPA	Environmental Protection Agency

ESFs	Emergency Support Functions
FARR	Federal Air Rules for Reservations
FEMA	Federal Emergency Management Agency
FHORT	Framework of Historical Oppression, Resilience and Transcendence
FRP	Fire Radiative Power
FWS	Fish and Wildlife Service
GAO	Government Accountability Office
GAP	General Assistance Fund
GCRA	Global Change Research Act
GIS	Geographic Information System
GLIFWC	Great Lakes Indian Fish & Wildlife Commission
GSHP	Ground Source Heat Pump
HAB	Harmful Algal Bloom
HAE	Harmful Algae Event
HEARTH	Helping Expedite and Advance Responsible Tribal Home Ownership
HITS	Home Inventory Tracking System
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HNR	Hanford Nuclear Reservation
HRL	Health Reference Level
HUD	Housing and Urban Development
HWB	Health and Wellbeing
IDEQ	Idaho Department of Environmental Quality
IDJC	Isle de Jean Charles
IEN	Indigenous Environmental Network
IGAP	Indian General Assistance Program
IGSM-CAM	Integrated Global System Model–Community Atmosphere Model
IHIs	Indigenous Health Indicators
IHS	Indian Health Services
IK	Indigenous Knowledge
IPCC	Intergovernmental Panel on Climate Change
IPCCWG	Indigenous Peoples Climate Change Working Group
IRMP	Integrated Resource Management Plan
ITEDSA	Indian Tribal Energy Development and Self-Determination Act
ITEP	Institute for Tribal Environmental Professionals
ITF	Infrastructure Task Force
KSM	Kerr Sulphurets Mitchell
LAWA	Lake of the Arbuckles Watershed Association
LPNF	Los Padres National Forest
MACS	Multiagency Coordination Groups
MCL	Maximum Contaminant Level
MTE	Menominee Tribal Enterprises
MW	Megawatts
NAFSI	Native Agriculture and Food Systems Scholarships
NASA	National Aeronautics and Space Administration

NAU	Northern Arizona University
NCA	National Climate Assessment
NCAI	National Congress of American Indians
NFIP	National Flood Insurance Program
NGO	Nongovernmental Agency
NHBP	Nottawaseppi Huron Band of the Potawatomi
NIACS	Northern Institute of Applied Climate Science
NICC	National Indian Carbon Coalition
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NPNH II	Native Peoples-Native Homelands second workshop
NPS	National Park Service
NREL	National Renewable Energy Laboratory
NRF	National Response Framework
NTAA	National Tribal Air Association
NTEMC	National Tribal Emergency Management Council
NYCALC	Native Youth Community Adaptation and Leadership Congress
O&M	Operations and Maintenance
ODEQ	Oklahoma Department of Environmental Quality
PAH	Polycyclic Aromatic Hydrocarbons
PBPN	Prairie Band Potawatomi Nation
PM	Particulate Matter
PNSN	Pacific Northwest Seismic Network
PNW	Pacific Northwest
PSP	Paralytic Shellfish Poisoning
PTSD	Post-traumatic Stress Disorder
PV	Photovoltaic
PWS	Public Water System or Public Drinking Water System
RCPs	Representative Concentration Pathways
RPS	Renewable Portfolio Standard
RTC	Reservation Tribal Council
SAFER	Safe and Affordable Funding for Equity and Resilience
SAITC	Southeast Alaska Indigenous Transboundary Commission
SDS	Sanitation Deficiency System
SDWA	Safe Drinking Water Act
SEATOR	Southeast Alaska Tribal Ocean Research
SMBMI	San Manuel Band of Mission Indians
SMM	Sustainable Materials Management
STACC	Status of Tribes and Climate Change
STACCWG	Status of Tribes and Climate Change Working Group
STA-ERL	Sitka Tribe of Alaska Environmental Research Lab
STAR	Status of Tribal Air Report
STEAM	Science, Technology, Engineering, Art, and Math
STEM	Science, Technology, Engineering, and Math
SYCEO	Santa Ynez Band of Chumash Indians Environmental Office

TAM	Tribal Adaptation Menu
TAP	Tribal Alliance for Pollinators
TAR	Tribal Authority Rule
TCRP	Tribal Climate Resilience Program
TCUs	Tribal Colleges and Universities
TDS	Total Dissolved Solids
TEAM	Tribal Environmental Action for Monarchs
TEISS	Tribal Emissions Inventory Software Solution
TERA	Tribal Energy Resource Agreements
TNC	The Nature Conservancy
TWG	Tribal Working Group
UCAR	University Corporation for Atmospheric Research
UCMR	Unregulated Contaminant Monitoring Rule
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGCRP	U.S. Global Change Research Program
USGS	United States Geological Survey
VA	Vulnerability Assessment
VW	Volkswagen
WCS	Wildlife Conservation Society
WQI	Water Quality Index
WQMP	Water Quality Monitoring Program

INTRODUCTION

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The *Status of Tribes and Climate Change (STACC) Report* seeks to uplift and honor the voices of Indigenous peoples across the U.S. to increase understanding of Tribal lifeways, cultures, and worldviews; the climate change impacts Tribes are experiencing; the solutions they are implementing; and ways that all of us can support Tribes in adapting to our changing world. The Indigenous peoples of North America have seen many hardships, including legacies of colonialism, forced assimilation, intergenerational trauma, upheaval and repression of Native economic systems, and the loss of ancestral lands, languages, natural resources, and traditions but have continually proven to be resilient and innovative in finding solutions. This resiliency dates back thousands of years to time immemorial and holds true in today's changing climate. Furthermore, as this Report and the narratives herein demonstrate, Tribes are often at the leading edge in adapting to climate change; implementing locally based, scientifically supported actions to mitigate climate change; and creating the necessary systemic shifts to reconnect people with both environment and community. Despite this resiliency, climate change impacts for many Tribal communities are already severe, the challenges they face responding to impacts are daunting, and the need to take action is urgent.

Tribal ability to respond to climate change is influenced by capacity and the degree to which they can exercise their sovereignty, which is in turn influenced by external policies. The Doctrine of Discovery is one such external policy and was utilized from the mid-1400s through the mid-1900s to influence and justify the dispossession of Indigenous lands. Ideas that led to the Doctrine of Discovery predate the colonization of the Americas, with foundational elements dating back as early as the 1100s (Upstander Project, n.d.). Federal Indian policy has shifted over time, in large part due to the ongoing efforts of Tribal communities who have continually engaged in activism, political participation, and resistance movements. Previous eras of federal Indian policy include Relocation (1828–1887),[3] Allotment and Assimilation (1887–1934), Indian Reorganization (1934–1953), Termination (1953–1968), and Self-Determination (1968–present) (Pevar, 2012). Most recently, federal Indian policy has coupled Self-Determination with Self-Governance, which "returns decision-making authority and management responsibilities to Tribes" (as quoted in Wilkins & Kiiwetinepinesiik Stark, 2011). This is implemented across several federal agencies through self-determination contracts and compacts with Tribes to manage, develop, and take ownership of their programs, functions, services, and activities, including many environmental and health programs.

[3] The Treaty-Making Era (~1778–1871) and the Removal Era (~1820–1850) overlap with the Relocation Era; the Removal Era is very similar to the Relocation Era.

On January 26, 2021, President Biden released a Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships,[4] reaffirming the critical importance of Executive Order 13175, which charges all federal agencies to engage in "regular, meaningful, and robust consultation with Tribal officials," in all matters with Tribal implications. The memorandum opens with the following paragraph:

> *American Indian and Alaska Native Tribal Nations are sovereign governments recognized under the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions. It is a priority of my Administration to make respect for Tribal sovereignty and self-governance, commitment to fulfilling Federal trust and treaty responsibilities to Tribal Nations, and regular, meaningful, and robust consultation with Tribal Nations cornerstones of Federal Indian policy. The United States has made solemn promises to Tribal Nations for more than two centuries. Honoring those commitments is particularly vital now, as our Nation faces crises related to health, the economy, racial justice, and climate change—all of which disproportionately harm Native Americans. History demonstrates that we best serve Native American people when Tribal governments are empowered to lead their communities, and when Federal officials speak with and listen to Tribal leaders in formulating Federal policy that affects Tribal Nations.*

Understanding Tribal Sovereignty

In order to effectively support Tribes in their efforts to address climate change, it is vital to understand both Tribal sovereignty, self-determination, the federal trust responsibility, and consultation requirements within the government-to-government relationship. Tribal sovereignty is the inherent right of American Indians and Alaska Natives to govern themselves, and any decisions that could impact their property or citizens must be made with their participation and consent (NCSL, 2013; USDOI Frequently Asked Questions, n.d.). Similar to states, Tribes "possess the right to form their own governments; to make and enforce laws, both civil and criminal; to tax; to establish and determine membership (i.e., tribal citizenship); [and] to license and regulate activities within their jurisdiction…" (USDOI Frequently Asked Questions, n.d.). The Indian Self-Determination and Education Assistance Act of 1975 articulates a pathway for Tribal control, responsibility, and autonomy over programs and services usually administered by the Bureau of Indian Affairs (USDOI Self-Determination, n.d.; USDOI Frequently Asked Questions, n.d). The federal trust responsibility addresses the reality that Tribal nations ceded their homelands in exchange for the guarantee of protection of their rights to self-government and lands and of provision for federal assistance (NCAI Tribal Governance, n.d.). The government-to-government (or nation-to-nation) relationship is a fundamental principle of the federal trust responsibility (NCAI State/Tribal Relations, n.d.), and government-to-government consultation must occur from the beginning stages of all decision-making that could potentially impact Tribes.

[4] Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships, January 21, 2021, https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/26/memorandum-on-tribal-consultation-and-strengthening-nation-to-nation-relationships/

Elevating Tribal Voices

The STACC Report includes 34 narrative submissions directly from Tribes, which are identified in the Report by using green font. These narratives include diverse voices that speak of the innovative, active, collaborative projects addressing the serious challenges that Tribes face, their searches for solutions, their use of both traditional knowledges and Western science, and much more. Impacts from climate change and Tribal responses to climate change are as diverse as are the Tribes across the U.S. As the narratives in this Report demonstrate, many Tribes are on the cutting edge of climate change adaptation and mitigation, while others struggle with limited capacity to respond to the major changes they are experiencing. Tribes have shown time and again that their traditional lifeways, worldviews, knowledges, and wisdom provide guidance for the systemic shift that is necessary to create a sustainable, reciprocal relationship with the environment.

The design of the STACC Report reflects the intention to uplift and honor Indigenous voices. *Section 1: Briefing on Climate Change in the Tribal Context* gives an overview for the reader to deepen their understanding of how Tribal lifeways and cultures influence their potential responses to climate change and how their lifeways and cultures are dependent upon clean air and water, healthy soils, and the ability to exercise their inherent sovereignty. *Section 2: Impacts & Solutions by Topic* is structured to highlight the Tribal narratives by including them in the beginning of each chapter, followed by reviews of each topic by the diverse writing teams. The *Conclusion, Key Messages, and Recommendations* includes a full listing of the key messages and recommendations generated by the authors of each chapter. *Appendix A: Funding* highlights key resources to assist Tribes in developing funding strategies for Tribal climate change projects, and *Appendix B: Resources* provides descriptions and links to resources of all types mentioned throughout the STACC Report.

The topic reviews in Sections 1 and 2 were written by teams of authors representing a wide array of backgrounds and expertise who include elements from their own experiences and knowledge as well as information from the most current peer-reviewed literature. These teams provide diverse expertise, writing styles, and perspectives on the key points to address in Tribal responses to climate change.

The STACC Report seeks to create dialogue across diverse cultures, heritages, and worldviews. Many Indigenous perspectives worldwide describe the environment, climate change, and the various impacts and solutions as an interconnected whole, demonstrating some of the uniqueness of how Indigenous peoples understand the world. (See *Chapter 2: Worldviews, Knowledges, & Social Impacts*.) The Indigenous Holistic Worldview Illustration (Figure 1) was developed for this Report to visually depict the interconnected way in which many Indigenous peoples experience the world. For most Indigenous communities, there is no separation between earth, sky, water, humans, animals, plants, and other elements. All are interconnected relations, and the experiences of one inevitably affect the others. Other factors also influence these interconnected systems, such as the legacy of colonialism, guidance from ancestors, choices today that will affect future generations, and climate change.

The 2021 STACC Report also seeks to inform the work of the U.S. National Climate Assessment (NCA). As described in the next chapter, the NCA has included Indigenous peoples in the last several iterations,

most heavily in *Chapter 15: Tribes and Indigenous Peoples* in NCA4 (2018), but the need for a deeper dive into the experiences and circumstances of Tribal peoples required a novel approach. Hence, the STACC Report was created. While the 2021 STACC Report addresses a wide variety of topics, it is by no means exhaustive of all the impacts felt by Tribes, solutions implemented by Tribes, or factors that impact Tribes, as related to climate change. Future editions of the STACC Report will attempt to fill the gaps left by the 2021 edition, as well as provide updates that occur between now and the next publication.

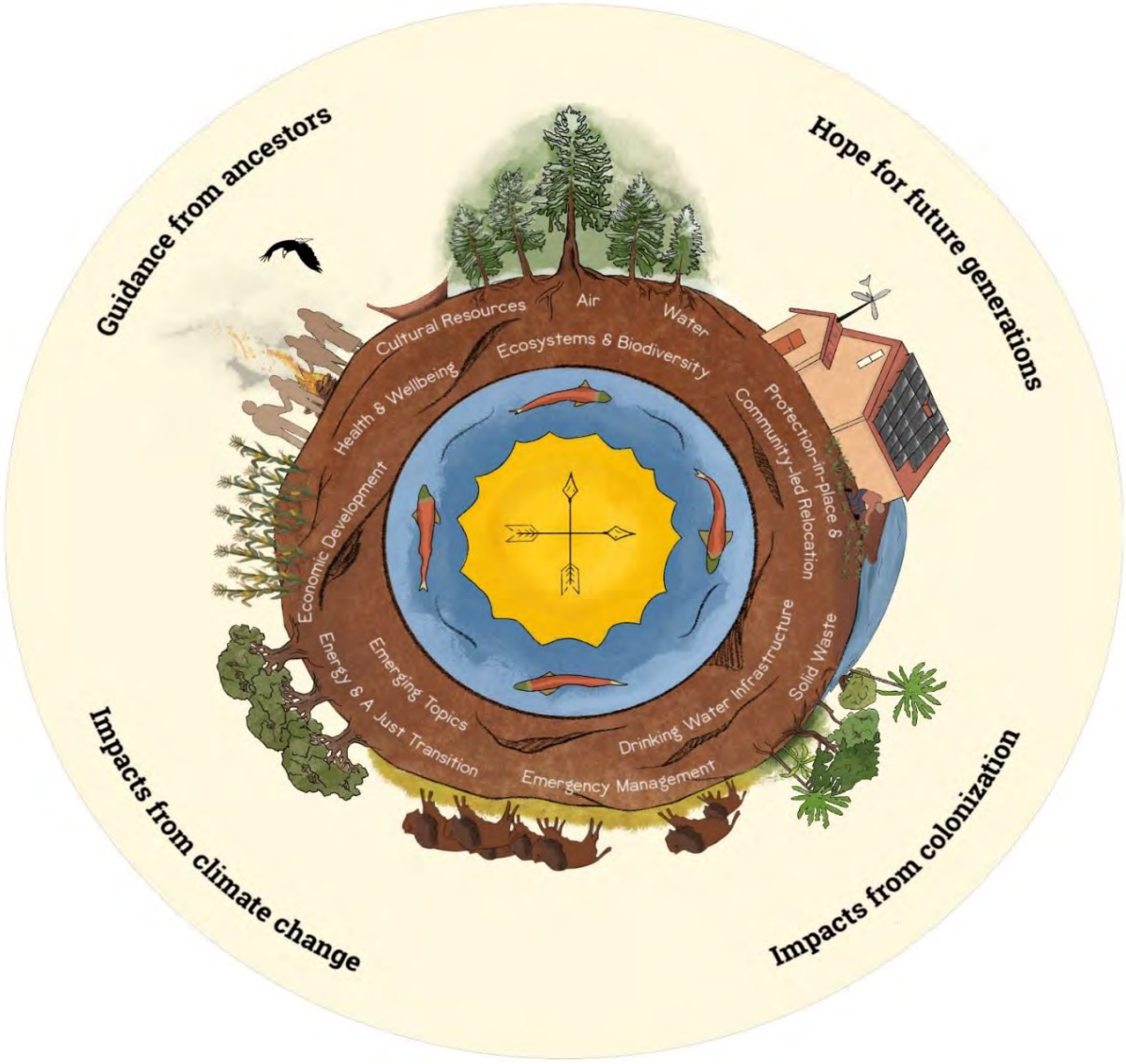

Figure 1. The Indigenous Holistic Worldview Illustration visually depicts the interconnected way in which many Indigenous peoples experience the world and includes factors that influence the natural world. The various topics that the STACC Report addresses are included in the roots to demonstrate that while the Report is divided into independent chapters, the topics are, in reality, part of an interdependent whole. The Illustration shape resembles a turtle in reference to Turtle Island, as some of the creation stories of Indigenous peoples of North America include a turtle, which can be thought of as either the continent of North America or as the entire Earth, depending on the storyteller. Illustration design: Coral Avery and Molly Tankersley

Introduction References

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SECTION 1: BRIEFING ON CLIMATE CHANGE IN THE TRIBAL CONTEXT

Chapter 1: History of Indigenous Peoples in National Climate Assessments

History of Indigenous Peoples in NCAs
Key Message
Indigenous peoples have been substantively involved in national and international climate assessments for decades, and this involvement has grown, including more Indigenous engagement and authorship on the third and fourth National Climate Assessments. There is still much work to be done to engage and include Indigenous perspectives, knowledge, and expertise in climate assessments.

Recommendation
Future reforms to make NCAs more inclusive should acknowledge, learn from, and build on Indigenous peoples' involvement throughout the history of the U.S. Global Change Research Program.

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Indigenous peoples globally have worked to advance their equitable participation in high-stakes scientific reports. In New Zealand, a Māori Working Group on climate change formed following the establishment of the New Zealand Climate Change Programme in 1988 and a workshop that same year entitled "Climate Change: The New Zealand Response" (Tunks, 1997). The Arctic Council called for the creation of the Arctic Climate Impact Assessment, which issued a 2004 report entitled "Impacts of a Warming Arctic." At the time, and currently, the Council consists of eight arctic states, six Indigenous permanent participants, and various official observers. The Indigenous permanent participants include the Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Council, Russian Association of Indigenous Peoples of the North, and Saami Council (Arctic Climate Impact Assessment, 2004). Diverse scientific reports, more locally and globally, have their own histories of engagement with and involvement of Indigenous peoples (see, for example: Goode et al., 2018; IPCC, 2019).

In the U.S., diverse Indigenous peoples and Indigenous educational institutions, such as Tribal colleges and universities, have long been involved with scientific research and assessment performed by federal and state agencies, universities, and nonprofit organizations. We will discuss the many ways that, since

at least the mid-1990s, Indigenous persons have been substantively involved with the U.S. Global Change Research Program (USGCRP), a program mandated by Congress in the Global Change Research Act (GCRA). The GCRA of 1990 seeks to advance "a comprehensive and integrated United States research program, which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change."

One of the first engagements was the Native Peoples-Native Homelands Workshop (Albuquerque, NM, 1998), which was organized by NASA and the Intertribal Council on Utility Policy. The workshop included over 100 participants representing Tribal leadership, Tribal organizations, Indigenous knowledge-keeping traditions, U.S. government, and climate science. The final report from that workshop, titled *Circles of Wisdom*, was published in 2002 (Maynard, 2002). The report references the Indigenous-focused chapter in the first NCA (NCA1) (National Assessment Synthesis Team, 2000). It states, "Following this workshop, the discussion results from the Wisdom Circles (Breakout Groups) were synthesized and augmented based upon comments from a number of workshop participants and other reviewers into what is now Chapter 12 of the U.S. National Assessment" (Maynard, 2002, Editor's Notes). The chapter is titled, "Potential Consequences of Climate Variability and Change for Native Peoples and Homelands" (Houser et al., 2000).

The chapter highlighted the importance of Indigenous knowledge systems and that Indigenous peoples have a history of relating to human-caused climate change through land-use changes imposed on them by the actions of U.S. citizens and policy-makers. Key issues included tourism and community development, human health and extreme events, rights to water and other natural resources, subsistence economies and other natural resources, and cultural sites, wildlife, and natural resources (p. 351). The chapter advocates for more research relating to Indigenous peoples and climate change while raising ethical concerns about previous abuses by researchers. NCA1 also included an Overview Report that was intended to be more widely accessible to the public. Limited material from Chapter 12 was included within a regional section in the NCA1 Overview Report. A 1999 Special Issue on Indigenous peoples and climate change in the academic journal *Native Americas* references the Native Peoples-Native Homelands workshop and the GCRA (Barriero, 1999).

In NCA2 (Karl et al., 2009), there are references in a section on "society" to the description of "unique vulnerabilities" of Native Americans, including "limited relocation options," specific mentions of Alaska, reduction of availability of traditional food sources, problems of Indigenous peoples being subject to flooding and erosion, and how Native cultures in the Southwest are vulnerable to climate change impacts on water availability and quality. In references to regional climate change impacts in the Great Plains, Southwest, and Alaska, some Tribal issues are referenced. There is no Tribal chapter, nor are Indigenous peoples referenced in the recommendations. It is unclear how Indigenous authors or topical experts may have contributed. At the same time, during this broad period, Indigenous peoples continued to organize efforts to address climate change. The Indigenous Peoples Climate Change Working Group (IPCCWG) was established at Haskell Indian Nations University (2006) (Shepherd, 2016). Members of the IPCCWG have contributed to NCA and other climate assessments. Grossman documented reports and conferences on Indigenous peoples and climate change during the years 2006

and 2007 (Grossman, 2008), such as the Northwest Indian Applied Research Institute's report titled *Climate Change and Pacific Rim Indigenous Nations* (2006).

A second Native Peoples-Native Homelands (NPNH II) workshop was held in 2009 on the homelands of the Shakopee Mdewakanton Sioux Community at the Mystic Lake Casino Hotel in Minnesota (Maynard, 2014). Close to 400 Tribal leaders, elders, scholars, and students convened to share Indigenous perspectives and solutions. The Mystic Lake Declaration (2009) was written there and was intended as input into the 15th Conference of Parties of the United Nations Framework Convention on Climate Change. The declaration tied climate change adaptation issues to human rights, the sacredness of human relationships to the land, Indigenous knowledge traditions, and concerns about certain solutions to lowering carbon footprint, among other topics.

Over 20 people served on a technical team for Indigenous peoples' involvement in NCA3 (Melillo et al., 2014), which would lead to a Tribal chapter (Bennett et al., 2014). Technical input was provided, in part, through regional workshops that produced reports (Coastal Louisiana Tribes, 2012; Riley, 2011; Souza and Tanimoto, 2012). There were also Indigenous regional reports and media created outside of these workshops (Blanchard, 2013; Redsteer et al., 2013; Ojima et al., 2015). An author team was developed that synthesized the information provided by the technical team, resulting in the *NCA3 Chapter 12, Indigenous Peoples, Lands, and Resources* (Bennett et al., 2014).

The efforts leading to NCA3 coincided with increasing Indigenous leadership in climate change nationally, as well as federal funding and support for Indigenous climate initiatives. For example, the National Center for Atmospheric Research, managed by the University Corporation for Atmospheric Research (UCAR), began hosting the Rising Voices Center for Indigenous and Earth Sciences, which is jointly funded by the National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management. Rising Voices seeks to bridge diverse worldviews on climate change, with an emphasis on Indigenous knowledges. The Indigenous Peoples Climate Change Working Group continued to hold student-oriented events engaged with scientific and other climate change issues (Shepherd, 2016). A U.S. Forest Service technical report on climate change impacts on Indigenous peoples was published as an interim synthesis between NCA3 and NCA4 (Norton-Smith et al., 2016). The U.S. Geological Survey's Climate Science Centers (now Climate Adaptation Science Centers) established some Indigenous consortium and partners members, such as the Chickasaw and Choctaw nations and the College of Menominee Nation. The Bureau of Indian Affairs (BIA) initiated funding support specifically for Tribal climate resilience in 2011 and focused its support on Tribal adaptation planning, training, data development, and leadership engagement. The Department of Interior's Advisory Committee on Climate Change and Natural Resource Science included members representing Indigenous peoples and Indigenous issues. In 2014, the committee published a report with a primer, *Climate Change and Indigenous Peoples: A Primer*, and a guide, *Traditional Knowledge Guidelines* (Morishima, 2014; Climate and Traditional Knowledges Workgroup, 2014). By 2014, Congress appropriated $10 million and supported the BIA's Tribal Climate Resilience Program at that level until 2020, when it further increased its support. A special issue of the peer-reviewed journal *Climatic Change* focused on issues related to Indigenous peoples and climate change in the U.S. context, with over 50 authors contributing, the

majority of authors being Indigenous (Maldonado et al., 2013). In 2016, USGCRP produced a synthesis report on climate change and health (USGCRP, 2016). There is a subsection of Chapter 9 on Indigenous peoples. The subsection covers diverse health issues tied to food and nutrition, cultural and family integrity, traditional practices, and mental health. In 2016, NOAA established a 15-member Advisory Committee for the Sustained National Climate Assessment, which included two specialists in Indigenous climate change as part of the membership (National Oceanic and Atmospheric Administration, 2016).

NCA4 (USGCRP, 2018) was the first time there was a concerted effort to ensure Indigenous authors and sections were spread throughout the report on each of the regional chapters. The team of approximately 50 authors also conducted an assessment of Indigenous-related terms throughout the entire NCA4 draft to develop a set of consistent terms as a reference for all of the NCA4 authors. The *Tribes and Indigenous Peoples* chapter features an interactive map of Tribal climate change initiatives, primarily supported through federal funding sources, organized by the BIA, which at the time of publication had 800 initiatives (Bureau of Indian Affairs website, 2021; Jantarasami et al., 2018). Currently the map has well over 1,000 entries of Tribal resilience actions. Similar to NCA3, there was considerable effort to get input and engage Indigenous peoples and Tribal experts throughout the U.S. and its territories through regional workshops, engagement at major conferences, webinars, focus groups, mini-grants for community meetings, and publicizing of the opportunities for public review throughout Tribal distribution networks.

Over time, Indigenous peoples have engaged in diverse ways in NCA. In the case of certain aspects of NCA, Indigenous engagement has increased, such as through the continuation of a dedicated chapter to Indigenous climate change issues in each NCA. This has led to a wider array of credible sources of information being included in the program's reports. The special report on how to build a sustained assessment (Buizer et al., 2013:27) stated, "The NCA should ensure adequate support for Tribal engagement in future assessments and include Tribal engagement as a metric of success for ongoing efforts."

History of Indigenous Peoples in NCAs References

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Chapter 2: Worldviews, Knowledges, & Social Impacts

Worldviews, Knowledges, & Social Impacts
Key Messages

- Indigenous peoples have their own systems of governance that have norms of behavior for land use and land care.
- A growing dialogue among some Indigenous peoples articulates Indigenous knowledge systems through an understanding that all things are interconnected.
- Legacies left by colonialism in economic, social, environmental, and educational systems have altered lifeways, traditions, practices, customs, and values of Indigenous peoples, influencing their understanding of how climate change affects their daily lives and opportunities for adaptation.

Recommendation

Climate change policy and climate science fields should respect Indigenous self-determination in governance and knowledge exchange. Indigenous peoples should be consulted meaningfully from the earliest stages of policy and research development. Legal, policy, ethical, and cultural best practices and requirements should be followed to make consultation meaningful.

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Indigenous Worldviews, Sovereignty, and Climate Change

This section seeks to provide some of the general context on Indigenous peoples' worldviews and sovereignty and intends to be useful for contextualizing the issues, knowledge, experiences, and recommendations to which this report bears witness.

Indigenous peoples have their own social and cultural norms of behavior and action governing interactions between people and the land, water, air, plants, and animals that all share environments together. These norms include systems of governance regarding protection and transfer of knowledge that have been developed over countless generations and are commonly expressed through language, practices, ceremonies, traditions, educational programs, mentorship bonds, and kinship networks (e.g., clans, lodges) (see, for particular examples, Trosper, 2009; Menzies, 2006; Kimmerer, 2013). Today, Indigenous peoples also commonly employ methods adopted from other cultures to formalize and record their expectations for normative behavior and action by enacting written laws, policies, codes, regulations, rights, rules, resolutions, procedures, and protocols as self-determining sovereign

governments (see, for particular examples, Chief et al., 2016; Royster et al., 2002). As political sovereigns, Indigenous peoples engage in diplomatic relations with local, regional, state, national, and international governments through multilateral laws and policies, including treaties, statutes, and agreements that set forth rights, requirements, obligations, duties, and responsibilities.

There are, of course, many dimensions of Indigenous peoples' worldviews, and we recognize here the semantic inadequacies of the very term "worldviews." Although Indigenous peoples are diverse internally and across peoples in terms of their worldviews, religions, and practices, there is an overlapping dialogue among many Indigenous people about how Indigenous cultures, histories, social institutions, and knowledge systems provide critical context, knowledge, and practical wisdom regarding adaptation and mitigation in relation to anthropogenic climate change. The authors of this chapter seek to convey some key points regarding this overlapping dialogue and provide a snapshot of some of the relevant literature.

In the U.S., the "government-to-government relationship" is a term used to describe some Indigenous relations with the U.S. federal government and to set forth expectations of how Tribes must relate to other units of government (whether those expectations are satisfied in practice). Due to long histories of legal relationships evolving between federally recognized Tribes and the U.S., the exercise of Indigenous sovereignty is tethered to U.S. sovereignty, which is sometimes referenced by the term, "nations within a nation."

Indigenous peoples' diverse worldviews and systems of governance affect how they approach climate change adaptation and mitigation, informing how they address impacts on their cultures, economies, multilateral governance relationships, and stewardship responsibilities toward the environment and future generations. As contemporary political sovereigns, Indigenous peoples recognize that self-determination and intergovernmental relations are cornerstones of solutions for addressing global issues of climate change as well as opportunities for adaptation and mitigation. Yet, as nations within a nation, their sovereignty is both protected and limited, operating within the bounds of treaties, acts of Congress, executive orders, administrative agreements, and court decisions. For federally unrecognized Tribes, Native Hawaiians, and other Indigenous peoples, their externally acknowledged sovereignty is more limited than federally recognized Tribes.

Addressing climate change is connected with the issue of how people come to know climate change (Callison, 2014). Indigenous peoples have diverse cultures, histories, social institutions, and knowledge systems that are highly relevant to understanding environmental change, whether changes are seasonal, intermittent, or long-term. Ancient stories kept by Indigenous peoples tell of social and environmental disruptions and convey lessons learned from the observations, experiences, and responses of their ancestors (Therrell & Trotter, 2011). Many Indigenous families, communities, and governments practice or are guided by traditions of living that pay close attention to the dynamics of seasonal and climatic change (Child, 2012; Hatfield et al., 2018). The languages of Indigenous peoples often incorporate specific terms to reference or describe local places, events, or times of importance, such as timing of flowering, migrations, fruiting, wildlife movements, plant life cycles, or availability of water. Indigenous linguistic scholarship has demonstrated important relationships between how language connects to knowledge and a sense of responsibility for protecting the environment (see Noodin, 2017, and Oh et al., 2021, for example). Indigenous knowledge is often articulated through concepts and practices that express interconnections across spatial, physical, spiritual, cultural, political, and temporal dimensions.

Stories and lifeways frame and draw on time-tested knowledge systems. Indigenous peoples have depended on such knowledge systems for surviving and maintaining continuity in complex, uncertain environments to sustain food, medicine, and materials and develop methods to successfully negotiate shortages and crises. Such histories, memories, and experiences can motivate recognition of the need to honor the wisdom and decisions of ancestors and the profound responsibility to carefully consider the consequences of decisions and actions for future generations. Indigenous knowledge systems are sometimes articulated as place-based, yet they are far from static or limited in their geographic usage. Scholarship has covered how Tribes have used their knowledge systems to rebuild their societies after forcible relocation to territories hundreds and sometimes thousands of miles away from their homelands (see Carroll, 2015).

Indigenous peoples sometimes rely upon English language terms and expressions such as "cosmology" or "all our relations" to try to convey the importance of recognizing and respecting the interconnections on which their worldviews and knowledge systems are based. It is critical to understand that the worldviews of Indigenous peoples deeply tie the past to the present and the present to the future. Societal continuity of Indigenous peoples means that Indigenous persons seek to acknowledge explicitly that their decisions and actions of today are influenced by the experiences of their ancestors. Their past is colored by a long, painful history of social and economic disruption from broken treaties, land-theft, assimilative education, territorial trespass, cultural erasure, and the denial of their rights to self-determination (Hartmann & Gone, 2016).

Many U.S. laws, policies, and practices subsequent to the signing of treaties have led to the loss of access and inherent rights to the lands, water, and plant and animal species. This loss of access and inherent rights is a major factor creating challenges for Indigenous peoples to adapt to and mitigate climate change, to which some of the material in this report bears witness. As a matter of general context, the U.S. allotment policy of the 1880s, for example, dispossessed Indigenous peoples of 90 million acres of land. The effects of colonialism on economic, social, environmental, and educational systems have altered, disparaged, and disregarded lifeways, traditions, practices, customs, and values of Indigenous peoples, creating generational and intergenerational trauma (Walters et al., 2011). The long-lasting effects of such deeply rooted historical trauma may not be perceived outside of Tribal communities, but are leading concerns within these communities (Evans-Campbell, 2008).

Indigenous peoples have, at the same time, worked ingeniously to create legal and policy avenues to recover and protect their lands and self-government. Many such avenues are crucial to addressing climate change. The expansion of Tribal lands through bringing fee land into trust (a repudiation of the General Allotment Act) and legislation like the Indian Self-Determination and Education Assistance Act of 1975, as amended (25 U.S.C. 450 et seq.), and the Tribal Self-Governance Act of 1994 (25 U.S.C. 458aa et seq.) involves Tribes taking on programs and services the federal government had administered in the past. Court decisions have led to partial victories for Tribes, such as the Boldt Decision that affirmed treaty rights to the fishery in Washington state. State- and un-recognized Tribes, working without affirmation of their self-government, have strategically used incorporation as 501(c)(3) nonprofits as a way to build capacities to provide services for their members. They have used private conservation tools as well to protect their lands (see Middleton, 2011). Native Hawaiians have organized through institutions such as the Office of Hawaiian Affairs (OHA), a self-governing corporate body established in

the 1978 state constitution of Hawaii (OHA, 2021). Inter-Indigenous organizations, such as the Inter-Tribal Timber Council (ITC), have developed strategies for sustainable economies (ITC, 2013).

Ethics of Multicultural Knowledge Exchange

This section discusses one of the most prominent issues in Indigenous peoples' engagement with major climate science institutions: the exchange of knowledge about climate change. There are ethical issues that must be understood when people seek to braid diverse knowledge systems together. The Climate and Traditional Knowledges Workgroup developed a set of proposed guidelines for Indigenous peoples, scientists, and government professionals when working with Indigenous knowledge and content with strong cultural and economic values for Indigenous peoples. This section directly reflects some of the information from the guidelines, used with permission from the authors of the Workgroup.

Indigenous peoples do not generally view knowledge or science as simply information. Rather than a form of bare information, knowledge is deeply and inextricably linked to Indigenous origins, ancestors, lands, and traditions (Forbes, 2001; Greenwood & Lindsay, 2019). In some communities, knowledge often comes with obligations and restrictions for its use (Climate and Traditional Knowledges Workgroup, 2014). Indigenous knowledge systems are connected to Indigenous self-determination as peoples. Based on these reasons, there are ethical issues that can arise when non-Indigenous individuals and institutions seek to exchange information about worldviews and knowledge tied to climate change.

These guidelines created by the Workgroup are intended to cover, in particular, traditional knowledge in relation to climate change within the context of potential risks to Indigenous peoples in the U.S. for sharing traditional knowledge in federal and other non-Indigenous climate change initiatives. Traditional knowledge refers to some dimensions of larger Indigenous knowledge systems described in the previous section, but there are some challenges with delineating traditional knowledge by definition. Both the words "traditional" and "knowledge" carry much baggage in English and can inappropriately objectify, essentialize, or interject foreign understandings and assumptions. "Traditional" tends to characterize what is being referred to as "old" in time, passed in a material way "from generation to generation." While this is a common way that traditional knowledge is transmitted and characterized by Indigenous persons, Indigenous knowledge keepers may also receive knowledge through spiritual means, ceremonies, and direct communication with other-than-human beings, persons, and entities (ANSC, n.d.; Simpson, 2000). What makes such knowledge traditional is not its age in the Western time system, but its spiritual origins and relational validity—the way it fits into the First Instructions or ancestral teachings of the Tribes (Marsden, 2004).

The guidelines focus on two formative ethical principles: "Cause No Harm" and "Free, Prior, and Informed Consent." Broadly, these principles establish a foundation for equitable and meaningful relationships. "Consent" recognizes that each Tribal community has its own governance norms and expectations that guide and structure how different facets of traditional knowledge are treated by Indigenous and other entities, and more broadly regulates interactions. The "Cause No Harm" principle involves the identification and avoidance of risks that could lead to loss or harmful misappropriation of traditional knowledge (CTKW, 2014).

Traditional knowledge has been shared most successfully where Indigenous protocols are respected and followed. However, much work remains to ensure that there are appropriate legal, policy, and ethical protections wherever traditional knowledge is shared outside of Indigenous territories and governance

systems (Norgaard, 2014). Non-Indigenous persons must understand that sharing traditional knowledge may carry risks for Tribes, as there are many potential conflicts of worldviews and laws and few safeguards for their protection. Used in compliance with these protocols, traditional knowledge is often essential in providing solutions to climate change impacts (CTKW, 2016).

The account of traditional knowledge just offered here is generalized and does not express the beliefs of any particular Indigenous peoples. Each Indigenous peoples should be consulted for their views on what traditional knowledge means to them. The account in this section is meant to illustrate some of the fundamental challenges of working with traditional knowledge. Indigenous peoples and persons in practice live in multiple worlds, and the phrase "traditional knowledge" is used in multiple senses both within particular Indigenous peoples and when working with non-Indigenous persons, institutions, and agencies. Some ways that Indigenous peoples use and share their knowledge are more like a kind of practical information, and Indigenous knowledge holders often share the informational aspects of their knowledge while keeping the spiritual aspects to themselves (SAMHSA, 2009).

Case Study: The State of Wisconsin's Respectful Integration of Traditional Knowledges
The Wisconsin Governor set up the Governor's Task Force on Climate Change in 2019, including the Bad River Band of the Lake Superior Tribe of Chippewa Indians and staff members from the Great Lakes Indian Fish & Wildlife Commission (GLIFWC). The Task Force was open to working with Tribes and bringing in Indigenous knowledges they were willing to share in order to inform the science and generate policy recommendations for the state of Wisconsin. The GLIFWC spokesperson brought in traditional knowledges from Ojibwe rice chiefs who monitor and interpret the health of manoomin, or wild rice, that is a sacred and culturally important food. One observation from traditional knowledge, not generally appreciated by scientists, was that there had once been seven bodies of water in the Sokaogon Ojibwe reservation that had now merged into a single body of water due to increased runoff. The rice harvest has decreased dramatically, to 5% of prior levels. A rice chief with Sokaogon Ojibwe believes this is due to brown spot disease and rice worm infestations associated with higher runoff from extreme weather events and increased humidity associated with climate change (Vaisvilas, 2021). These observations brought the Task Force to recommend creating a permanent Manoomin (Wild Rice) Stewardship Council to work directly with rice chiefs from Tribes that voluntarily choose to work with the Council to provide traditional knowledge expertise to the state of Wisconsin. The state is establishing a permanent institution that will allow for the voluntary submission of information drawn from traditional knowledge that will provide a venue for manoomin rice chiefs to discuss their observations and assessments and make decisions about what to share with the state. The Council can hopefully provide a test bed and a way to spread the institutionalized use of traditional knowledges in a way that is controlled by the knowledge keepers.

Social Impacts on Indigenous Peoples from Climate Change
Climate change has multiple and interconnected impacts on Indigenous governance systems. Impacts-based language in risk and vulnerability assessments can take the form of victimhood where Tribes are viewed as passively and adversely affected by climate drivers beyond their control (Cameron, 2012; Haalboom & Natcher, 2012; Callison, 2014; Whyte, 2016, 2013). Indigenous peoples are active, self-determining societies, and they are working to heal and negotiate historical traumas, rebuilding their identities and strengthening resilience to climate change impacts. This section must be read with great care, given its coverage of the social layers that are connected to climate change.

Indigenous peoples have diverse histories. For many Indigenous peoples, the influence of historical traumas is a prominent dimension of their recent histories. It is necessary to understand these traumas in some depth to appreciate ongoing challenges to addressing climate change (Billiot et al., 2020). Historical trauma interacts with other often-linked social determinants of vulnerability such as low income, socio-economic status, lack of savings, lack of information, inadequate housing, chronic diseases, disabilities, minority status, and linguistic vulnerability (see review in the context of COVID-19, Hathaway, 2020). Further social vulnerabilities arise as a consequence of AI/AN resource- and place-based lifeways (Ford, 2012).

These impacts must be understood under different frameworks. Indigenous researchers have assessed Indigenous responses to climate change impacts through the following and other frameworks necessary to understand them from an Indigenous lens. These frameworks are not exclusive, and the authors who worked on this section emphasize that the categories are provisional.

- An *Indigenous decolonization framework* can focus on the capacity to respond within Indigenous concepts, methodologies, processes, understandings, assessment criteria, and indicators that are understood by them and compatible with their cultures (Armstrong, 1998; Simpson, 2017; Dhillon, 2018; Yazzie & Riesling Baldy, 2018).

- An *Indigenous agency framework* can emphasize the governance and decision-making dimension of Tribes as agents that actively shape their own destiny through full autonomy and self-determination (Abate & Kronk, 2013; Maldonado et al., 2013; Carroll, 2015; Chief et al., 2016; McNeeley, 2017; Donatuto et al., 2020).

- An *Indigenous survivance/continuance framework* can focus on the goals of responses that are more than targeted toward cultural survival or subsistence, as is sometimes presented. Indigenous responses to challenges are strongly based on their values, creativity, and ingenuity. It is not enough just to solve a problem, but to solve it in a way that is consistent with such values as ancestral teachings, moral responsibilities, relational accountability to community and the natural world, trust, reciprocity, and consent (Vizenor, 1999; Goeman, 2009; Wildcat, 2009; Ortiz, 2011; Maracle, 2015; Whyte, 2019). Because of their unique origins, place-based histories, collective identities, and deeply spiritual beliefs, climate solutions often involve negotiations within their Tribes and with more-than-human beings (GLIFWC, 2019).

Indigenous responses to climate change therefore attempt to solve the problem while ensuring that it moves the collective whole of Indigenous ways of being, knowing, and doing in ways that are active, engaged, resilient, and sustainable. They work to renew and continue the culture as a whole rather than focus narrowly on technical solutions implemented by experts. Their responses usually involve the whole-of-community and achieve this through their own worldviews (Maldonado et al., 2013; Whyte, 2017). The *Dibaginjigaadeg Anishinaabe Ezhitwaad—A Tribal Adaptation Menu* illustrates the use of these kinds of frameworks (GLIFWC, 2019). Anishinaabe peoples of the Great Lakes region assess adaptation opportunities through multiple perspectives. They assess climate responses using some common non-Tribal frameworks (e.g., reduce biological and anthropogenic stressors, promote landscape connectivity). They also assess impacts and responses in a cultural framework (e.g., actions to help more-than-human beings to adapt, maintain reciprocity and balance, and frame actions in the

context of cultural calendars). *A Tribal Adaptation Menu* exemplifies diverse dimensions of decolonization, agency, and survivance/continuance.

One reason why decolonization, agency, and survivance/continuance frameworks are critical is that Indigenous lifeways, wellness, and political sovereignty are vulnerable to climate change. Many traditional activities occur outdoors on the land. The elements of the natural world that they depend upon are affected by climate impacts (Houser et al., 2001; Maldonado et al., 2013; McNeeley, 2017; Jantarasami et al., 2018; Donatuto, 2020). Their ways of life are fundamentally relational—they do not just utilize the environment, they inhabit it and maintain spiritual and mutual relationships with multiple tangible and intangible beings that may also be affected by climate change and nonclimate stressors (Hatfield et al., 2018; Thomas et al., 2019).

Tribal vulnerability varies and is affected by interacting and complex historical, political, and social factors, such as differential access to resources, poverty, and different ways of accessing and transmitting knowledge (Thomas et al., 2019). The existing historical context of trauma, discrimination and neglect, and high connectedness to and dependence on the landscape and seasonal timing increases exposure among many interrelated facets of Tribal culture that can cause cascading impacts on multiple dimensions (Clarke et. al., 2018; Lawrence et al., 2020). Extreme climatic events such as floods or extreme heat events, in addition to impacts from longer-term climate changes, can harm health and make activities risky, dangerous, or impossible, e.g., outdoor work and traditional activities under extreme heat events, harvesting of driftwood during breakup of river ice, or hunting over thinning sea ice (Hansen et al., 2013; Jones et al., 2015; Sharma et al., 2020). These multiple and sometimes cascading impacts can interrupt the transmission of traditional knowledge and norms and lead to the loss of trust in traditional institutions and external partnerships and cooperation (Billiot et al., 2019; McKinley et al., 2019; Lyver et al., 2019; TPEHTT, 2019).

Impacts associated with climate change affect Indigenous peoples' infrastructure, energy systems, and businesses. Economic disparity is a major factor that increases the impact of climate change on wellbeing. Access to economic resources, resilient infrastructure, and diverse economic opportunities allows Indigenous peoples and their communities to be proactive in addressing their priority issues. A thriving economy offers flexibility and adds to the capacity for addressing challenges. It allows for Tribes to maintain and attend to their aging infrastructure. It allows them to relocate community resources that are threatened by flooding, sea-level rise, or coastal storm surges. It allows Tribes to hire staff to research the loss of habitat for subsistence species and to design and implement habitat restoration projects to improve access to culturally important fish and wildlife. Funding allows Indigenous peoples to develop forest management plans so that their forests are less prone to drought-induced disease, pest infestation, and subsequent wildfires. Thriving economies also allow Tribes to protect and care for the most vulnerable individuals and families in their communities and to monitor overall physical and mental wellbeing (NCAI, 2017; NCAI, 2019; ATNI, 2020).

In addition to reducing economic disparities, measures are needed to address the historical traumas that Indigenous peoples face and revitalize Tribal institutions, languages, and traditional knowledge systems. Activities that work to restore relations with the land, waters, and living world are necessary to restore balance in social systems (Maldonado, 2018; McGinnis et al., 2019; Donatuto et al., 2020). For Indigenous peoples, adaptation and mitigation measures must be holistic. They must be approached in an interconnected way that is aligned with the values and knowledge of the communities. Adaptation

and mitigation are not just about "solving" a single physical problem such as flooding or establishing solar power. Rather, they are about empowering the community to restore, revitalize, and strengthen their cultures, social wellbeing, and political sovereignty. For many Indigenous peoples, it is about achieving good relationships of interdependence with the diverse nonhumans that share the environment.

Figure 1. Word Cloud using words from the CRCCS

Figure 2. Word Cloud using words from the TAM.

Words and concepts matter, and they influence how climate issues are characterized, problematized, prioritized, and acted upon. The spiritual, place-based, and traditional words of Indigenous peoples are value-laden (Donatuto et al., 2020). One recent project compared the language of two reports, the Cultural Resources Climate Change Strategy (CRCCS), written by the National Parks Service in 2016, and the Tribal Adaptation Menu (TAM), written by Tribal and non-Tribal partners, that reflected Anishinaabeg worldviews and translated Ojibwe and Menominee words (Oh et al., 2021). Word clouds from the two documents revealed differences in worldviews and values in approaching cultural issues in adaptation. While there is overlap in the language of the documents (e.g., climate, cultural, change), there are important differences. The CRCCS emphasizes the standard nomenclature of natural and cultural resource management, while the TAM language emphasizes relationships through language focused on other-than-human beings, adaptation, and community. See Oh et al. (2021) for a more detailed discussion of findings. Graphic source: Oh et al., 2021. Figure numbers are from original source.

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Chapter 3: Actionable Science & Collaborative Climate Planning

Actionable Science & Collaborative Climate Planning

Key Messages

- Tribes are investing efforts in adaptation planning and projects to keep their communities, ecosystems, and people healthy. In doing so, they are implementing the most cutting-edge work on climate. Tribal nations are actively creating climate-vulnerability assessments, adaptation plans, and hazard-mitigation plans. Protecting traditional knowledges is an important part of these processes.
- Locally relevant and regionally specific information is needed to understand local climate impacts and develop solutions that incorporate local, traditional, and Western knowledge for holistic solutions.
- Actionable science co-produced in partnership with Indigenous peoples can support Tribal resource management decision-making.

Recommendation

Support Tribal sovereignty and self-determination through Tribally-led climate adaptation planning to allow Tribes to prepare for climate uncertainty and associated risks. Management decision-making should involve consultation with Tribes early and often, co-production of actionable science, and the incorporation of local knowledge.

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Introduction

The global rate of climate change is continuing at a rapid pace, and future climate projections demonstrate the increasing severity of climate impacts without immediate and intentional mitigation efforts (Xu et al., 2018). In general, these impacts will negatively affect human and nonhuman populations across the globe, some more than others. Indigenous peoples and their livelihoods, in particular, are affected by climate impacts (CCTHITA, 2019; Chisolm Hatfield et al., 2021; Jantarasami et al., 2018; St. Regis Mohawk Tribe, 2013; USRT, 2017). As a result, organizations and entities across the

U.S. are taking collective action to reduce greenhouse gas emissions in order to reduce these impacts (Steen-Adams et al., 2020). Still, the uncertainty in future greenhouse gas emissions is substantial. As such, different representative concentration pathways (RCPs) are used to model possible future emissions scenarios (Figure 1; adapted from Vose et al., 2017). RCPs capture the effects of different potential emissions levels and delineate the current and future impacts of climate risks on the economy and infrastructure, the natural environment and ecosystem services, and human health and wellbeing. Appropriate mitigation and adaptation strategies are needed to reduce these risks posed by climate change.

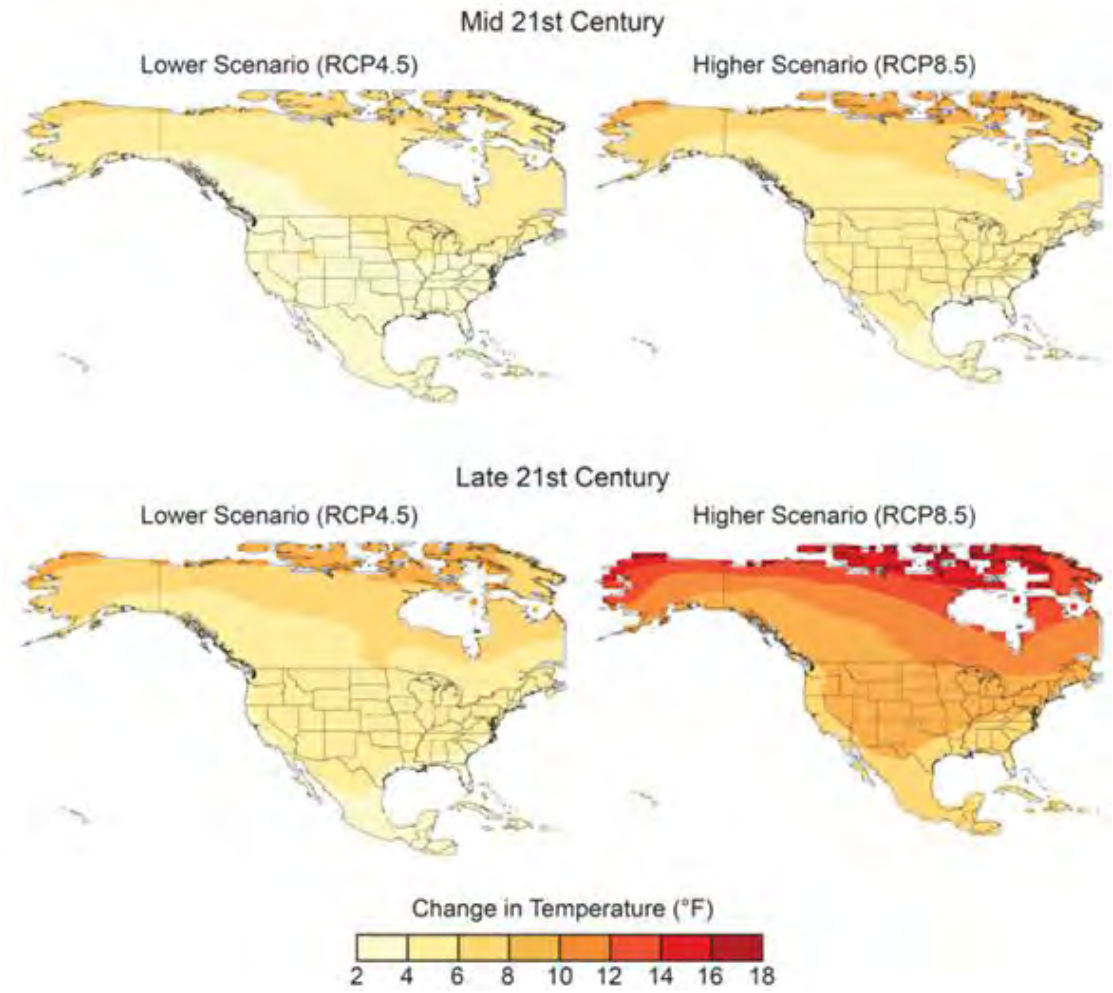


Figure 1. Annual average temperatures across North America are projected to increase over this century, with greater changes at higher latitudes and under higher CO_2 emissions scenarios (RCP8.5; right). This figure shows projected differences in annual average temperatures for mid-century (2036–2065; top) and end of century (2071–2100; bottom) relative to the near present (1976–2005) (Vose et al., 2017).

Mitigation strategies that involve market forces and technological changes have already successfully contributed to the decline of greenhouse gas emissions (Fahey et al., 2017). Meanwhile, adaptation strategies require a consistent reassessment of climate risks and can be conceptualized through the

following stages: awareness, assessment, planning, implementation, and monitoring and evaluation (Figure 2). Building climate resilience for the benefit of all, but especially Indigenous peoples and other marginalized communities, requires coordinated efforts between different entities and implementation of various mitigation and adaptation strategies. These efforts have started to be implemented using a combination of strategies.

Figure 2. Successful adaptation requires a continuing risk-management process. With this general approach, individuals and organizations become aware of and assess risks and vulnerabilities from climate and other drivers of change, plan, take actions to reduce those risks, and learn over time. The gray arcs indicate the status of implementing this process with the status reported by the Third National Climate Assessment in 2014; darker color indicates more activity (Lempert, 2018). In 2021, there are more Tribal projects that have been implemented and some projects that are starting to be monitored and evaluated.

Actionable Science Based upon Regional and Locally Derived Information

The impacts of climate change that have long been predicted are being observed on local, regional, and global scales. While global climate models provide a valuable starting point for addressing these impacts broadly, downscaling these models to individual regions is important for making the data accessible, useful, and actionable. It is even more important to couple that information with local and traditional knowledge (see sidebar titled *Protecting Traditional Knowledges in Locally Derived Studies*) so that the information can be considered in a local context. Observations and knowledge of place are key to understanding short- and long-term impacts and to supporting decision-making in the face of uncertainty. The cultural, social, economic, historic, and geographic context of each region's Tribal

communities is as unique and intricate as the natural ecosystems themselves. Impacts felt in one community or system might differ from the next, and knowledge provided by downscaled models coupled with a knowledge of the land over time provides a pathway for resilience and transformation into the future. Native American Tribal communities have always adapted, while remaining steadfast stewards of the land with a deep knowledge of place.

Protecting Traditional Knowledges in Locally Derived Studies

It is important that the traditional knowledges of Indigenous peoples be protected, as recognized in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP; UN General Assembly, 2007; Steen-Adams et al., 2020). There are protocols that have been developed to provide guidelines and considerations (Sloan & Hostler, 2014; CTKW, 2014) for collaborative research projects. This is particularly important when using federal funding from the U.S. government, which can sometimes require that any data gathered for a project be shared and made publicly available upon conclusion of the project.

Within the Western science paradigm for climate adaptation planning, there is a strong desire for more fine-scaled/local downscaling as an approach for creating solutions and taking actions. As data are refined to finer scales, we run the risk that errors will be magnified and may give potential users the impression that they are "correct" because the finer scale data more closely resemble the scale of information observed on the ground. However, the observational vs. modeled data could differ greatly. Multiple downscaled scenarios can be useful in that they can provide a range of possibilities but can be stronger if based upon local knowledge and regionally specific data. This type of modeling is important for allowing Tribes to be adaptable and strive for management practices that are resilient across multiple scenarios.

To that end, bringing together finer scale climate information, local data, and traditional knowledge can help provide a better understanding of possible scenarios of local impacts, providing opportunities to focus on solutions that are specific to location. This is especially important for climate adaptation and mitigation planning, because it can bridge the gap between global and local effects (Cooney, 2012), while allowing for opportunities to incorporate real-time and local knowledge and data. Pairing downscaled climate models with regionally specific information and the observations from those closely tied to place opens pathways for targeted regional or local solutions that are informed by local input. Coupling climate models and information with local inputs helps to make data accessible, useful, and relevant, while also providing an opportunity to Indigenize a process that has been long dominated by Western science, making space for Tribal and Western science to be equally valued and brought together to produce actionable science, when appropriate. For an illustration of this approach that builds on the application of downscaled models, please refer to the narrative below titled *Bringing Together Climate Data and Local Knowledge to Regional Downscaled Data to Advance Tribal Adaptation Planning.*

Actionable science in partnership with Indigenous peoples involves collaboratively using data (including traditional knowledges and Western approaches to information gathering), analyses, projections, or tools with the intention or goal of supporting decision-making in resource management that Tribes can use (Vogel et al., 2016). As a result, actionable science can be perceived as more holistic than current

goal-oriented management approaches. There is not a single manner for developing actionable science, but Tribes should be consulted early and often when these types of efforts are being considered.

Climate Change Planning

Adaptation planning is one type of actionable science that is improved through the use of locally relevant information derived from traditional knowledge. There are opportunities to transform how adaptation planning is approached and incorporated into existing Tribal planning efforts and documents. Certain environmental areas, such as "natural resources" and "wildlife" that are often represented in Tribal agencies and programs, have opportunities to incorporate adaptation planning into their existing work. In doing so, they can start to address challenges shared across Tribal programs to minimize impacts to Tribal resources and respect existing capacities. In this manner, adaptation planning can be included in departmental planning processes across a Tribal government. Given current and future projected climate impacts, adaptation planning is often considered to be an active and ongoing process that will need to occur simultaneously with implementation (Nelson & Andrew, 2020).

Tribal nations are among the most active entities in creating climate vulnerability assessments (VAs) and adaptation plans (APs) (see databases created by Institute for Tribal Environmental Professionals[5] (ITEP), the University of Oregon's Tribal Climate Change Project[6] (TCCP), and the Climate Adaptation Knowledge Exchange (CAKE) Network[7]). A number of Tribes are also considering climate change as they develop hazard mitigation plans (HMPs), while others have been included in state- or county-wide HMPs. Availability of this information for knowledge exchange and resource management is important for allowing Tribes to build from the knowledge, expertise, and experiences of other Tribal nations. The above-mentioned catalogs of Tribal VAs and APs are incomplete, as not all Tribes make their plans available to the public. There is not a single repository for HMPs; however, the Federal Emergency Management Agency (FEMA) keeps records of which entities have finished FEMA-approved HMPs and which have been funded to do so.

In regard to the VAs and APs, Tribal nations have taken a wide range of approaches to develop these types of documents. Some make extensive use of habitat-suitability models, climate-modeling outputs, geographic information systems, remote sensing, and other technical Western science-based quantitative data to develop various vulnerability scenarios (USRT, 2017; CCTHITA, 2019; St. Regis Mohawk Tribe, 2013). Other Tribal efforts incorporate traditional knowledges, input from traditional knowledge keepers, perspectives from local subject-matter experts, feedback from their most valued subsistence hunters and gatherers, community meetings, youth involvement, and other types of locally derived, place-based data to inform their VAs and APs.

[5] Institute for Tribal Environmental Professionals: http://www7.nau.edu/itep/main/tcc/Mindmap/TribalAdaptationPlans
[6] University of Oregon's Tribal Climate Change Project: https://tribalclimate.uoregon.edu/
[7] Climate Adaptation Knowledge Exchange (CAKE) Network: https://www.cakex.org/resources/type/document

HMPs are often based upon templates created by FEMA and tend to result in a similar format (CTUIR, 2016; Lac du Flambeau Tribe, 2019; Penobscot County, 2016). This approach is useful in some ways: templates can help Tribes overcome limited capacity by providing the foundational legwork of the planning process so that Tribal staff can actually perform the HMP, VA, or AP analyses. The templates help them frame their analyses at a high level, rather than focusing on the minutiae of how to initiate the effort. HMP templates are also useful for allowing users that are familiar with the document structure to quickly identify the information that they are seeking. The potential downside is that documents created with templates could be considered to be a colonial construct that lacks the holistic approaches that are commonly encountered in Tribal planning efforts, such as vulnerability assessments and adaptation planning.

Overcoming Limited Capacity through Partnership

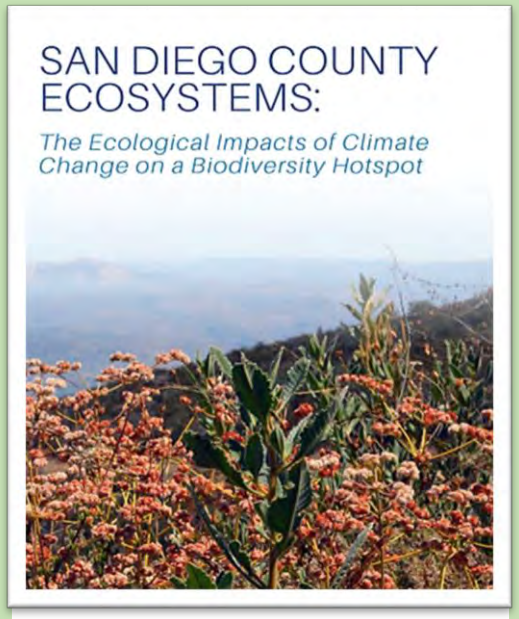
Tribes are often understaffed and overworked, with a limited amount of time and resources to focus solely on climate change. Partnerships that value different ways of knowing provide a robust pathway for remaining resilient in the face of ongoing challenges, managing in the face of uncertainty, and bringing knowledge and wisdom acquired through generations of practices and beliefs (Jantarasami et al., 2018; National Congress of American Indians, 2019). Integrating climate change into already ongoing planning and implementation efforts can be more efficient, less time-consuming, and more cost-effective and lead to actions that are more sustainable in the long term. Examples of plans in which climate change can be considered include FEMA Tribal HMPs and EPA Tribal environmental, community comprehensive, and land/resource management plans (Dalton et al., 2018; Pletnikoff et al., 2017). The BIA also produces a variety of plans that could include climate change considerations. Such plans include forest management, wildland fire management, irrigation projects, fish and wildlife, agricultural resources, and integrated resource management plans (IRMPs). There is also the opportunity to utilize BIA IRMPs, a comprehensive management planning program for Tribes that incorporates multiple aspects of planning with various federal agencies. This planning process allows Tribes to create a single cross-cutting plan that relates to many Tribal departments and federal agencies instead of working on a separate plan for each issue. Climate change considerations could be included within the IRMP. The inclusion of climate change and utilizing partnerships into any and all of these planning efforts help Tribes to advance their planning needs.

It can be challenging for Tribes to find the capacity to perform climate planning with existing staff and resources, but there are opportunities and resources available to assist. Collaborations and partnerships with outside entities can lead to the co-production of relevant and important information. Strong relationships and trust are necessary to form the basis for relationships between Tribal nations, governments, staff, or intertribal organizations and other existing networks. Some of those Tribally focused networks and boundary organizations include intertribal consortia, ITEP, the Tribal Climate Change Network (University of Oregon), and the regional DOI Climate Adaptation Science Centers, among others. However, in developing actionable science projects, it should be recognized that the objectives for different partners may vary. Publication in a high-caliber research journal may not be a high priority for Tribal nations, whereas habitat suitability projections and resource management plans under a warming climate could be important to the management actions of a Tribe. Partnerships should

be established in advance of potential projects so that each organization can come to the table and have significant input on defining the project objective(s) and pertinent project details. In many cases, non-Tribal groups are interested in collaborating or partnering with Tribes. It is important that these groups solicit partnership from Tribes as early in the process as possible. Best practices include establishing these collaborations before acquisition of funding or developing a project proposal. For additional guidelines for working in collaboration and partnership with Tribal nations, see the guidance developed by the USFS (Steen-Adams et al., in press).

Conclusions

It is important that Tribal nations can support their priorities in ways that honor their sovereignty and rights to self-determination. Tribally-led climate planning that is informed by locally relevant data (including downscaled modeling data and traditional knowledge) allows Tribes to better prepare for uncertainty imposed by climate factors and their associated risks. Collaborative partnerships can be a tool for Tribes to overcome issues of capacity, but also to provide technical expertise, if needed. Those partnerships can also help to relate local knowledge to climate data to better inform actionable science and management resource decisions.



The Summary Magazine of "San Diego County Ecosystems: Ecological Impacts of Climate Change on a Biodiversity Hotspot" for use by natural resource practitioners and managers.

Bringing Together Climate Data and Local Knowledge to Regional Downscaled Data to Advance Tribal Adaptation Planning

Climate change is a global phenomenon whose impacts are felt locally. As such, in order to advance adaptation actions, it is essential to take an inherently local approach. Advancing regionally specific downscaled modeling is critical for providing the detailed information necessary for climate change adaptation planning and implementation but is more effective when coupled with local and traditional knowledge. In 2018, the Climate Science Alliance (CSA) convened a distinguished, bi-national team of ecologists, climatologists, and Tribal leads to formulate a scientific assessment entitled, *San Diego County Ecosystems: The Ecological Impacts of Climate Change on a Biodiversity Hotspot* (Jennings et al., 2018). This assessment was the first of its kind to provide regionally specific climate hazard information for natural communities in the south coast of southern California. This document was published as a technical report for the State of California's *Fourth Climate Change Assessment* (Jennings et al., 2018); however, from the onset of this endeavor, all participants made an intentional effort to consider how the results of this technical report would play out across different jurisdictional boundaries and audiences that included natural resource management, decision-makers, the public, and youth. The results of the assessment were synthesized into specific resources that were created for Tribal and non-Tribal audiences:

- A summary magazine was created for natural resource practitioners and managers
- A summit was held for assessment authors to interact and discuss findings with decision-makers and planners
- Data from the assessment was integrated into a hands-on 6–12th grade science education curriculum for youth
- A public campaign was created titled, "San Diego Wildlife, Climate Change, and You!" with a web page and pocket guide targeted specifically for the public to learn more about the findings of the assessment and the 10 things they could do to help

This approach integrated regionally downscaled modeling with regional data on local species and ecosystems coupled with local knowledge to inform and identify impacts, strategies, and opportunities for advancing climate adaptation actions across boundaries and within communities. In addition, this approach is being replicated by the CSA to support planning efforts for Tribal nations within San Diego County such as the La Jolla Band of Luiseño Indians Climate Adaptation Plan (2019) and the Manzanita Band of Kumeyaay Indians Tribal Resilience Strategy (2020). The CSA is bringing together Tribal and non-Tribal experts in a process that equally values all ways of knowing in the creation of strategies and solutions. These plans are living documents for the Tribes that provide strategies and actions the Tribes have created by building off the information co-created with Western researchers and managers. These efforts take a holistic approach and integrate a variety of sectors, including natural resources, infrastructure and economy, health and wellness, and community and culture, that can evolve through successive updates, be expanded as needed, and serve different purposes over time as deemed appropriate by their respective Tribes. This flexibility and ability to adapt to a range of future scenarios provides space to be resilient in the face of uncertainty.

"San Diego Wildlife, Climate Change, and You!" Pocket Guides were distributed to local libraries targeted specifically for the public to learn more about the findings of the regional assessment and the 10 things they could do to help.

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SECTION 2: IMPACTS & SOLUTIONS BY TOPIC

Chapter 4: Ecosystems & Biodiversity

The narratives in this chapter illustrate the way Tribes live and protect their ecosystems and biodiversity through self-determination as practitioners of biodiversity conservation and ecological protection. The Fond du Lac Band of Lake Superior Chippewa in Minnesota has taken an integrated ecosystem management approach by incorporating Indigenous Knowledge to protect their black ash trees, forests, wild rice lakes, and groundwater. In the video narrative that is linked and transcribed, the Yurok Tribe in California speaks to using their traditional knowledge to develop a Comprehensive Burn Plan to develop a healthier landscape for their communities and wildlife. Then, in the next video narrative that is linked and transcribed, a member of the Colville Confederated Tribes of Washington State gives a description of how the forests on his reservation are dying due to climate change impacts. Lastly, the Tribal Environmental Action for Monarchs and Tribal Alliance for Pollinators describe their partnerships that serve the central U.S. Tribes that restored their Tribal lands to save the threatened monarch butterfly. A researched overview of Ecosystems & Biodiversity as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Climate Change and Invasive Species on the Fond du Lac Band's Lands

Written by: Christian Nelson from the Fond du Lac Band of Lake Superior Chippewa

The Fond du Lac Band of Lake Superior Chippewa's community members have a close relationship with baapaagimaak (literal translation "snowshoe making tree"), also known as black ash. It is used for many ceremonial purposes, and baapaagimaak's unique biology lends itself to

making snowshoes and woven baskets. Many plant foods and medicines can be gathered from baapaagimaak stands. There are also unique macroinvertebrate assemblages and other animals that rely on these ecosystems and contribute to their functions. Many of Fond du Lac's baapaagimaak stands occur within the watershed that feeds and drains the manoomin (wild rice) lakes. With manoomin being a crucial component of Anishinaabe culture and subsistence lifestyle, it is imperative to consider the hydrological effects of baapaagimaak loss on the entire watershed. Fond du Lac has taken an integrated ecosystem management approach as well as incorporated Indigenous knowledge into planning for the loss of baapaagimaak in these unique ecosystems. It is crucial to look at more than the monetary value of baapaagimaak itself when planning for the effects of the inevitable infestation of emerald ash borer (EAB), which is currently decimating ash trees just 15 miles away in and around the Duluth, Minnesota, area.

Fond du Lac's forests have over two square miles of baapaagimaak stands. The rapid loss of ash transpiration—where ash trees uptake ground water and release the water through their leaves—may alter water tables and surface runoff, potentially stressing a watershed already greatly affected by the judicial ditching that occurred in the early 1900s. Judicial ditching is the excavation of new water channels, or straightening and deepening of existing channels, that was done across northern Minnesota to drain wetland areas, including forested wetlands, in an attempt to make more land available for farming. This channelization has made wild rice lakes prone to rapid water level fluctuations following spring snow melt or summer rainstorms as water, cut off from natural flood plains and wetlands, rapidly drains from the landscape and is channeled into lakes. Manoomin is very sensitive to water level fluctuations, and EAB will likely exacerbate this problem by killing ash trees that naturally lower water tables and therefore reduce and slow surface runoff. Hard-to-access locations and small stand sizes present a logistical and practical barrier for any possible large-scale preemptive or post-EAB infestation treatments.

Fond du Lac's Forestry and Wetlands Programs have collaborated on a research project since 2015 to assess the viability of planting non-ash trees in baapaagimaak stands with the goal of ultimately maintaining the hydrology of these systems in the event of EAB-induced mortality (i.e., keeping forested wetlands forested). The early and ongoing results of this project and similar projects in the area are helping guide current and future tree-planting projects. Other management strategies include methods to slow the spread of emerald ash borer, preserve ecosystem function and conditions, and preserve baapaagimaak for cultural use. Fond du Lac supports existing state regulations of ash and other hardwood movement and storage. Monitoring efforts are also carried out by our Invasive Species Program in collaboration with the USDA's APHIS division. With no effective remedy for EAB, prevention and adaptation are essential to maintaining the health of these forested wetlands and the ecosystems and watersheds they impact.

Power to the People: Fire as Land Management[8]

Written by: Elizabeth Azuz from the Yurok Tribe, Cultural Fire Management Council

Transcript:

Speaker 1 (00:04):
All the Natives burnt their lands back in the day. When our burns started to get taken away from us, it was way before I was born.

Speaker 2 (00:15):
About a hundred years ago, they made a law that outlawed burns.

Speaker 1 (00:22):
When they told us, if we catch you out there lighting fires, we're going to put you in the penitentiary. And so it kind of scared us a little bit.

Speaker 2 (00:32):
It's resulted in just massive brush, thick impenetrable brush. If a wildfire ever comes, we won't have any defense against it.

Speaker 1 (00:46):
Everything is just getting choked off and our wildlife ain't got nowhere to go. I always felt the land kind of crying out, you know, help me. I'm...I'm suffocating.

Speaker 3 (00:59):
Fire helped us to keep our land, to keep it clean and healthy. Therefore, people can be healthy. It's time for us to make a change, create that connection, the bond with the land.

Speaker 2 (01:18):
Our local organizer went around and talked to hundreds of people in the community. And the people said, we need to put fire back on the land.

Speaker 4 (01:29):
A project of this magnitude requires the coordination working with private land owners and other Indian people in the Yurok Tribal government and of a lot of federal and state agencies that are all part of managing the land and landscape here. I told my mom what we were doing in this project. And she said, son, I think this is the hardest thing you've ever tried to do. She said, we as Indian people, we don't even like to talk to each other. Now you want us to talk to other people? So I said, yes, mom, I do want us to talk to other people because I think that's how we get stronger.

Council Meeting Speaker 1 (02:02):
I'm so happy to see so many people here tonight from up and down the river, people from Hoopa, people from Weitchpec, people from Morek Won, people from down, all the way down to Pecwan.

[8] Power to the People: Fire as Land Management. https://www.youtube.com/watch?v=q9c1KBgzU00&feature=youtu.be

Council Meeting Speaker 2 (02:15):
Over the last nine months we've had conversations with almost 100 people, from Johnsons to Weitchpec, and through this work, many concerns have been surfaced.

Council Meeting Speaker 3 (02:24):
Our main issue with burning is pretty much its liability. It's who's responsible if, if our fires get away.

Speaker 2 (02:30):
Educating the community is really important because fear of fire has been ingrained in us for a hundred years. And so people need to understand that it can be done in a controlled, safe manner.

Council Meeting Speaker 4 (02:47):
I hope we will unify as a community to use fire to fight fire in the way our local Indigenous cultures did since time immemorial.

Council Meeting Speaker 5 (02:55):
Sovereignty has been one of the things that I've preached for many years. If you don't use it, you lose it. We're not firebugs, it's our history. It's our past. It's how we've lived. Okay. Thanks. (Applause)

Council Meeting Speaker 6 (03:12):
We're asking that the Yurok Tribal Council exercise its authority as the governing body of a federally recognized sovereign nation to support the creation and implementation of a comprehensive community burn plan.

Council Meeting Speaker 7 (03:24):
Does the Yurok Tribe support the work of and will they partner with the Klamath River local organizing committee on building a comprehensive community burn plan?

Council Meeting Speaker 8 (03:35):
Yes, so says the Council. (Applause)

Speaker 2 (03:49):
We had to get a permit from Cal Fire. They came up and they helped us with our first burn that we did. They brought a couple of fire engines and then they brought a 20-man crew from Alder Camp. And then also the Yurok Wildland Fire, they helped put the fire on the ground and we burned seven acres our first time.

Speaker 5 (04:11):
We're so blessed right now, today is just awesome.

Speaker 2 (04:13):
They're professionals, they're professionals. They know what they're doing and they're training our people.

Speaker 6 (04:21):
Just a perfect burn. Two units split up, both sides of the river, on fire, prescribed burn. It's the thing. People from all walks of life, from all over the world, coming together, like minds, like spirits, it's flawless, it's flawless.

Speaker 1 (04:43):
All this stuff ties to our, our food security. In my heart that's what I'm pushing for is for our people to be able to stand on their own two feet and have their food security.

Speaker 2 (04:59):
So our goal is to, to take care of our whole ancestral territory. We need to have big burns. We need landscape burns. As Native people, our whole identity is connected to the land. It gives us hope that we can be healthy again.

Speaker 1 (05:22):
Our creator, you know, he gave us this land to take care of. Dominion is a responsibility to act in the best interest of the land so that the land will always provide for all people. Together we...we will restore it.

Observed Evidence of Changing Forests: A Testimonial[9]

Written by: Darren McCrea from the Colville Tribes

Transcript:
Darren McCrea (00:00):
My name's Darren McCrea. I'm a member of the Colville Confederated Tribes. You're gonna see me do a little shaking, you'll hear a tremor in my voice. I have Lewy body dementia. When I was 15 years old, I was in a Native youth program and I job shadowed a guy on the Spokane Rez named Neil Abrahamson. He taught me how to set up logging units. I also planted trees and did some tree thinning for the Spokane Tribe. A little later on I bumped knots and cut logs for another company. I worked at a post and pole plant on the Colville Indian Reservation in Inchelium. And I worked at a little plywood mill, a little south of the Canadian border here in Washington state in a town called Kettle Falls. The day before I presented at the Affiliated Tribes of Northwest Indians Conference on Global Warming at the Northern Quest Casino, I noticed the insects disappeared from around all the lights and are still not here.

Darren McCrea (01:11):
There is an article in the May 2020 issue of *National Geographic* that says we've lost 70% of our insects from 1990 to 2016. *The Spokesman Review* put me on the front page of their paper about them. Let's see. This is, would be back at the beginning of September and August, talking about the disappearance, of the insects. But what I presented at the ATNI conference was that I noticed all the trees dying. I discovered five signs that's wrong with the pine needles. The first one is they're supposed to be forest grey-green. They're a long ways from forest green. They're a dull green. And the reason they're so dull is because the cuticle has disappeared. That's the waxy substance that you find on leaves and needles that hold in moisture reflects the sunlight. Pine needles are supposed to come on in different parts of the branch.

[9] Observed Evidence of Changing Forests: A Testimonial. https://youtu.be/BOobI8-Sehw

Not anymore. Now they come on in a circumference around the end of the branch, like a chimney brush was what came to mind when I first noticed this in 2014. Last two signs I want to share: I can go out and I can take a pine needle. I can take say eight of them. I can put them into a bunch and I can start pulling those pine needles apart in, say, quarter-inch pieces from one end to the other. I can go and I can rake up a pile of needles with my hands. And it doesn't take a very big area because of the amount of pine needles. I can take that pile of pine needles, put it between my hands and scrunch it and turn it to powder. Either that, or I can bunch up a bunch of them and, and pull them apart.

Darren McCrea (03:35):
So what's wrong with those last two examples? Indian Country has been weaving with pine needles forever. One needle at a time. If I can pull eight apart, a person wouldn't be able to weave with just one. You can go out and you could feel a leaf, say a maple leaf, and you can feel how much thinner they have become. Pine branches are supposed to go straight out and lean down. Not anymore. All the branches are trying to become a leaders, reaching for the light. The trees are dying so fast they don't have time to shed their branches. They're dying from the ground up. The trees are dry and brittle, but they look like they're flourishing.

Darren McCrea (04:38):
It doesn't matter what species; I will be showing you examples of me breaking saplings, but you should almost be able to tie them in a knot. Pre-industrial revolution CO_2 sat at 280 parts per million. Today, it sits at 417. That's an increase of about 50%. The elevated levels of CO_2 are forcing our vegetation to grow at an accelerated rate. Everything has a tipping point. They're being forced to grow in an accelerated rate and they don't have enough nutrients and water to sustain themselves using that type of energy to grow that way. So thanks for listening to what I got to say. This is what I'm talking about. These trees are dying so fast. They don't have time to shed their bottom branches, but you can still, you can see that they're still flourishing and you can see the tops of those where every one of those branches are reaching for the sun. Again, you can see how many of these branches are dead. So with that, we're going to see a lot of dead pine needles. And this right here is what I'm talking about. Look, look at the mat of needles, how thick this is. Now this is just a little tiny area right here.

Darren McCrea (06:33):
And if you would, come over, take a look at this as well here while I'm ripping, while I'm pulling these pine needles away from this, take a look at these seedlings. We are, we are, where are we at guys? What's the date today? I guess 2nd of October isn't it, 2020. Pine seeds will germinate during the winter and they'll come up in the spring when the ground is soft and they're able to establish a root system. Look at these and you can see there's two years right there. You can see the year before. And then this is the next year. Notice that there's just a taproot there, there aren’t any roots going off to the side. It shows two years of growth. Indian Country wouldn't have made mats and bowls out of these needles if they're going to be this brittle. These trees are growing at an accelerated rate. These trees are dry and brittle, but they look like they're flourishing. It doesn't matter what species: a maple tree or a pine tree, hardwood, softwood, deciduous trees, conifers. Best to you guys.

Left picture: Two years of growth. Note there are no lateral roots, the needles are losing their tint, and they seem to be stunted. Second picture from left: Four seedlings harvested in 2019; note there are no lateral roots. Third picture from left: Three seedlings harvested in 2020. Right picture: three years of growth, with a lighter for size comparison.

Tribal Environmental Action for Monarchs and the Tribal Alliance for Pollinators

Written by: Jane Breckinridge from the Muscogee Nation and Collin Spriggs from the Cherokee Nation – Tribal Alliance for Pollinators

Tribal Environmental Action for Monarchs (TEAM) was launched in 2015 as a partnership between the University of Kansas Monarch Watch, the Euchee Butterfly Farm, and seven Tribal nations in Oklahoma: Chickasaw Nation, Seminole Nation, Citizen Potawatomi Nation, Muscogee (Creek) Nation, Osage Nation, Miami Nation, and Eastern Shawnee Tribe of Oklahoma. TEAM united the seven Tribes to help save the threatened monarch butterfly by training Tribal staff in all aspects of habitat restoration and native plant production. To date, TEAM has restored over 60,000 milkweeds and 50,000 native wildflowers to Tribal lands in Oklahoma.

The TEAM project has been so successful that it spawned a new organization, the Tribal Alliance for Pollinators (TAP), in 2017 to keep up with the demand. TAP is a new Native-led nonprofit organization that unites traditional ecological knowledge with cutting-edge technical resources to create an innovative model for conservation and restoration of Tribal lands. TAP provides training and technical support for Tribes throughout North America that want to conserve and restore grassland ecosystems to help threatened pollinators and to preserve the native plants that serve as the foundation for Indigenous cultural, medicinal, and culinary traditions. TAP also has a regional seed bank of native plants that is available for Tribes to use at no cost. TAP is the only Native American group in the country working on monarch and pollinator habitat restoration. It is leveraging the infrastructure and best

Rhonda Sellers, Ecological Resource Coordinator for the Chickasaw Nation Cultural Center, demonstrates how to stratify native plant seeds to Ryan Herrod of the Wetumka Indian Community during a TAP training workshop.

management practices created by the TEAM project to create a conservation model that is transferable across Tribal communities in different geographic areas.

A hallmark of this project has been its ability to engage with, support, and connect entities not typically included in other monarch conservation outreach programming. These entities include Tribal nations, but also include other groups that are not directly a part of Tribal governmental structures, such as Native American cultural, environmental, and agricultural groups. Past examples of direct technology transfer to these cohorts have included native plant horticultural training to the Yuchi Language Project, interactive education/conservation outreach tables at multiple powwows, pollinator plant seed cleaning demonstrations for Seminole Nation Winery grape farmers, and TAP recruitment at the Native Corn/Honoring America's First Farmers conference in Nebraska. Without TAP, communities such as these would not have access to conservation information produced by Native people and tailored for their needs or, most likely, any monarch conservation outreach at all.

Yuchi Language Project students transplanting milkweed as a hands-on training exercise to boost their language skills.

Historically, intertribal collaborations on habitat restoration efforts have been virtually nonexistent. The TEAM project was groundbreaking in establishing a new precedent of cooperation and assistance, and TAP is building on and expanding those relationships. Participating Tribes have consistently volunteered to provide technical support and share resources with each other, and close relationships have developed. New Tribes have been warmly welcomed into the coalition and generously supported in every way. These collaborations are unique and have the potential to have a profound impact on future Tribal monarch conservation.

No other nongovernmental or community organization currently exists to provide support or technical resources for monarch/pollinator habitat restoration on Tribal land. Tribal nations are unique communities that need specialized outreach and education efforts, and for historical and cultural reasons these efforts are unlikely to succeed unless designed by and for Native people. The potential resources that the Tribes can bring to habitat restoration efforts are enormous. In Oklahoma, over one million acres are currently under Tribal jurisdiction, and the Tribes are aggressively purchasing property to increase their land base. Native people have cultural values which revere nature, making them ideal candidates for conservation programs. In every possible way, this is a demographic that should be viewed as an important potential partner in the fight to save the monarch butterfly migration, which has cascading benefits to ecosystems that are being impacted by climate change.

TAP also provides a nexus for state, national, and international groups to exchange monarch conservation ideas and information with Tribal entities. Organizations that have enlisted our assistance in connecting with Native monarch conservation efforts include CEC, NatureServe, and the Oklahoma Monarch and Pollinator Coalition.

Blane Stacy of the Oklahoma Conservation Commission leads a field training session on controlling non-native invasive species at a TAP workshop on habitat restoration.

Partnerships with Tribal colleges create additional avenues for transferability and long-term impact through the creation of educational programming that will continue to be used as curricula beyond the duration of the grant project funding. We have seen firsthand that when students at Tribal colleges, many of whom are adult scholars, participate in monarch conservation through TAP, they take that knowledge back to their home communities in other parts of the state, empowering them to become community educators and policy influencers. TAP currently has a multidepartmental partnership with the College of the Muscogee Nation in Oklahoma and has received partnership requests from the Fond du Lac Tribal and Community College in Minnesota and the Pawnee Nation Tribal College in Oklahoma. We are actively seeking to develop these programs further as we receive additional funding.

TAP also partners with Langston University, Oklahoma's only Historically Black University, in their agricultural outreach to rural Oklahomans about the importance of supporting pollinators. These efforts include all rural Oklahomans, with an emphasis on educating African American and Native American youth using butterflies as a hands-on science engagement tool to promote conservation of monarchs and pollinators.

Tribal partners and participants for TAP currently include the following nations: Chickasaw, Seminole, Citizen Potawatomi, Muscogee Creek, Osage, Miami, Eastern Shawnee, Choctaw, Sac and Fox of Missouri in Kansas and Nebraska, Sac and Fox Nation of Oklahoma, United Keetoowah Band of Cherokee Indians in Oklahoma, Pawnee Nation, Alabama-Quassarte Tribal Town, Kialegee Tribal Town, Ponca Nation, Tonkawa Tribe, Shawnee Tribe, Karuk Tribe, Iowa Tribe of Oklahoma, Cherokee Nation, Delaware Nation, Modoc Nation, Quapaw Nation, Kickapoo, Nottawaseppi Huron Band of Potawatomi, Iowa of Kansas and Nebraska, Yuchi, Seneca-Cayuga, and Fond du Lac Band of Lake Superior Chippewa.

For more information on how Tribal Alliance for Pollinators can assist you with restoring habitat on Tribal land to benefit monarch butterflies and other pollinators, please go to www.tribalallianceforpollinators.com or contact Collin Spriggs at collin@tribesformonarchs.org.

Ecosystems & Biodiversity

Key Message

Indigenous peoples' worldviews are often explicit in their centering of relationality, responsibility, and reciprocity as critical concepts. These concepts may inform Indigenous responses to climate change impacts. Examples of these impacts include increases in destructive wildfires and invasive species and decreases in ice cover due to warming temperatures. Indigenous actions to address climate change are vast, but some specifics include cultural burning, protection of keystone species, and observation and evaluation of invasive species before deciding how to respond.

Recommendation

Indigenous peoples' self-determination as practitioners of biodiversity conservation and ecological protection should be respected and reinforced. This can be accomplished through collaboration across jurisdictions; consultation and consent in the first stages of land and water planning, research, and management processes; increasing support mechanisms for the exercise of Tribal sovereignty; and the removal of barriers to Indigenous peoples' rights to implementing land management practices. Special measures need to be taken to provide access to and management of off-reservation areas to promote the retention of culturally valued species to the maximum extent possible. This helps to ensure the promotion and maintenance of Indigenous economies, traditional knowledge systems, livelihoods, meanings, and identities. Where retention is not feasible, measures are needed to support Tribes in making new relationships with newly arriving living beings.

Climate Change, Ecosystems, and Biodiversity: A Broad Perspective

Indigenous peoples often describe their experiences with and knowledge of climate change in terms of the responsibilities they have to support the wellbeing of human and other-than-human entities now and for generations to come. Responsibilities do not refer to actions that take place in isolation. Indigenous concepts of responsibility are socio-ecological systems approaches to understanding and responding to climate change. By systems, it is meant that the causes and effects of climate change are viewed as functions of interconnected, cross-scale relationships. Indigenous experience and knowledge of climate change move beyond narrow descriptions of climate change impacts, such as changing water temperatures in rivers. Indigenous peoples often recognize that such a change is exacerbated by breakdowns in responsibility between human groups to the environment. Euro-American colonial and settler industrialization and overdevelopment of river systems, for example, can be related to detrimental impacts to water quality, such as rising temperatures, although Indigenous peoples did not consent to this hydrologic system modification. Warming can negatively affect fish populations and hence humans' ability to take care of fish and other cold water adapted aquatic species. The less humans can carry out their responsibilities to fish, the less fish can support humans and other species. As this mutual responsibility changes, so too do human ceremonies and social activities, as subsistence harvesting lessens. This leads to changes in cultural and family lifeways. At the same time, the threat of warming waters caused by riverine water impoundments (e.g., dams) can mobilize political action locally and more broadly and motivate Indigenous knowledge keepers to engage with scientists.

Indigenous systems approaches, then, often involve grassroots, bottom-up activities as responses to climate change. Systems-level action can start with families, clans, or lodges and ripple out through different parts of society. This is different from other systems approaches that start with attempts to

view an entire system from a higher scale (e.g., regional, state/provincial, national, global) and issue analyses and recommendations from that vantage point.

Holistic Approaches to Ecosystems and Biodiversity

Indigenous peoples approach climate change through socio-ecological cross-systems concepts, often using terms like "land" to stand in for complex systems of responsibilities like those just described. In English, some Indigenous peoples use concepts like "cosmovision," "kincentricity," or "our relations in nature," among others, to denote systems that are moral, social, cultural, and environmental. Indigenous peoples also use their own words integrated within English language discourse. Margaret Noodin (2017) discusses the concept of ganewendamaw, which denotes complex caretaking and responsibility in the Anishinaabe language. Jeanette Armstrong (1998) discusses the concept of naw'qinwixw, which denotes long-term sustainability in terms of people's interaction with each other, the environment, and their passing on of knowledge and ecological literacy, in the Okanagan language.

For at least some of these Indigenous peoples, scholars and knowledge-holders have expressed different understandings of other-than-human entities as self-determining agents who can engage in responsible and reciprocal relationships with humans (Larsen & Johnson, 2017). The behavior of these beings, persons, relatives, relations, ancestors, or other entities is taken very seriously by some Indigenous persons as a source of teachings, knowledge, and moral protocols supporting coexistence (Reo & Whyte, 2012). In certain contexts, Indigenous peoples' relationships with nonhumans are taken to express their sovereignty relating to the land, water, and air given the importance of relationships of interdependence with other-than-human entities (Quintana, 2020).

Some Indigenous persons have been involved in engagements with scientists on analogous concepts used in fields like ecology, climate science, ecosystem services, or sustainable resource management. For example, the concept of an ecosystem is often understood as a systematic organization, or a group of interconnected elements, formed by the interaction of a community of organisms, including humans, with their environment. The concept of biodiversity typically involves every living thing among ecosystems, including plants, bacteria, animals, and humans. These concepts highlight interconnectedness. Indigenous peoples have pushed these concepts to consider the integration of humans within environmental systems and ecological processes, highlighting how moral relationships like responsibilities (vs. rights) are important ways to learn about, plan for, and respond to current and future climate or socio-ecological disruptions.

Reciprocity, as a quality of responsibility, is one example. In the literature, reciprocity is often used by Indigenous people as a way of understanding the mutuality of relationships of interconnectedness. Reciprocity can be placed in dialogue with how ecologists view ecosystems. Indigenous peoples understand reciprocity as involving multiple relationships, often crossing generations, and as sustaining numerous species (including humans), which is comparable to the understanding of biodiversity and resilience. Yet often, where sciences of ecosystems and biodiversity exclude or limit connections to human societies, Indigenous peoples are among those (including many in different scientific fields) emphasizing that cultural, social, familiar, and political systems are integral aspects of environmental systems. Ronald Trosper, for example, has studied how potlatch (giveaway) ceremonies for Salish peoples were part of complex systems of reciprocity in which Indigenous peoples coordinated the stewardship of entire regional ecosystems. Reciprocity was systematically entwined with moral responsibilities, methods of evaluating the success of knowledge keepers and stewards of species like

salmon, and conflict mediation and mutual aid protocols to appeal to in times of disruption or hardship (Trosper, 2002).

Case Study: Beaver and Coho Salmon

One example of the value Indigenous peoples place on relationships and interconnected systems involves beaver and Coho salmon habitats. Beavers once populated many drainages and were critical to the habitat quality and populations of Coho salmon across the Pacific West in many coastal riverine systems. Fur trapping and industrial riverine development for hydrologic modifications (e.g., water resource impoundments and dams) actively removed beavers from many river systems. Beavers, as significant natural geo-hydro engineers, promoted and maintained aquatic habitat features, such as ponds and backwater habitats in fluvial river valleys that directly increased the suitability of habitat for Coho salmon. Coho salmon, as an anadromous fish, spawn in freshwater creek and river systems; the juveniles spend one year in the fresh water systems before migrating downstream to the ocean.

Beavers and Coho salmon are highly valued aquatic species by Tribes economically, culturally (e.g., ceremony), politically (e.g., treaty rights), and health-wise (e.g., nutritious diet). Efforts by Tribes for riverine restoration coupled with beaver and Coho salmon conservation are understood to be critical components of a healthy aquatic system's functionality, water quality, and water quantity and as mitigation measures to alleviate the effects of climatic-induced drought and changes in precipitation regimes (Dittbrenner et al., 2018; DeVries et al., 2012). These efforts involved political mobilization by leaders, actions by family members, harvesters, and knowledge keepers, studies and regulatory activities by Tribal and intertribal staff, and partnerships with other actors in the region (Ebbin, 2012). These grassroots efforts start with people taking personal responsibility locally and coordinating with others in ways that provide the basis for scaling up.

For some Indigenous peoples, ecosystem conservation protects key species for biodiversity while also conserving key sources of community medicine, food, and cultural activities, all of which are tied to maintaining and increasing the use of language, family activities, ceremony, and other broader societal groups such as clans, lodges, and houses. Indigenous notions of conservation are generally associated with sustainable resource use that fosters biodiversity by focusing on indicator or cultural keystone species that represent ecosystem integrity. Founded upon acknowledging that species have the right to survive, thrive, and reproduce, these Indigenous conservation tenets often include sacred areas (as protection area surrogates), rituals, practices that mitigate or reduce harvest of species at vulnerable times of their life cycles (e.g., mating or breeding), and retaining plant and animal propagules that sustain populations. This sustainable resource-use also consciously influences ecological processes (e.g., cultural burning, discussed below) that conserve the socio-ecological system as a form of mutualism (Garibaldi & Turner, 2004). Conservation of the land supports culture and creates a sense of community and connectedness that ultimately protects the health and wellness of the people and the environment. A respect for the aforementioned concepts and practices is crucial in some Tribal and non-Tribal relationships for environmental problem solving (Reo et al., 2017).

COVID-19 as a Systems Issue

The COVID-19 pandemic is another systems issue that can be understood similarly to ecosystems and biodiversity. Some Indigenous peoples face severe threats from the pandemic due to pre-existing

inequalities caused by Euro-American colonial invasion and settlement, related to access to water, economic opportunities, and food resources, among others. Risks are also tied to the meaningfulness and significance of cultural activities (e.g., rituals and ceremonies) that may have to be halted or modified from traditional practices due to social distancing. The pandemic affects systems spanning numerous relationships connecting humans and the environment. In particular, when intra- and inter-family ceremonial or subsistence activities that promote and foster broader socio-ecological resistance or resilience are prevented or greatly reduced, adaptive capacity to respond to climatic disruptions or recovery following climate-induced disturbances such as storm surges and flooding, wildfires, heatwaves, and extreme cold weather events may also be reduced.

As one of the greatest contemporary issues globally, climate change and its associated extreme weather and environmental hazard events present significant challenges for Tribal communities. These events bring on new stressors that can compound the impacts of the historical legacy and persistent socio-economic problems that many Tribes face (Bennett et al., 2017). In light of the COVID-19 pandemic, these climatic stressors and their systemic consequences are exacerbated by physical isolation and digital disconnection, leaving the most vulnerable in our communities at an even greater risk.

Introduced invasive diseases such as flu, smallpox, and others have decimated Indigenous populations (Pfeiffer & Voeks, 2008). COVID-19 could be considered the latest example of such an introduced species. (Other introduced invasive species are discussed in depth below.)

The already existing digital divide leaves some communities lacking access to resources and information that are commonly available to most of the U.S. Moreover, people without adequate cell phone coverage or reliable high-speed internet are not able to access time-sensitive information on how the virus is spreading, updates on where to access healthcare professionals or supplies, or access to each other to check in on family and friends. For this or future pandemics that require the need for quarantine and self-isolation, this divide can feel insurmountable. The inability to connect with others can take a physical and emotional toll, and the longer in-person contact is limited, the more individuals lose the ability to create or maintain a sense of community. Further isolation and lack of cohesion will also impact efforts to support or advance discourse on climate change or the implementation of climate adaptation activities.

Indigenous Fire Stewardship as a Systems Approach

Indigenous fire stewardship has been used by Indigenous peoples since time immemorial as an approach to managing landscapes. It is a contemporary term used to define the traditional practice of applying fire to enhance the resources integral to one's livelihood and culture and includes burning (or prevention of burning) for ecosystem health (Marks-Block et al., 2019). Indigenous peoples have a long history of managing the landscape through their use of burning (Boutsalis, 2020; Marks-Block et al., 2019; Marks-Block, 2020). The use of cultural burning mitigates the spread and threat of catastrophic wildfire and helps create resilient landscapes while promoting the growth of culturally significant plants used as food sources or as source material for activities such as basket-making. Burning can be understood as a strategy for addressing climate change, as drier grasslands and forests and changes in snowpack and snowmelt are connected to less vigorous plants, increases in invasive species, insect outbreaks, and stand-replacing fire events. Generations of fire suppression and the forced removal of Tribal fire use has left the landscape overburdened with fuel and out of balance in the composition of species.

In the western U.S., Indigenous fire stewardship was a common practice until the U.S. government outlawed the practice under the threat of punishment by death after colonization (Cagle & Hootnick, 2019). The proper timing, approach, and strategies for burning practices are held in the collective traditional knowledge of Indigenous peoples. In the Pacific Northwest, the United States Forest Service (USFS) has been experimenting with the use of cultural burning approaches in collaboration with the Yurok and Karuk Tribes. In a manner, they are exploring the concepts of co-management between the USFS and the Tribal governments. Lake and Christiansen (2019) discuss the concepts of Indigenous land stewardship using fire as a land management tool. In their chapter summary, they state, "Frequent and diversified Indigenous burning coupled with natural ignitions reduced fuel loading, which often lowered the intensity and resultant severity of subsequent fires. As such, lower fuel load continuity, increased proportion of fire-adapted vegetation, and heterogeneous habitats (mosaics) greatly reduced the threat of and impacts of non-desired wildfires."

An example of the interconnectedness of Indigenous stewardship, biodiversity, and ecosystems is the coupling of socio-ecological and cultural fire regimes. Indigenous fire stewardship exercised by cultural practitioners includes but is not limited to the diversification of natural ignitions (e.g., lightning) that often increases the frequency of fires, differing seasons or timing of burns within seasons (linked to phenology), specificity, and spiritual-ritual obligations of having fires that increase resilience, diversity, productivity, and functionality of fire-dependent plants, fungi, and animals that are highly valued Tribal resources. From Indigenous perspectives, the use of fire across different ecosystems among varied habitats in response to climate and socio-ecological processes is and can be human services for ecosystems and associated species (considered as relations). This stewardship approach can increase and promote species diversity, resistance or resilience among habitats and between species (reduced fuel loads and vegetation continuity, fostering drought-tolerant fire-adapted species), and socio-ecological systems. This can help moderate or buffer against extreme events that expand the range of variation (e.g., natural fires or lightning being sporadic results in more intensive fires, compared to an intentionally culturally burned area that moderates the intensity and severity of future fires), climate-induced disruptions (e.g., intentional burning to foster diverse vegetation mosaics reduces pest outbreaks and the vulnerability of other factors such as drought stress by having less water competition among trees that are drought-tolerant and fire-adapted), and Euro-American colonial modification of ecological processes (Lake & Christianson, 2019; Lake et al., 2017; Norgaard & Tripp, 2019; Lake, 2021).

Impacts on Ecosystems & Biodiversity Experienced by Tribes

The following sections describe some of the general and specific impacts to ecosystems that many Tribes are experiencing.

General Ecosystem and Biodiversity Impacts

Climate change is inducing species, habitat, and ecosystem range shifts that are slowly leading to the loss of valued resources and is making these resources less reliable (Bond et al., 2019; McNeeley et al., 2020; Weiskopf et al., 2020). These range shifts are moving culturally important resources outside of the territories and areas where Indigenous peoples can access them. Climate change can also cause phenological shifts that make resources less available or available at times outside of a legal harvest window or can disrupt ecological interactions, resulting in ecological reorganization and changes in species composition. This can lead to "biocultural hysteresis" due to interacting biological, ecological, legal, social, and other historical constraints, resulting in disruption of Indigenous human-nature-social

relationships and limiting capacities to adapt (Billiot et al., 2019; McKinley et al., 2019; Lyver et al., 2019).

Increasing Temperatures

While ecosystems on Tribal lands throughout the U.S. are experiencing impacts from climate change, one example is in the upper Midwest (northern Minnesota, Wisconsin, and Michigan), where climate changes threaten many beings on which Ojibwe Tribes residing in the region rely for spiritual, ceremonial, medicinal, subsistence, and economic needs. Many Ojibwe Tribes retained treaty rights to hunt, fish, and gather off-reservation in the upper Midwest Ceded Territories, and these treaty rights are directly threatened by climate change and its effects on culturally important beings. Increased air and water temperatures will stress northern animal beings such as wood turtle, moose, American marten, snowshoe hare, fisher, sharp tailed grouse, common loon, and tullibee, as well as many northern and boreal plant beings such as wild rice, paper birch, sugar maple, northern white cedar, and Labrador tea (Handler et al., 2012; Panci et al., 2018), many of which are found at the southern end of their ranges in the Ceded Territories. This may lead to reduction or possible elimination of accessible ranges or occurrences (Tribal Adaptation Menu Team, 2019), such as the modeled northward shift of suitable habitat for sugar maple (Iverson et al., 2008).

The Great Lakes, a resource vital to many beings in the upper Midwest, including human inhabitants in the region, are also experiencing warming, which could threaten the habitat and existence of many, make the lakes more prone to algal blooms, and create more suitable habitat for invasive species. Fish in the Great Lakes are under particular threat, as climate change, pollution, and invasive species are imperiling the entire food web of the Great Lakes, including native lake trout (Folger, 2020; Treat et al., 2020). Tribes in the region, as well as intertribal agencies, have begun adaptation planning processes together with other efforts to record valuable Tribal knowledge from elders and harvesters. (See the Midwest Region of the Tribal Climate Change Assessments and Adaptation Plans document for links to eight completed plans from the region.)

Where the ranges of species, habitats, and ecosystems are shifting, special measures need to be taken to provide access to and management of off-reservation areas to promote the retention of culturally valued species to the maximum extent possible. This helps to ensure the promotion and maintenance of Indigenous economies, traditional knowledge systems, livelihoods, meanings, and identities. Where retention is not feasible, measures are needed to support Tribes in making new relationships with newly arriving living beings. Collaborative efforts and initiatives between cross-jurisdictional stakeholder groups and Indigenous peoples are also needed.

Wildfire

According to the Congressional Research Service (CRS, 2020), the number of acres burned annually by wildfire has drastically increased as a result of anthropogenic climate change. The record-breaking wildfire seasons of 2019 and 2020 had such extreme impacts that public utility companies have begun to shut off power to millions of people in metropolitan urban and rural outlying areas as a preventative approach to wildfire inception during extreme wind and storm events (County of Santa Clara Emergency Management, 2020). This pattern is only expected to worsen, as climate change will continue to increase the number of extreme fire days by 2100 (Goss et al., 2020). As of October 2020, California was on track for another record wildfire season, with over four million acres burned (Freedman, 2020). In 2012, the California Public Utilities Commission ruled that energy companies can turn off power during

high wind events to avoid wildfire. This often leaves rural communities, and many rural Tribes, without power during high wind events that can last for days. This has a great impact on communities who do not have backup generators or other options to maintain critical infrastructure and care for elders and others who are at increased risk. Renewable energy development, microgrids, transmission infrastructure, and other associated infrastructure in rural areas could help reduce these risks to Tribal communities (see *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets*, and *Chapter 7: Energy & a Just Transition* for more on energy development).

While climate change is directly exacerbating extreme fire behavior, a history of fire suppression and loss of Tribal sovereignty over land management practices has removed fire from its ecological role on the landscape (Norgaard, 2014). Historical fire regimes throughout the southwestern U.S. (with presumed mean fire return intervals of 5 to 10 years, according to the LANDFIRE database) were disrupted through Euro-American colonial settlement of the West, arrival of the railroad, and a national policy of fire suppression. In Alaska, wildfires are becoming more frequent and severe as a result of climate change (Woo et al., 2020).

As a result of high-severity and catastrophic wildfires, communities like that of Santa Clara Pueblo, located on the eastern flank of the Jemez National Forest in New Mexico, have experienced severe post-fire runoff and costly damages to infrastructure ($200 million dollars) and are facing the question of what happens after the fire. Following the Las Conchas fire of 2011, landscapes that were once dominated by Ponderosa pine and Douglas fir are coming back not as forests, but as shrubland. Ecological disturbances like wildfire are increasing ecological transformation throughout the Southwest and threaten already declining snowpack-water resources (Keyser et al., 2020).

At present, the Tulalip Tribes and the Swinomish Indian Tribal Community are partners on a project that is studying forest fires on the west side of the crest of the Cascade Mountains in Oregon and Washington (Harvey et al., in progress). These fires tend to occur in areas that have a heavy fuel load, but are also wetter and less likely to burn. However, under the right conditions (extremely hot, dry winds from the east during droughts), the researchers have documented extensive and intense wildfires that are difficult to contain. They are exploring the climatic drivers of these wildfires and seeking a better understanding of how these forests respond to burning. For Tribes, a warming climate and its relationship to fire is a critical resource management concern, especially regarding natural resource planning in the wildland–urban interface. These research results will inform USFS Forest Plan revisions and National Park Service (NPS) post-fire planning under a warming climate and guide pre- and post-fire adaptive management by the NPS, USFS, Bureau of Land Management, and several federally recognized Tribes in the northwestern U.S.

Invasive Species

The concept of invasive species is important within Indigenous understandings of ecosystems and biodiversity. Often “invasive species” is a term used to indicate how the introduction, establishment, and migration of a species that was initially not Indigenous or native (i.e., exotic) disrupts the integrity of an ecosystem and its biodiversity. “Invasive” or “exotic” connotes a foreignness and a lack of belonging. Indigenous peoples, while concerned about invasive species, have in some cases taken a different approach.

Indigenous peoples have multiple beliefs and traditions concerning so-called invasives which may be held simultaneously within a community. Some conceptualize species as "nations" having their own sovereignty, and species new to an area are not treated as invaders but rather as approaching nations that are addressed through protocols with a foundation in respect for all life (Reo & Ogden, 2018). They are also viewed as relatives (e.g., "all my relations"), what has been called "kincentricity" (Martinez, 2018; Salmon, 2000). Rightful and respectful relationships with other-than-human beings and the natural world are central to Indigenous societies. This creates an "original compact" between humans and living beings, violations of which can cause plants and animals to refuse to give their lives for human sustenance (Martinez, 2018).

Indigenous peoples often wait for a time after a new relative arrives to understand what they are offering to provide and in return the mix of responsibilities for them and how best to relate to or address the new member to the socio-ecological system (Reo & Ogden, 2018). This approach then mobilizes multiple ways of evaluating a newly arrived potential relative, including cultural knowledge, rather than immediately engaging in the eradication of the invasive or exotic species. At the same time, Indigenous peoples make decisions about their conservation and climate change priorities based on the degree of relatedness. Although all species are related, they may have different degrees of relatedness. Some species may be prioritized over others because of the particular relationships, services, or functions they provide with respect to other relations they have with Indigenous peoples, given ramifications beyond their ecological function (Pfeiffer & Voecks, 2008). Some are recognized as disrespectful relatives that are outcompeting, modifying, or degrading the suitability of biocultural systems and their relationships with close relatives, and these harmful effects are also evaluated and assessed (Bond et al., 2019).

Some scientists have voiced concern that taking cultural concerns into account, such as through incorporating the concept of “cultural keystone species,” fails to acknowledge the ecological, environmental, biodiversity, and economic harms associated with invasive species and claim that there is insufficient evidence that it is effective (Garibaldi & Turner, 2004; Nuñez & Simberloff, 2005). This criticism itself fails to recognize that Indigenous peoples often follow the same policy prescriptions of scientists to evaluate invasive species on a case-by-case basis, using multiple criteria to decide whether to eradicate, control, or accommodate invasive species (see Long et al., 2018, for many examples of culturally appropriate invasive species management).

Impacts of invasive species on Indigenous peoples and relations

Human travel, trade, colonial environmental management policies, and climate change are contributing to the spread of invasive species both within the U.S. and worldwide, with invasive species being one of the leading drivers of biodiversity loss (Lipton et al., 2018; Norgaard, 2007; APHIS, 2020). From a Western science and management perspective, such species are often defined as organisms, nonnative to a particular ecosystem, that cause or are likely to cause economic or environmental harm or harm to human health (ISAC, 2006; Lipton et al., 2018). Invasive species can include animals, plants, or pathogens.

For Indigenous peoples, another type of harm that can occur is cultural. This can be evaluated in terms of relationships and responsibilities as discussed above. Invasive species can affect the quantity, health, and quality of culturally important resources and relatives, in some cases upsetting ecosystem balance (Pfeiffer & Voeks, 2008). For instance, in the southwestern U.S. tamarisks are replacing culturally

significant willows and cottonwoods. In the Pacific Northwest, escaped farm Atlantic salmon are competing with and transferring diseases to the native, wild salmon, threatening spiritual and cultural practices and identities. Another example is when an exotic, nonindigenous aquatic invertebrate (e.g., mussel or snail) is introduced to a river or lake ecosystem, it begins to displace other native aquatic species, changes the water quality, and may be more adaptable given industrial modification of the river's hydrologic network (Petsch et al., 2020; Kernan, 2015).

Dibaginjigaadeg Anishinaabe Ezhitwaad: A Tribal Climate Adaptation Menu

There is no way to translate "invasive species" into Anishinaabemowin, and the term itself is considered disrespectful. The *Dibaginjigaadeg Anishinaabe Ezhitwaad: A Tribal Climate Adaptation Menu* author team was given the phrase "bakaan ingoji gaa-ondaadag" by an Ojibwe elder and language speaker to refer to these beings (TAM Team 2019). Loosely translating in English to "non-local beings," the phrase reflects the Anishinaabe belief that all beings deserve respect and that all were given original instructions by the Creator. Beings that have found themselves outside their original community are still acting according to their instructions, but their actions may not be balanced by the other beings in their new communities, in some cases causing disruption to the normal function and health of an ecosystem. The Menu recognizes this conflict and suggests that climate adaptation may require respectful actions to minimize or prevent the establishment of bakaan ingoji gaa-ondaadag if they pose a threat to the health of the local environment. Culturally appropriate approaches and tactics include not only physical and biological control, but also respectful observation, seeking traditional and cultural knowledge from areas where beings may be native and the creation of new reciprocal relationships through ceremony and harvest.

In the western U.S., American colonial settler fire suppression policies combined with a decline in Indigenous land tenure have disrupted socio-ecological fire regimes (including Indigenous fire stewardship). This has contributed to the expansion of some conifers and hardwoods, as well as other vegetation invading formerly burned habitats that hosted many fire-dependent plant and animal species on which Indigenous peoples rely (Huntsinger & McCaffrey, 1995; Keeley et al., 2010). Subsequently, ecosystem services and functions have been degraded, leading to increased vulnerability to drought, increased prevalence of insects and diseases, and an increase in the risk of severe wildfire that is exacerbated by climate-induced drought (Knapp et al., 2013; Heyerdahl et al., 2006).

Invasive species can also affect the accessibility of resources. In California, invasive plants with spines and thorns such as starthistle and stinging nettle can inhibit weavers from gathering basketry plants (Pfeiffer & Ortiz, 2007).

In addition to these more direct effects, management responses to invasives can also affect Tribal peoples. One of the major factors in the establishment of the California Indian Basketweavers Association was opposition to herbicide use to control invasive plants. Concerns include impacts on the quality of basketry materials (e.g., stunted growth, plant physical deformities), potential health impacts to weavers, plants, wildlife, and aquatic species resulting from chronic exposure to herbicides or their residues, and desecration of sacred sites by spraying poisons on the sites (Norgaard, 2007; Pfeiffer & Ortiz, 2007). All of the impacts discussed above can lead to cultural erosion in which stories, language, management practices, intergenerational connections, and relationships with and reverence for species and places are diminished or lost and not passed on to younger generations (Pfeiffer & Voeks, 2008).

Responses to invasive species and climate change

The Indigenous focus on relationships and responsibilities increases ways to respond to invasive species when compared to Western methodologies. For instance, while some species may be considered culturally impoverishing, leading to cultural erosion as described above, other invasives might become used in culturally enriching or facilitating ways and become included in or help to retain cultural practices. Examples include wild horses becoming incorporated into the traditions of Tribes in the western U.S. or invasive plants becoming a part of Indigenous pharmacopeias. In some cases, integration of an invasive species into cultural practices and harmful impacts may occur simultaneously. Feral pigs introduced into Hawaii from Polynesia have become a part of Indigenous Hawaiian cultural rituals, yet at the same time the pigs contribute to the destruction of native ecosystems and the food and medicinal plants found therein (Pfeiffer & Voeks, 2008).

In California, basketweavers advocate for the management of invasive plant species from a more relational perspective, including protecting native plant competitors of invasive species, using traditional cultural burning to promote ecosystem balance, protecting gathering sites from invasion, and restoring native plants. They oppose chemical treatments that could harm basketweavers and other relatives within the ecosystems that they steward (Norgaard, 2007; Pfeiffer & Ortiz, 2007). In other instances, invasive plants that are native pollinator host surrogates are valued and understood to have a service or function while the habitat is being actively restored. In such a case, the Tribal philosophy of "feeding your relations" is embraced and exercised by not eradicating all nonnative flowering plants, but instead fostering a transition to native host plants for pollinators (Long et al., 2020).

As the climate continues to change, species will continue to shift in response, with different species within ecosystems moving at different rates. Species may disappear from some regions and move to others or may become extinct. New species interactions and ecological communities may develop with no prior precedent, further challenging and complicating Western conceptualizations of what it means to be invasive (Lipton et al., 2018). Indigenous approaches to newcomers that focus on relationships, understanding, and responsibilities can inspire a broader array of paths forward and may be particularly relevant as we choose how best to respect and respond to all our relations in a transforming and uncertain world.

<u>Thawing Permafrost, Glacial Retreat, and Loss of Sea Ice</u>

Degradation of Alaska's permafrost began as early as the mid-1700s due to relatively naturally occurring warm climatic cycles, but that has accelerated substantially due to climate change in the 1900s and 2000s (Jorgenson et al., 2001). This degradation has led to loss of ecosystem services, conversion of dominant terrestrial landscapes to aquatic or wetland-type classifications, and the alteration of subsurface hydrology (Jorgenson et al., 2001).

Glacial retreat, which occurs whenever melting of a glacier exceeds the rate of snow accumulation that would form new glacial ice, and rising sea levels are altering the shoreline of places like southeast Alaska. When glaciers retreat, land that was previously ice covered becomes exposed, while rising sea levels can lead to inundation of shorelines. Overall, Alaskan glaciers show the highest global rate of acceleration of mass change (Li et al., 2021), and southeast Alaska is particularly vulnerable because of the combined factors of glacial retreat and sea level rise. Additionally, the isostatic rebound (which is the rising of land masses once the weight of an ice sheet is removed) in southeast Alaska has the highest measured rate in the world: the community of Yakutat has a measured isostatic rebound rate of one

inch per year (McDaniel et al., 2019). This shoreline alteration impacts both the coastal habitats and the availability of food resources, particularly for Alaska Natives who typically have a more subsistence-based diet than other communities (see *Chapter 5: Health & Wellbeing*). The projected change over the next 100 years in shoreline elevation in southeast Alaska ranges from almost six feet of new land emergence due to glacial retreat to a loss of 0.65 feet of land due to rising sea levels (McDaniel et al., 2019). Where land is emerging, the length of estuaries (specifically, eelgrass and clam habitats) is projected to decrease by up to 30%, while estuaries in areas of land submergence may lengthen by up to 3% (*Id.*). Both scenarios will greatly impact the traditional foods of the Indigenous peoples in southeast Alaska.

Melting sea ice impacts species that are dependent on the ice for their hunting, which has cascading effects on Alaska Natives who in turn depend on those species for sustenance (Marks-Marino, 2019). The loss of sea ice in the Arctic is impacting marine mammals (e.g., walrus and seals) that are unable to haul themselves out of the water and onto the ice, which is relatively protected from predators. Walruses show a general preference for sea ice to molt, mate, nurse, and rest (Joling, 2018). As an alternative, these mammals are gathering on lands connected to the mainland or islands, which are occupied by humans and other predators. These areas offer much less protection, greater exposure, and more risk for these animals.

Inupiaq and Yup'ik hunters have observed and described significant changes, such as to the timing of sea ice formation and weather patterns that have, in turn, changed the timing of marine mammal migrations, their distribution, and their behaviors, as well as the efficacy of the hunting methods they have used for generations (Huntington et al., 2016).

Alaska Natives typically use snowmobiles and four-wheelers as primary sources of transportation in the winter to cross both land and bodies of frozen water; in recent years, people have died by falling through rivers that had been dependably frozen in the past (Marks-Marino, 2019), making wintertime travel and hunting simultaneously more dangerous and less accessible (Huntington et al., 2016; Sharma et al., 2020).

Air and Water

Air and water are two topical areas in which Indigenous peoples have devoted their energies toward environmental protection and climate change adaptation and mitigation. While air and water are inextricably connected to the broader topic of ecosystems, the structure of many natural resource agencies like the U.S. Environmental Protection Agency delineates air, water, and land into their own, siloed programs (Office of Air and Radiation, Office of Water, and Office of Land and Emergency Management). Although this is counter to the interconnected way in which the world truly functions, this report will take an additional, deeper look into the impacts to and responses by Tribes regarding both air and water in the following chapters.

Conclusions

As discussed previously, Indigenous peoples address these issues systemically, relying on diverse scientific (Indigenous and Western knowledge) approaches, and leveraging political, cultural, and social connections to their ancestral lands that can benefit Indigenous communities and society. Indigenous teachings, often with creation stories of norms and responsibilities to family and community, relate interconnectedness and dependency. Such teachings are potent reminders of culturally rooted ethics,

responsibility, and reflection on the appropriateness of human actions and implications for the environment. These approaches are applicable to climatic disruptions that result in degradation or damage to valued species used for resources, to localized observations of climatic-induced changes to species distributions, or to seasonal or annual movements in relation to ecological factors, be they extreme heat or cold, intensified weather, drought, or disturbances such as wildfires.

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Chapter 4.1: Air

The narratives in this chapter from the Kootenai Tribe of Idaho and the Nottawaseppi Huron Band of the Potawatomi of Michigan speak to the challenges and solutions Tribes are encountering in maintaining air quality programs and protecting the health of their Tribal members. Both Tribes lack adequate funding for staff, support, and equipment. Without air quality programs, the communities they serve suffer health related consequences. The Kootenai Tribe provides an example of how states and Tribes can work together, and the Nottawaseppi Huron Band describes how they actively sought solutions to implementing a complete network of air monitoring. A researched overview of Air as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Kootenai Tribe of Idaho Air Monitoring Equipment

Written by: Carol Kriebs, Environmental Director – Kootenai Tribe of Idaho

I have been working with the Kootenai Tribe of Idaho since July 9, 2018, and inherited an air station with equipment that was 20-plus years old. There were many things that needed to be replaced, and priorities had to be set on how to begin. The first year the deck was replaced; the wood construction had made it unsafe for people to walk on due to rotten wood under your feet. I was able to move some funding around and replace it with a corrugated metal platform. This allows snow to pass through the platform and gives staff a slip-resistant surface, as well as longevity for many decades.

In 2019, our sensors and equipment began to fail. Due to COVID-19, we had travel funding that wasn't spent, so with permission I was able to move those funds to buy a new data logger and wind and temperature sensors. The data logger was so old that this model wasn't even being serviced anymore. Thinking I was in good shape, the unthinkable happened. My nephelometer ($PM_{2.5}$ monitor) motherboard went out. That took my site offline for months just prior to smoke season (a really bad time to lose a major piece of equipment). This time there was no available funding for replacements, but conversations with the Idaho Department of Environmental Quality (IDEQ) led to them sending us four old nephelometers that they had replaced. We found one of the four

that was still working. I did some research and found out these units are being phased out. IDEQ has also loaned me an E-Sampler so we can co-locate, since no one was sure how long the nephelometer would last, giving us time to find funding to replace our nephelometer.

Kelby Sullins from the Idaho Department of Environmental Quality setting up the portable air monitoring station.

Equipment failure is happening all across Indian Country, and additional funds are greatly needed to be able to, at a minimum, keep equipment running and in most cases to upgrade. The National Tribal Air Association has reported this need for many years in the *Status of Tribal Air Report* to EPA leadership, and still grant funds being allocated to Tribal programs continue to decrease. It is my hope that this article will shed new light on this issue and help others to build partnerships with their states, for without the State of Idaho's help the Kootenai Tribe wouldn't have been able to monitor through the smoke season.

Nottawaseppi Huron Band of the Potawatomi's Particulate Matter Monitoring Program

Written by: Amy Boetcher, Environmental Specialist – Nottawaseppi Huron Band of the Potawatomi

Non-Tribal land located about 9 miles from Pine Creek Reservation in Calhoun County, Michigan, showing industrial farms (circled in orange) and oil/gas wells (circled in yellow). There were zero oil/gas wells here in 2013.

BACKGROUND

The Nottawaseppi Huron Band of the Potawatomi (NHBP) air program serves approximately 1,600 Tribal members and is located on the Pine Creek Reservation in southwest Michigan. We do not receive any air-specific funding. We run eligible components of our program with EPA GAP funds and the rest with Tribal general funds.

NHBP is concerned about pollution from area sources, particularly activities relating to land use on and near local farm operations. With few exceptions, Tribal members live in counties with at least 40% (and as much as 80%) of land use in crops and/or are within about 20 miles of industrial farm operations (the Reservation is within five miles of three industrial farms). The Pine Creek Reservation lies within the St. Joseph River Watershed, of which about 70% is used for crop and animal production. On area farms, particulate matter (PM) is a potential concern, coming from windblown dust, pesticides, herbicides, and manure use. Another potential source of PM in the area is active oil and gas wells. There are currently 15,500 active oil and gas wells in the state of Michigan, and they are becoming more numerous in agricultural lands near the Reservation. As the number of active oil and gas well sites increases, we would like to be able to monitor the potential impacts on our air.

IMPORTANCE OF THE PROJECT

Street view of a rural oil and gas operation in Calhoun County, Michigan.

We are concerned about PM because it impacts the health of our community, and climate change may have additive impacts. Michigan Department of Health & Human Services/Great Lakes Integrated Sciences and Assessments reports that one of the top five climate-related health concerns in Michigan is respiratory diseases. According to Johns Hopkins Bloomberg School of Public Health, adverse health impacts linked to PM include development/exacerbation of chronic lung issues, heart attacks, and hospital admissions and ER visits for heart and lung disease, among others. In addition, PM is known to cause more risks for elders, children, and people with heart and/or lung disease. We have a disproportionate number of community members that are considered to be more sensitive to PM. We know that Michigan has already experienced a 2°F increase in average annual temperature. We do not know what intersectional impacts climate change might have on PM pollution and Tribal member health.

PREVIOUS STEPS

In our first year focusing on ambient air (2018), we identified our generic concerns. They include: 1) Tribal member health, and 2) area sources of PM from agriculture. We started exploring how to perform an emissions inventory (EI) to create a formal plan of action. We utilized free online trainings, guidance documents, and the Tribal Emissions Inventory Software Solution (TEISS) to get oriented, particularly the Inventory Preparation Plan wizard. We also read about the $249 PurpleAir monitor, known for its robust use in California to detect PM from wildfires. We are interested in the monitor's potential to get Tribal citizens involved in our efforts and to serve as a health screening tool. Studies from reputable air quality control agencies indicate high levels of correlation between PurpleAir sensors and expensive, commercial-grade sensors used by EPA.

One challenge we face in understanding local PM conditions is a lack of local monitors. Of the 68 PM monitors currently operated by the state of Michigan and PurpleAir, about 80% are in its southeastern counties. PM can vary from neighborhood to neighborhood, so local screenings are important.

CURRENT AND FUTURE STEPS

PurpleAir Monitoring Network and the NHBP Environmental Dashboard

We are currently operating one PurpleAir monitor to screen for potentially unhealthy air days. With help from our membership, we have placed our first off-Reservation monitor in northern Michigan. We have an additional five PurpleAir monitors to strategically expand our screening to areas where Tribal members are living (throughout Michigan). We plan to display data from our Tribal PurpleAir monitoring

network on an NHBP Environmental Dashboard. The Dashboard is a website for Tribal membership that displays local environmental conditions and highlights Environmental Department program areas. It includes local, live weather, PM, and water quality readings. It also has an interactive map of Tribal parcels, and local radon and environmental assessment actions. The PM screenings from our local PurpleAir monitor (housed at the government campus) are used to apply an existing EPA Air Quality Index to our dashboard. Once we complete our EI, we will have a better idea of how to best monitor pollutants of interest, and how to incorporate them into the index.

Pine Creek Reservation Tribal homes pictured just east of an active ag field. We are curious what the prevailing winds blow onto the Reservation.

GOALS FOR DATA

In 2020/1, we plan to expand our screening of neighborhood-scale PM levels by placing PurpleAir monitors in other counties with an NHBP presence. Our long-term goal is to be able to impact policy relating to sources/impacts of particulate pollution that will help improve and/or protect our community's air in an ever-changing climate.

Air

Key Messages

- The federal government must uphold Tribal sovereignty, authority, and co-management rights for air quality management. Impediments to exercising sovereignty could be removed. For example, Tribes should be allowed to perform traditional fire-prevention activities on their lands, such as cultural burning of the landscape to prevent wildland fires.
- Tribes experience disproportionate impacts from poor air quality, including smoke/fine particulates, heat, and humidity, all of which can be connected to climate change. These factors are believed to impact rates of mortality and morbidity from COVID-19.

Recommendation

Fully engage Tribes as co-regulators in the very first stages of air quality regulatory planning, development, implementation, and enforcement. Adequate funding of air quality programs for staffing, monitoring, and emergency response to air quality issues supports Tribal sovereignty, as does addressing underlying causes of environmental, social, and health inequalities and injustices with the full participation of Tribal peoples.

Spiritual Foundations of Tribal Air-Related Climate Actions

Indigenous peoples inhabit a living universe, in which proper and respectful relationships lie at the core of their Creation stories, identity, cultural integrity and meaning, and dignity as peoples.[10] The wind and air are often conceived of as living spiritual forces and inhabited by deities such as Father Sky (Forbes, 2001). All Tribal communities have spiritual protocols, ceremonies, beliefs, and practices related to the air, wind, smoke, and sky and cultural responsibilities to respect and maintain balance among these spiritual forces and beings. Tribal climate actions are not only about objects and physical processes, but relate to maintaining healthy spiritual and environmental balance and relationships (Kimmerer, 2015; Krakoff, 2008; LaDuke, 2016).

Tribal Sovereignty and Air Programs

Tribal sovereignty refers to the rights of American Indians and Alaska Natives to self-governance, as recognized in the U.S. Constitution. This concept recognizes that these sovereign states existed long before the arrival of Europeans and recognizes the inherent right of Tribal nations to regulate their internal affairs. Tribal air programs were born out of Tribal sovereignty rights and are connected to federal policy initiatives. The 1984 EPA Indian Policy recognized the unique sovereign status of Tribes. The Clean Air Act (CAA) Amendments §301(d) of 1990 established a Tribal role in implementing the CAA. The Tribal Authority Rule (TAR) in 1998 recognized the right of Tribes to assert their authority within the exterior boundaries of their reservations. The TAR also established Treatment as a State status for Tribes that allows them to implement and manage certain environmental programs in Indian Country as a state

[10] Every Tribe is sovereign and has their own beliefs and the authority to articulate those beliefs. The references on spiritual issues are only provided as preliminary and general orientation and are not intended to voice the beliefs of any particular Indigenous peoples, who should be consulted directly on these issues.

and receive long-term funding. An example of Tribes asserting air quality authority is the EPA Region 10 incorporation of the Federal Air Rules for Reservations (FARR). These rules were designed to protect air quality on the 39 reservations in the region in the absence of Tribal-specific regulations. In 2011 the EPA promulgated the Federal Indian Country Minor New Source Review Rule, which created a mechanism for permitting of minor sources on reservations. Prior to this action, there was no mechanism for any permitting authority to issue these permits, allowing sources to operate unchecked. This permitting authority was an important step toward recognizing Tribal sovereignty. Presidential Executive Order 13175 of 2000 requires federal agencies to engage in "Consultation and Coordination with Indian Tribal Governments," further acknowledging the importance of Tribal contributions to air quality management.

As of 2020 there are 121 Tribes with either §103 (project) or §105 (program) air quality funding.[11] Many Tribes conduct air quality activities through Indian General Assistance Program[12] (IGAP) work plans and funding. Tribes use §103, §105, and IGAP funding for multiple purposes, from conducting indoor air quality assessments and completing emissions inventories to carrying out air quality monitoring in order to protect the health of their Tribal members and their environments, all of which can also be connected to climate change.

The National Tribal Air Association's (NTAA) 2020 *Status of Tribal Air Report* (STAR) outlines how Tribal funding has remained stagnant, even as Tribes are being asked to do more in the field of air quality. As described in the STAR, the original Tribal funding amount of $11 million (1996) would translate to $31 million if it kept pace with increasing health care costs, or $18.1 million if it kept pace with the rate of inflation (NTAA, 2020).

Air Impacts and Tribal Vulnerability

The U.S. Department of Health and Human Services Office of Minority Health (2018) has shown that American Indians and Alaska Natives (AI/AN) have higher rates of disease and lower life expectancy than Caucasians, often from diseases that can be connected to high levels of fine particulate matter ($PM_{2.5}$) (such as heart disease, cancer, diabetes, and stroke [Bowe et al., 2019]) as well as to lower incomes and geographic isolation. (See narrative titled *Nottawaseppi Huron Band of the Potawatomi's Particulate Matter Monitoring Program* in this chapter for an example of particulate matter emissions and the impacts to human health.) An NTAA white paper[13] states:

> *Studies have also been conducted specifically regarding asthma and AI/AN children. We know that AI/AN children have greater incidence of asthma (approximately 13% compared with 8.6% of children of non-AI/AN descent) [Brim et al., 2008]. Health*

[11] The National Tribal Air Association's Status of Tribal Air Report https://www.ntaatribalair.org/status-of-tribal-air-report/

[12] Indian General Assistance Program https://www.epa.gov/tribal/indian-environmental-general-assistance-program-gap

[13] NTAA's White Paper Detailing the Science and Connections Between Air Pollution, Tribes, and Public Health https://secureservercdn.net/198.71.233.47/7vv.611.myftpupload.com/wp-content/uploads/2020/05/NTAAs-2020-White-Paper-Detailing-the-Science-and-Connections-Between-Air-Pollution-Tribes-and-Public-Health.pdf

> *disparities such as poverty and inadequate access to respiratory care impact AI/AN children with asthma that live on reservations, and environmental challenges such as both indoor and outdoor air pollution compound the problem [Lowe et al., 2018]. More AI/AN people use biomass for heating and cooking than do non-AI/AN people (in fact, 89% of families on the Navajo Nation reservation do), elevating the levels of both PM2.5 and PM10 in their homes, and contributing to the increased incidence of asthma severity and morbidity [Garcia et al., 2019].*

While there are many contributing factors to these disproportionate health impacts, ensuring that activities such as those listed in the Nottawaseppi Huron Band of the Potawatomi's narrative (e.g., agricultural development leading to increased windblown dust, pesticides, and herbicides as well as oil and gas wells) are located a safe distance from Tribal lands and that Tribes have robust air quality monitoring programs could reduce the prevalence of air pollution related diseases.

The COVID-19 pandemic has disproportionately impacted Tribal communities. "Historical trauma and persisting racial inequity have contributed to disparities in health and socioeconomic factors between AI/AN and white populations that have adversely affected AI/AN communities; these factors likely contribute to the observed elevated incidence of COVID-19 among the AI/AN population" (Hatcher et al., 2020, as cited in Sequist, 2020). An increase in COVID-19 contagion and mortality has been correlated with both long- and short-term exposure to air pollution (Comunian et al., 2020; Wu et al., 2020). Climate change is exacerbating and amplifying these existing vulnerabilities and other social determinants of health, which include economic and social conditions—such as income, education levels, discrimination, and health care access and quality—that influence a wide range of health outcomes. Given the disparities in health outcomes for Tribal communities and the emerging connections between air quality and COVID-19 risks, more research, improved air quality, and a focus on addressing social, environmental, and health justice issues must be undertaken (Centers for Disease Control and Pollution, 2020; Raine et al., 2020).

Wildland Fires and Air Quality Impacts

Climate change is contributing to an increased risk in catastrophic wildfires due to rising temperatures, decreasing snowpacks, and extended droughts, in part by increasing the amount of dried vegetation available to provide fuel. As shown in Figure 3, the number of acres burned in wildfires has a clearly increasing trend per year since 1983, which plays an important role in the impacts to air quality. According to the EPA, wildfires were responsible for 40% of the total PM emitted (EPA, 2019) in the U.S. as of 2018. Very high $PM_{2.5}$ concentrations have been shown to increase respiratory and cardiac illnesses, particularly in sensitive populations (Edwin & Mölders, 2018). Polycyclic aromatic hydrocarbons (PAHs) are naturally occurring chemicals in fossil fuels such as coal, oil, and gasoline and are also produced when fossil fuels or wood, garbage, or tobacco are burned. "Events such as wildfires greatly increase the amount of PAHs containing $PM_{2.5}$ entering and transporting throughout the atmosphere" (Kramer et al., 2020, from Navarro et al., 2016, ns).

This increase in $PM_{2.5}$ and other air pollutants—caused by wildfires that are increasing in acreage and duration from climate change—leads to an increase in indirect mortality. A recent study on the

consequences of a spike in $PM_{2.5}$ exposure by just 1 microgram per cubic meter ($\mu g/m^3$) for just one day led to "0.69 additional deaths per million elderly individuals over the three-day window that spans the day of the increase and the following two days" (Deryugina et al., 2016). While this data is for elderly people at large, as stated above, Tribal peoples experience increased deleterious health impacts for a wide variety of reasons. Concerningly, analysis suggests that in interior Alaska, levels of $PM_{2.5}$ caused by wildfires in the month of July will increase by an average of at least 15–20 $\mu g/m^3$ by the year 2047 due to climate change (Woo et al., 2020).

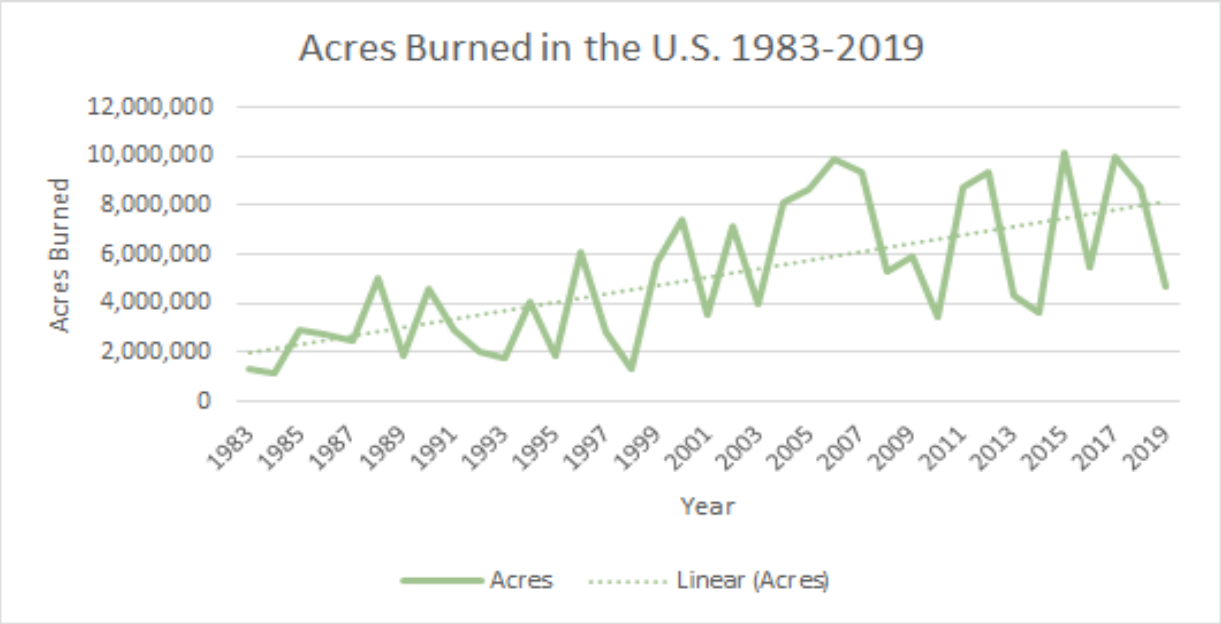

Figure 3. Acres Burned in the U.S. 1983-2019. Data source: National Interagency Fire Center.

In 2020, like in many recent years, wildfires particularly impacted the western regions of the U.S. While air quality impacts from these wildfires have been detected as far away as the east coast of the U.S., those closer to the fires generally experience greater air quality impacts. Alaska and the western U.S. have very high numbers of Tribal communities (231 Tribes in Alaska and a combined total of 215 Tribes in the 11 western states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming; these 446 Tribes represent nearly 78% of the total number of federally recognized Tribes in the U.S.), many of whom have experienced direct impacts to their air quality from wildfires in recent years:

- Among the 11 western states, all 215 Tribes experienced episodes of "thick density" smoke (21–32 $\mu g/m^3$) between September 1, 2019, and September 30, 2020, affecting 149,608 square miles, or 95,749,120 acres, of Tribal land. For point of reference, this is nearly the size of the entire state of California, which is 105,000,000 acres. (J. Payne, personal communication, November 18, 2020.)

- The Hoopa Valley Tribe in California declared a state of emergency due to smoke impacts in September 2020 following the Red Salmon Complex Fire; then, during the first week of October, their air quality index (AQI) registered in the 400s to 500s with spikes up to 1,500 $\mu g/m^3$ for $PM_{2.5}$ for 10 days straight (for reference, an AQI of 250 $\mu g/m^3$ or above is considered "hazardous"). (B. McCaughey, personal communication, October 14, 2020.)
- The Yurok Tribe in California has had episodes of unhealthy air quality from smoke impacts for 15 of the last 21 years, but the summer and fall of 2020 had the worst air quality impacts since 2008. They measured AQIs in the 300s to 400s for several weeks in a row, and the first week of October remained in the 400s to 500s with spikes up to 600. (J. Hostler, personal communication, October 13, 2020.)
- The Confederated Tribes of the Colville Reservation in Washington lost 78 homes and 60 other buildings in the Cold Springs Fire, plus 14 homes and other structures in the Inchelium Fire Complex. There were 13 days in September that the AQI was in the unhealthy, very unhealthy, or hazardous ranges due to the Cold Springs Fire. (K. Ray, personal communication, October 8, 2020.)

Cultural or Indigenous burning is a traditional practice that has been utilized by Indigenous peoples for millennia in order to enhance the health of the land and its people (Boutsalis, 2020; Marks-Block, 2020). Continuing the practice of cultural burning of the landscape is one way Tribes are not only exerting their sovereignty, but also leading the way in reducing the frequency, size, and intensity of wildfires and therefore lessening the risk of diminished air quality. Decreased precipitation and changing precipitation patterns have led, in many cases, to an excess of underbrush and nonnative species that need to be cleared in order to prevent eventual uncontrolled burning. Regular cycles of burning that take place under favorable weather conditions and with careful supervision can prevent catastrophic burning under adverse circumstances.

This reduction in risk, however, is just one benefit among many that exemplifies the interconnected relationship with the Earth that is integral to Tribal cultures. (See *Chapter 4: Ecosystems & Biodiversity.*) In addition to clearing undergrowth, dead leaves, tree limbs, and other debris, Tribes may engage in cultural burning to stimulate the growth of desirable, native vegetation and reduce the spread of invasive species and pests, which are becoming more prevalent due to warmer conditions resulting from climate change. For example, burning blueberry fields helps control pests such as mummy berry, flea beetles, and spanworm (Fater, 2020). Some seeds, such as those from certain pine species, cannot be released from their cones without fire (*National Geographic*, n.d.). Burning also returns nutrients to the soil and allows additional sunlight to penetrate forests, supporting new growth (*Id*.). Soils can be impacted by climate change through changes in temperature and moisture patterns and by erosion caused by frequent high-intensity precipitation events (Hamidov et al., 2018). Habitat improvements resulting from controlled burns also have been shown to positively impact fish and wildlife populations, and regenerated vegetation can provide food for moose and grouse (Woodford, 2003). Increased populations of small mammals provide food for raptors (*Id.*). Wildfire smoke appears to have a cooling effect on water temperatures by blocking solar radiation, benefitting cold-water species such as salmon (David et al., 2018).

While cultural burning activities have been practiced throughout time by some Tribes, others have been unable to do this due to restrictions imposed by local, state, or federal authorities. However, there is now additional momentum and legal authority for continuing these practices, along with scientific evidence to support the important role that fire plays on the land. Members of the Yurok, Karuk, and Hoopa Tribes in California have reached out to other Tribes, nonprofits, and land management agencies to form training and support networks for local burns (Buono, 2020). (See also *Chapter 4: Ecosystems & Biodiversity*.)

Although it is not one of the more frequent observations, changes in wind strength and direction have been observed by Indigenous communities, particularly by people in the tropical Pacific and Arctic regions (Savo et al., 2016). Extreme wind events such as Santa Ana or Diablo winds are exacerbating wildfires by driving them or by leading to the failure of electrical infrastructure, which can ignite extreme fire events and contribute to drying conditions, thereby heightening drought impacts. These dry winds have been documented to drive fire and smoke across large landscapes, knock down power lines (causing mass blackouts), spark wildfires in backcountry settings, and heighten the danger of fire ignition. Urbanization, particularly in southern California, puts not only the endangered chaparral landscape at risk, but nearby communities as well. The 2020 August Complex Fire in northern California was the largest complex fire in the state since record-keeping began, according to data from CAL FIRE, while the Creek Fire in September 2020 was the largest single fire (ABC7 News, 2020).

Tribes in the northwest U.S. experienced an anomalous wind shift (both direction and speed) that led to the expansion of the Labor Day fires of 2020 (J. Hostler, personal communication, October 13, 2020). This shift in wind dynamics has cascading effects on ecosystems, such as pollination, smoke dispersion, animal behavior, environmental cues for hunter navigation, tidal surges, sea ice conditions, and precipitation delivery. Indigenous communities living subsistence lifestyles not only tend to be more aware of these dynamics, but their lifestyles are also more dependent on understanding these shifts and changes in order to make adaptive responses. Additionally, changes in wind will have an impact on Tribal (or anyone's) plans for wind energy development. (See also *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets* for discussion of wind energy potential on Tribal lands.)

Extreme Heat and Humidity

With climate change comes increased heat in most locations. In the U.S., the past five years have been the hottest years on record, and the year 2019 completed the hottest decade on record (Climate Central, 2020). Many Tribal people work outdoors in settings where they are raising food or tending animals related to food production. This could include farming, raising sheep or cattle, gardening, fishing, or gathering food products. Rising temperatures and humidity can put these people at risk of heat stroke or other heat related health problems, particularly in southern areas of the country.

In places like the Four Corners Region of the Southwest, trends indicate the largest increases in temperature are occurring in the winter minimum temperatures, summer minimum temperatures, and summer maximum temperatures (Meadow, 2018; Ute Mountain Ute Tribe, 2020). Extreme heat and

higher nighttime temperatures have big impacts on Tribal members. The Ute Mountain Ute Tribe (2020) interviewed elders about their observations on changing climatic conditions. These interviews indicated that extreme heat has negative impacts on their health (due to heat stress and lack of reliable access to air conditioning) and leads to higher electric bills in the summer (for those with access to air conditioning). In some cases, elders have decreased participation in traditional and cultural activities, due to extreme heat.

Higher temperatures lead to increased ozone formation due to accelerated chemical reactions in the atmosphere. According to the EPA, high ozone levels can adversely impact sensitive grasses, forbs, shrubs, and trees, which are important to the cultural practices and lifeways of AI/AN people, who use those plants for economic benefit, personal subsistence, food sovereignty, medicines, and other traditional practices. More than 30 ozone-sensitive plants used by Tribes have been identified by the EPA (EPA, 2014).

Extreme heat and drought both lead to more frequent and more intense wildfire events, which can emit thousands of tons of pollutants (Peterson et al., 2013). In addition to these increased levels of pollutants, higher air temperatures can lead to weather conditions that cause stagnation, trapping these pollutants in the lower atmosphere where people live and breathe. Drought events associated with high temperatures can keep the air dirty, as falling precipitation tends to cleanse the air of these pollutants. The combination of heat stress and increased drought can also lead to crop failure (Ute Mountain Ute Tribe, 2020).

Rising CO_2 levels contribute to increased growth and pollen levels in plants such as ragweed that cause human allergies and asthma attacks. Increased temperatures can lead to longer growing seasons, which extends the length of time that people are exposed to allergens. Further, allergens can interact with air pollutants in ways that amplify their individual impacts (National Wildlife Federation, 2010).

Warmer winter minimum temperatures in the Midwest will allow for increased survival of pests or pathogens. For example, the nonnative emerald ash borer (EAB) has decimated ash populations throughout its range and has been expanding its range as winter temperatures are less frequently reaching levels that would keep EAB populations in check (Poland & McCullough, 2006). (See narrative titled *Climate Change and Invasive Species on the Fond du Lac Band's Lands* in *Chapter 4: Ecosystems & Biodiversity*.) The longer growing season will also give EAB and other invasive (nonlocal) beings time and habitat in which to expand their ranges. White-tailed deer will be able to expand their ranges and population, which can have major effects on plants browsed by deer or on other beings such as moose, which can be impacted by diseases spread by deer (Weiskopf et al., 2019). Decreased ice cover on lakes will affect the timing of spawning for walleye and other fish, as well as make northern lakes more vulnerable to invasive species, algal blooms, etc.

Higher levels of relative humidity have been shown to lead to increased formation of secondary particulates, especially sulfate and nitrates. This can have a marked impact on visibility, particularly in the winter (Liu et al., 2018). High humidity can lead to formation of secondary particles of larger than

usual size, which can then trap pollutants near the ground along with excess water vapor, causing a self-amplification mechanism (Tie et al., 2017).

Many individuals, especially older people, experience health impacts during extreme heat events. Heat can place increased stress on individuals with cardiovascular disease, diabetes, obesity, or respiratory disease, leading to increased rates of heat illness or potentially death (Kenny et al., 2010). High levels of humidity can act in conjunction with higher temperatures in putting additional stress on human bodies by impeding the body's ability to cool itself. High humidity can also be dangerous because bacteria and viruses thrive in humid conditions. The lower socio-economic status of many Tribal Nations has led to a disproportionate number of Tribal people living in substandard housing that lacks proper insulation or cooling systems to allow for cooling spaces on the hottest and most humid days. It is unclear what impact humidity has on the coronavirus and its epidemiology, which is a topic in need of further study.

Indoor Air Quality

During wildfire and prescribed fire smoke events, the protocol to protect health is often to shelter in place. However, indoor environments can also expose people to high levels of smoke, particularly if they do not have air conditioning and rely on open windows to cool their indoor spaces, as many Tribal people in the West do. Additionally, commercial air filters can be cost-prohibitive. Many Tribes are actively addressing these dual concerns through Smoke Ready Communities and do-it-yourself indoor air filter box fans.[14] The Air Quality Program (AQP) of the Confederated Tribes of the Colville Reservation has been a leader in developing Smoke Ready Communities[15] information, providing webinars, printed information, and other forms of outreach and education, in addition to their air quality monitoring. Colville's AQP is funded by an EPA §105 Clean Air Act grant and is governed under EPA's FARR. This structure and financial support allow the Colville Tribe to invest deeply in building their AQP and protecting the health of their Tribal and community members.

Increasing temperatures and rising humidity levels both contribute to increases in mold and fungi growth inside of homes and buildings. Mold can lead to health impacts such as coughing or wheezing, asthma attacks, nasal congestions, and shortness of breath (Centers for Disease Control and Prevention, 2020). High indoor humidity can also lead to higher levels of airborne chemical contaminants due to off-gassing from carpet or household wood products. This can lead to skin, eye, and throat irritation (Arundel, 1986). Indoor air pollution is an environmental justice issue, as exemplified by the flooding event in the summer of 2012 on the Fond du Lac Band of Lake Superior Chippewa's Reservation, which caused extensive mold damage to several homes. Workers removed wet carpeting from over 60 homes following this incident; inadequate response from state and federal agencies in the aftermath of this flood showed the Band that they must be self-sufficient in taking care of Band members' needs, as these other agencies were overwhelmed and unable to respond on the Reservation.

[14] Colville Tribe's DIY Box Fan Filters https://www.cct-enr.com/box-fan-filter

[15] Colville Tribe's Smoke Ready Community Resources https://www.cct-enr.com/smoke-ready-community

Many Tribes across the nation have taken steps to address indoor air quality, such as conducting radon testing and mitigation activities, educating Tribal members on mold prevention and removal, and exchanging old, poorly operating woodstoves with updated, cleaner versions. The organization Trees, Water & People[16] works with rural communities to replace open-fire cooking methods with clean cook stoves, greatly improving indoor air quality and reducing the amount of firewood needed for cooking.

Air Monitoring

As of 2020, a total of 88 Tribes operate air monitors that are funded through EPA (NTAA, 2020), representing just 15% of the federally recognized Tribes in the country. Many of those air monitors are more than 10 years old and are reaching or have exceeded their lifespans. (See narrative titled *Kootenai Tribe of Idaho Air Monitoring Equipment*.) Without properly functioning air monitors, Tribes' ability to protect their members' health from wildfire smoke impacts and other air quality pollutants is truncated. Additional challenges experienced by some Tribes, particularly those located in remote areas of Alaska, include the difficulty of maintaining air quality monitoring networks when access to the area is limited to travel by boat or small aircraft. This adds to the costs and widens the data gaps (Edwin & Mölders, 2018). Alaskan Tribes and Villages not only have a limited network of air quality monitors, but the $PM_{2.5}$ monitors that are in place measure the total mass of $PM_{2.5}$ without differentiating between $PM_{2.5}$ from wildfire smoke, road dust, vehicles, etc. (Woo et al., 2020). On top of wildfire smoke impacts, dust is also an increasing concern for many Tribal communities both within the Alaskan interior and in places such as the desert Southwest, where dust impacts are increasing due to drought conditions that are exacerbated by climate change. In the Southwest, fine and coarse dust are projected to increase significantly (57% and 38%, respectively) (Achakulwisut et al., 2019). These increases are predicted to lead to increases in climate-attributable cardiovascular diseases and mortality, asthma-related hospital visits, and other forms of dust-related morbidity and mortality, coupled with economic impacts. Most studies focus on the human dimensions of dust, smoke, and other particulates, and there is little research on climate-attributable effects on wildlife upon which Tribes depend. Without robust and accurate data, it is difficult for Tribes to begin to address these problems.

In order to expand the network of air monitoring with low-cost monitors, some Tribal communities—including many in Alaska—are turning to PurpleAir sensors (see narrative titled *Nottawaseppi Huron Band of the Potawatomi's Particulate Matter Monitoring Program*), which can be easily installed for about $200 anywhere that has electricity and a wi-fi connection (Ellis, 2019).

Some Tribal environmental programs choose to monitor air quality and run air programs despite not having any dedicated funding, such as through CAA §103 or §105 grants. The Hoopa Valley Tribe, for example, does not have CAA §103 funding. Nonetheless, they operate two $PM_{2.5}$ monitors and are partnering in a project called the ASPIRE[17] (Advancing Science Partnerships for Indoor Reductions of Smoke Exposures) study to study the impacts of wildfire smoke on indoor air quality and mitigate

[16] Trees, Water & People: https://treeswaterpeople.org/

[17] ASPIRE https://www.epa.gov/air-research/wildfire-study-advance-science-partnerships-indoor-reductions-smoke-exposures

exposure to community members. Tribes in California also have excellent working relationships with the California Air Resources Board, which often provides support during wildfires. Although beneficial to both parties, cooperative projects like this are too few in number and should be widely expanded.

Recommendations

Tribal Engagement and Regulatory Authority

Tribal sovereignty and the role of Tribes as regulatory authorities should be acknowledged by federal, state, and local entities to a greater extent. This would lead to increased Tribal involvement in key issues regarding climate change. Specifically, Tribes should be involved as co-regulators in the very first stages of regulatory planning and development and in the implementation and enforcement of regulations. Policy revisions should encompass environmental justice, equity, diversity, and inclusion, as well as access to data and training.

Funding

Adequate funding is needed for multiple reasons. It is required for staffing, monitoring, and emergency response to air quality issues related to climate change, especially the increasing frequency and extent of wildfires. Tribes also need to be able to keep experienced staff in place because of the value of institutional knowledge. Increased funding allows Tribes to effectively participate in multijurisdictional organizations, work collaboratively on key issues, and truly be a part of air quality policy and implementation. It also allows Tribes to replace outdated and failing monitors.

Tribal Sovereignty; Systemic, Transboundary, and Justice Issues; and the Social Determinants of Health and Vulnerability

The air quality issues associated with climate change highlight the need for regulatory agencies to respect Tribal sovereignty, as these are interrelated problems that are systemic and transboundary in nature and cannot be solved by any one party, but only through respectful interactions and relationships. Solutions that are effective, ethical, and compliant with treaty and other obligations must address underlying causes of environmental, social, and health inequalities and injustices. AI/ANs' actions alone are not sufficient. Many social determinants of health, vulnerability, and environmental justice issues arise outside of their lands and cannot be addressed without their full and effective participation and accommodation in all climate-related decisions that affect their rights, air quality, and health.

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Chapter 4.2: Water

Water-related impacts from climate change are of particular concern to Tribes. The first two narratives explain how two Alaskan partnerships, the Southeast Alaska Indigenous Transboundary Commission (SAITC) and the Southeast Alaska Tribal Ocean Research (SEATOR), each composed of 15 U.S. Alaskan Tribes, collectively work together to face climate change issues. The SAITC fights with upstream Canadian mining companies that pollute their waterways by leakage from mining storage facilities that are weakened by climate change. The SEATOR tests subsistence shellfish samples for PSP toxins, which could be lethal to Tribes. Due to the changing climate, the Tribes cannot rely on traditional knowledge and observations to determine if the shellfish are safe to eat. In the lower 48 states, narratives from the Pyramid Lake Paiute Tribe of Nevada, Chickasaw Nation of Oklahoma, Fond du Lac Band of Lake Superior Chippewa, Crow Tribe of Montana, and the Eastern Shawnee Tribe of Oklahoma describe documented evidence of climate change. These Tribes have experienced severe water temperature changes, variance in precipitation frequency and amounts, and an increase in severe weather events. All these changes have had a direct effect on the Tribes' beneficial uses and subsistence lifestyles. A researched overview of Water as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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The Southeast Alaska Indigenous Transboundary Commission

Written by: Frederick Olsen Jr., Executive Director

Formed in 2014 as the United Tribal Transboundary Mining Work Group, the Southeast Alaska Indigenous Transboundary Commission (SEITC) is a consortium of 15 federally recognized southeast Alaska Tribal governments created to protect Tribal

lands and waterways for future generations. Each SEITC representative on our Board of Directors is elected or appointed by their Tribal Council. Tribes notify SEITC of representation by a Tribal Council resolution or letter from their Tribal President.

The Stikine, Taku, and Unuk Rivers flow from British Columbia, Canada, into Alaska.

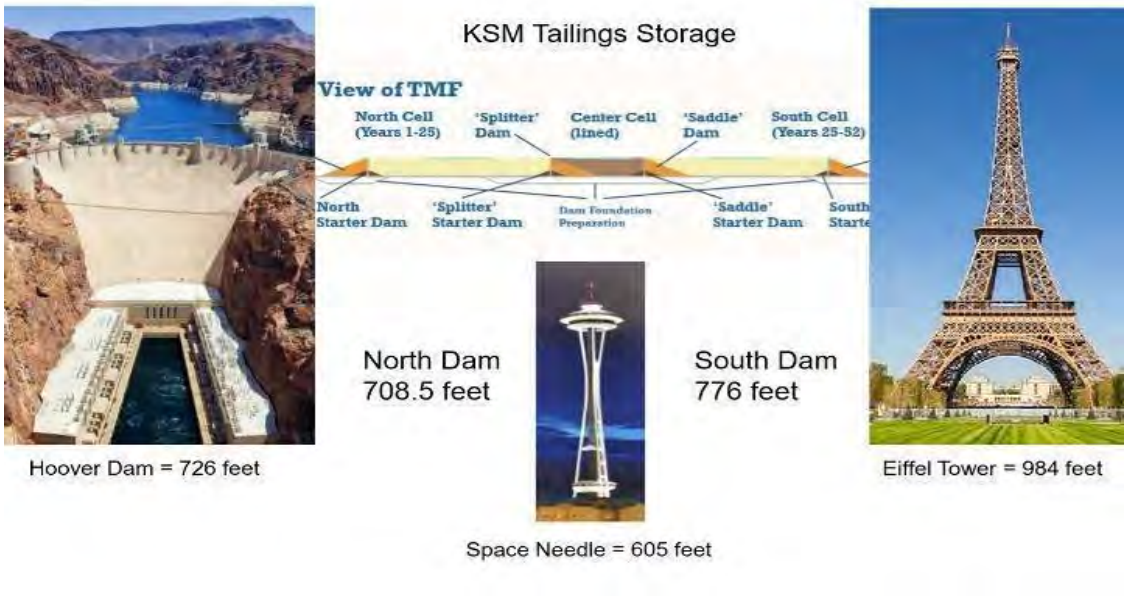
Where we live, in southeast Alaska, we are within the largest stretch of temperate rainforest left on Earth. Climate changes have already occurred in our lifetimes: paralytic shellfish poisoning is common now and each year concern grows for shellfish consumption, yellow cedars are in decline due to less lasting snowfall in winter, and fish habitats are under siege.

Tulsequah Chief Mine site, Taku River watershed, British Columbia (Credit: Colin Arisman, The Narwahl).

We seek to protect our customary and traditional ways of life and shared headwaters of our transboundary rivers. Our diverse, isolated communities depend on healthy rivers and watersheds for natural foods, medicines, and maintaining our cultural connections to the land that we've lived on since time immemorial. We have concerns regarding our shared transboundary watersheds facing threats from major industrial mining projects in British Columbia, Canada.

As polluted waters travel downstream, they destroy delicate ecosystems and devastate wildlife populations, such as those of wild salmon. While mining activities generate business in BC, the social and environmental cost is borne downstream by Indigenous communities who currently lack a say in how their region is managed.

A major way that climate change enters the transboundary equation is the so-called tailings storage facility of many industrial mining projects, aka a Lake of Poison left behind after operations cease. These lakes of poison need to be monitored for at least 200 years each. The proposed Kerr Sulphurets Mitchell (KSM) Mine would have two such dams, each taller than Seattle's Space Needle.



Huge dams proposed for passive water treatment at KSM project in BC.

As you read this, the abandoned Tulsequah Chief Mine continues to pollute the Taku River watershed since operations stopped in the 1950s. The BC government recently announced a new plan for the site and pledged nearly two million dollars but has not yet acted to clean this up. If they will not clean up a minor blemish like Tulsequah Chief, what will happen when a mega-mine's lake of poison (tailing storage facility) breaks loose into our shared watersheds? And taxpayers will pay.

For most people, we live in the middle of nowhere. We are all involved in our Native communities, and these values are part of our everyday lives. Sharing the customary and traditional values with non-Natives is essential for harmony between cultures. We continue to share life experiences on transboundary and BC rivers as a way to raise awareness. Our online visual production, "When the Salmon Spoke,"[18] helped to put a "face" to the rivers and the people who live there.

SEITC has been nurturing relationships with First Nations for several years. In order to create unity and dialogue between Alaska Tribes and First Nations sharing transboundary watersheds, SEITC has held two Indigenous leaders' summits. We are currently planning our third summit.

[18] When the Salmon Spoke: https://vimeo.com/424432430

The upcoming summit will be centered around the deterioration of the salmon stocks in the region. Attendees will be asked to research possible solutions prior to the meeting. Indigenous people have an obligation to take care of the land and water. SEITC and our First Nations partners are committed to working together to amplify clean water issues. Outreach to youth is a component of this objective. At the last summit, an Alaskan emerging youth leader attended as well as a BC university student. Plans are underway to have more youth involved with the next summit.

Southeast Alaska Tribes Face Climate Change with Partnership

Written by: SEATOR/Sitka of Alaska

Southeast Alaska is a place like no other. Coastal brown bears stalk the shores, old growth forests grow tall, and salmon serve as the lifeblood of the region. It is home to the Tlingit, Haida, and Tsimshian people, who have served as the environmental stewards of these lands since time immemorial. Their stewardship continues to this day. However, this stewardship has been forced to adapt because of climate change. The timing, abundance, and safety of subsistence foods has undergone significant changes. This is especially true for the subsistence resource shellfish. Shellfish is found in abundance throughout southeast Alaska. Typically, shellfish provide a healthy food source that is easily accessible to southeast Alaskans. However, in a changing climate, this once easily obtained food source can be deadly.

Shellfish harvested for subsistence toxin testing.

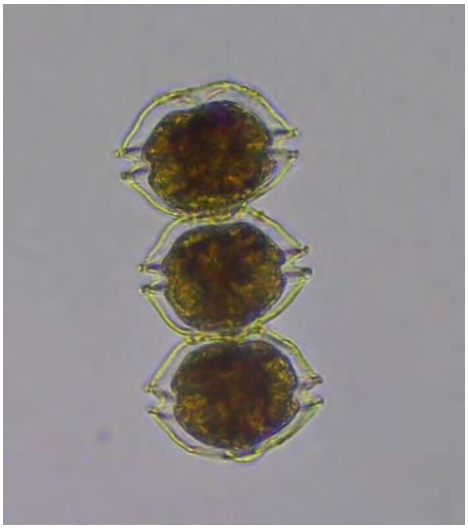
Shellfish are filter feeders. They filter seawater that is brimming with their food of choice: plankton. Once the waters warm and the sun returns in spring and summer, plankton grow wild, turning clear waters to a rainbow of colors. Some of these plankton are known as harmful algal bloom (HAB) species. If these HABs become abundant, the shellfish that consume them become toxic themselves, posing a risk to human and animal health.

The occurrence of HABs in southeast Alaska is not new or different. The Indigenous people of this area knew that during summer months shellfish were unsafe to eat. Many adages exist that describe the transition in shellfish consumption risk such as, “Don’t harvest shellfish once the herring return,” “Only harvest shellfish in months with an R,” and “Only harvest shellfish when there is snow on the mountains.” These adages, based on millennia of land and ocean observing, are no longer true in a changing climate. In fact, the state of Alaska suggests that people do not harvest wild shellfish and instead purchase it. For people who rely on subsistence, this is not a viable solution.

To ensure the access of subsistence shellfish in southeast Alaska, 15 Tribes in the region are working together to better understand when, where, and what species of shellfish can be gathered with less risk of exposure to HAB toxins. This network is called Southeast Alaska Tribal Ocean Research (SEATOR). SEATOR partners are located as far north as Yakutat and as far south as Metlakatla, spread out by nearly

500 miles of land and 18,000 miles of coastline. Partners sample plankton and shellfish in their local communities to understand the risks associated with eating shellfish in their community.

SEATOR partners scan surface seawater using a microscope looking for HAB species such as *Alexandrium* and *dinophysis. Alexandrium* is the most likely HAB species to be in Alaskan waters, and it can be very dangerous. When toxins from *Alexandrium spp.* accumulate in shellfish and people then consume those shellfish, people can get sick with paralytic shellfish poisoning (PSP). PSP can cause tingling lips and fingertips, difficulty breathing, and, in the worst cases, even death. If someone contracts PSP, they need to be treated in a hospital immediately. However, most communities in southeast Alaska are remote and rural, often hours away from medical facilities.



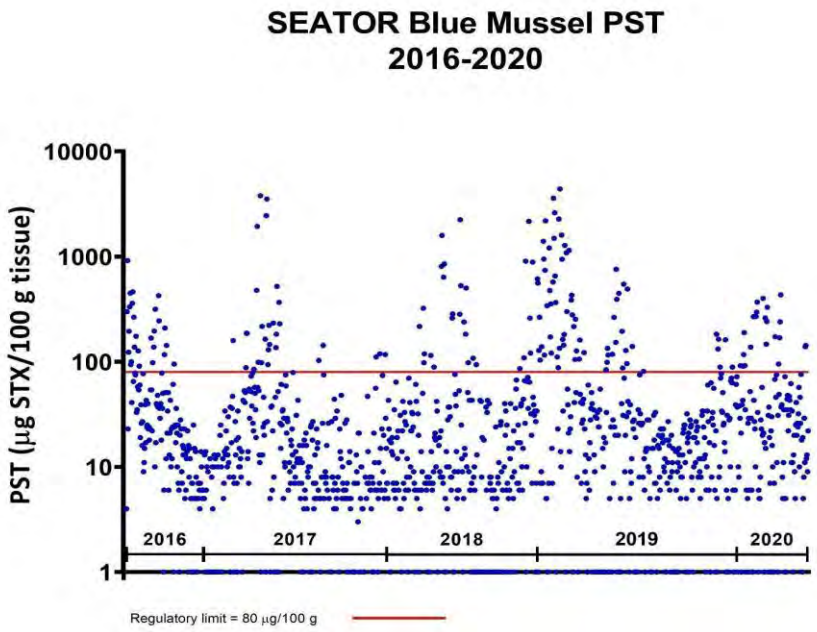
Alexandrium observed in a phytoplankton tow sample in southeast Alaskan waters.

In addition to looking for the presence of the HAB species in their surface seawater, SEATOR partners also send shellfish samples to the Sitka Tribe of Alaska Environmental Research Lab (STA-ERL) to be tested for toxins. STA-ERL has been in operation since 2016 and has tested over 2,000 subsistence shellfish samples for PSP toxins. The shellfish toxin data from SEATOR partner beaches is astonishing and one of a kind. Before the SEATOR data set, no data set of this magnitude ever existed in southeast Alaska. Unfortunately, what it reveals can be scary. Indigenous people from the region knew not to harvest shellfish in the summer months. The SEATOR data set supports this idea fully. Starting in April, shellfish in many communities exceed the regulatory limit for PSP toxins. However, due to changing climate conditions, some species of shellfish are exceeding the regulatory limit during all months of the year. This means that there is no longer a time of year when you can assume your shellfish will be safe to eat. During the summer months, southeast Alaska is seeing large and pervasive HABs. The shellfish accumulate the toxins from these HABs and then don't depurate the toxins. In fact, 76% of all butter clam species tested are above the regulatory limit.

The largest of these HAB and shellfish toxin events was tracked by SEATOR in the summer of 2019. Two hundred sixteen shellfish samples were above the regulatory limit that year, and only two communities did not have any species exceed the regulatory limit. The highest sample analyzed was a blue mussel with over 4000 µg of toxin per 100 g of tissue. This is more than 50 times above the regulatory limit.

Collecting plankton and testing shellfish are not enough. The SEATOR network also needs to make sure this information is communicated to over 50,000 people living in southeast Alaska. SEATOR has an email list, a website, and a Facebook page they use to distribute data. However, the real power of the network is the environmental coordinators that live in each community. They share the message far and wide with their communities in a way that fits locally. That may be an announcement on the local radio

station, a flyer up at the post office, or a sign on the local Clam Hub that is located at the entrance of the beach.



SEATOR blue mussel paralytic shellfish toxin data between 2016 and 2020. All samples above the red line exceed the regulatory limit.

The climate is changing. Subsistence resource availability is unknown. However, the SEATOR network is making huge strides to understand, adapt, and protect the people who call southeast Alaska home. In the coming years, SEATOR partner communities will continue to fight climate change with innovation and partnership.

SEATOR partners at the 2019 annual SEATOR Workshop

SEATOR Partners:
Craig Tribal Association
Chilkoot Indian Association
Hoonah Indian Association
Hydaburg Cooperative Association
Central Council Tlingit and Haida Indian Tribes of Alaska
Organized Village of Kasaan
Organized Village of Kake
Klawock Cooperative Association
Ketchikan Indian Association
Metlakatla Indian Community
Petersburg Indian Association
Sitka Tribe of Alaska
Skagway Traditional Council
Wrangell Cooperative Association
Yakutat Tlingit Tribe

Climate Change Impacts on Water Quality and Aquatic Life, Pyramid Lake, NV

Written by: Daniel Mosley, Fisheries Director – Pyramid Lake Paiute Tribe, NV

Pyramid Lake and over 30 miles of the lower Truckee River lie entirely within the reservation boundaries of the Pyramid Lake Paiute Tribe located in northern Nevada. Pyramid Lake is a terminal lake for the Truckee River Watershed. Several long-term effects have been observed due to the region's changing climate over the last 120-plus years.

Pyramid Lake loses approximately 4 feet of lake elevation annually due to evaporation, which means 424,000 acre feet (AF) of water is needed from the Truckee River flows to maintain lake level. As the population increased in western Nevada from 1900 to 1967, Pyramid Lake dropped approximately 80 feet in elevation and lost 10.7 million AF of water due to Truckee River diversions and out of basin diversions to the Newlands Project (Figure A).

During the extended drought of the 1930s, Winnemucca Lake dried up, and the original strain of Lahontan Cutthroat trout (*Oncorhynchus clarkii henshawi*) saw their last spawning run in 1938. As total dissolved solids (TDS) levels increased (Figure 2), species abundance and diversity decreased. Pyramid Lake lost two native cyprinids, the speckled dace (*Rhinichthys osculus*), and the Lahontan redside shiner (*Richardsonius egregious*). Both were important to the diet of the piscivorous Lahontan cutthroat trout. Since 1866, Pyramid Lake TDS has increased from 1,500 to 5,900 mg/L. Many snail shells can still be observed along the beach shores of the lake, the result of lowering lake levels and rising TDS in a lake that has had no outlet since the early 1900s.

Pyramid Lake received a total of only 700,000 AF of water from the Truckee River from 1987 to 1994, which resulted in a 24-foot drop in lake elevation (Figure B). During this period, Tribal water quality staff

observed an anoxic layer of low dissolved oxygen at the bottom of the lake, which extended from 5 meters to 30 meters from the bottom. This anoxic layer prevented the lake from completely turning over during winter during the later years of this drought period. Pyramid Lake elevation rose 25 feet during a five-year period (1995 to 2000) and then dropped 26 feet during an extended 16-year drought through 2016.

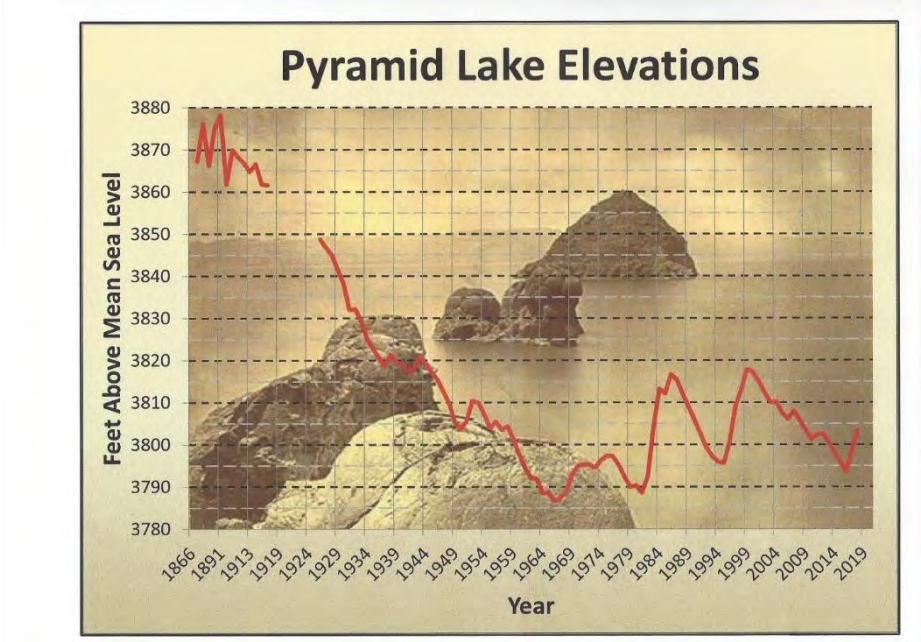


Figure A. Pyramid Lake historical water surface elevations (USGS data).

Pyramid Lake TDS increased from 1986 to 1994 and from 2000 to 2016 (Figure B). During these periods of drought, lake levels dropped 24 feet. In the early 1990s, Pyramid Lake Fisheries observed that spawning Lahontan cutthroat trout were getting smaller in size, to the point the Tribe implemented a

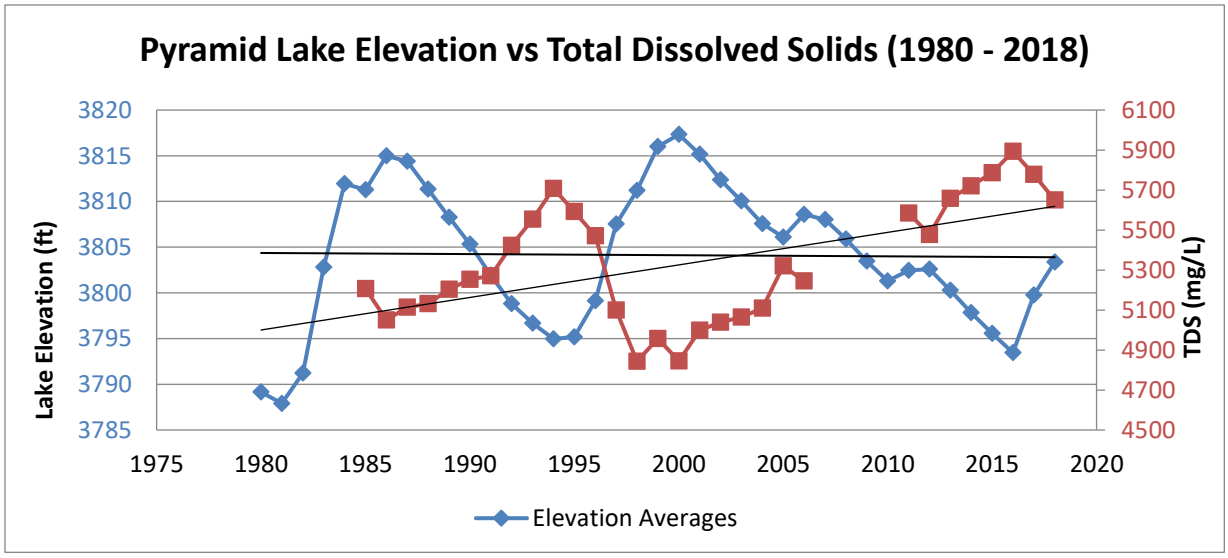
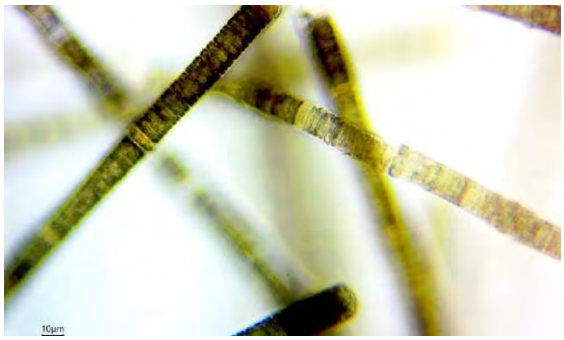


Figure B. Pyramid Lake TDS.

slot limit of 19 to 24 inches to protect bigger spawning fish. A limit of only one fish per day that was over 24 inches was implemented to protect the trophy-size fish populations. Increasing TDS levels have also affected the size and abundance of Tui Chub (Gila bicolor), the primary food source for the bigger Lahontan cutthroat trout.

Since 1987, the mean average temperature of Pyramid Lake and the Truckee River has increased over 2°C. This has led to higher water temperatures, increased levels of nitrogen, and increased occurrences of cyanobacteria blooms in Pyramid Lake. Testing results from five Pyramid Lake samples collected on 7/10/2020 and 7/14/2020 resulted in nodularin toxin concentrations from 2,000 µg/L to 10,000 µg/L, which were some of the highest toxin concentrations the contract lab had ever seen. Nodularia spumigena is a heptatoxin that can damage the liver.

Data obtained from the Western Regional Climate Center (WRCC 2020a) depicts a general warming trend for the Truckee River basin (Truckee Hydrologic Unit Code [HUC] 16050102) dating back to the early 1900s (Figure C). This warming trend has sharply increased since about 1980, continuing through the baseline period for this consultation. Since 2000, Tribal water quality staff have observed increased abundance of periphyton (filamentous algae) and tolerant benthic macroinvertebrates (planaria, snails, dipterans, etc.) during Truckee River sampling events.



Nodularia spumigena.

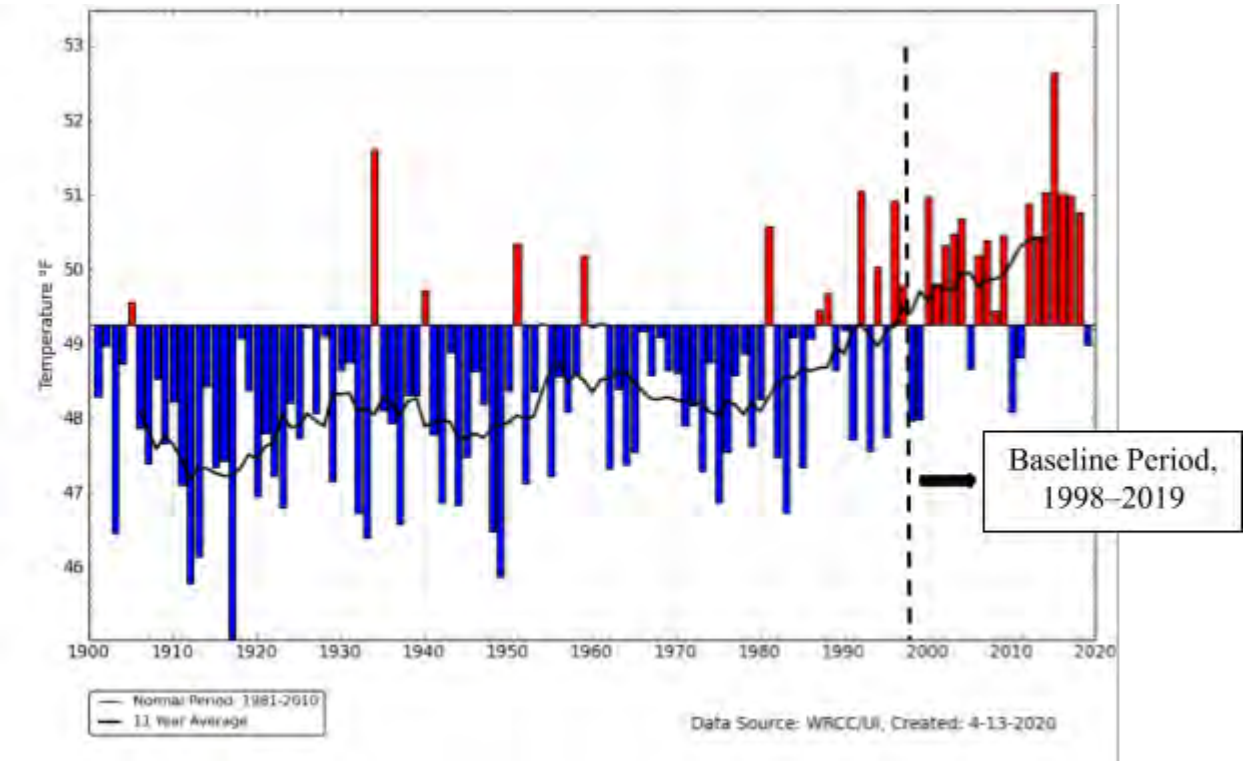


Figure C. Mean temperature by water year (ending in September) for the Truckee HUC, 1900–2019. Data source: Western Regional Climate Center (WRCC 2020a).

In conclusion, the Pyramid Lake Paiute Tribe has observed and documented evidence of climate change affecting water quality, increasing frequencies of algal blooms, and decreasing the abundance and diversity of aquatic life sensitive to warming water temperatures and rising TDS levels. This has a direct effect on the Tribe's beneficial uses and the subsistence lifestyle of Tribal members living on the Pyramid Lake Paiute Indian reservation in northern Nevada.

Harmful Algal Blooms Targeted by Grassroots Watershed Organizations

Written by: Chaylum Hogue, Watershed Fire Planner RTRL – Chickasaw Nation

Background on Chickasaw Nation Watersheds

The Blue River and the Lake of the Arbuckles are both vitally important to the south-central region of Oklahoma for ecological and economic purposes. These waters provide drinking water supplies to local communities and habitat to many native aquatic species.

The Lake of the Arbuckles has a total capacity of 108,839 acre feet with a surface area of 2,350 acres. The Arbuckle Master Conservancy District operates and maintains the Arbuckle Lake Dam and water supply infrastructure. The Lake supplies water for the cities of Ardmore, Sulphur, Davis, and Wynnewood, as well as the refinery that is located near Wynnewood. Arbuckle Lake provides water supplies for many residents and agricultural practices and is an ideal fishing location for crappie, catfish, bluegill, white bass, and largemouth bass. The Lake is also important for tourism and allows for fishing, scuba diving, camping, and hiking at the nearby Chickasaw National Recreation Area (CNRA). The Lake, part of a greater watershed, receives water from the Buckhorn, Guy Sandy, and Rock creeks, which are all sub-watersheds. The Lake also receives groundwater in the form of spring flow from the Arbuckle-Simpson aquifer.

The Blue River is a system beginning near Roff, OK, with a southeast flow to near Durant, OK, ultimately becoming a tributary of the Red River at the southern border of Oklahoma. The River spans a length of 141 miles and is one of the last free-flowing streams in Oklahoma. The river contains a number of aquatic species (such as crappie, catfish, smallmouth, spotted, and largemouth bass) that draw anglers as a means of recreation. The River also contains other aquatic species, including subspecies of orange belly darter (orange throat darter and least darter), ringed crayfish, and rabbit's foot mussel, among others. The Blue River is an important water supply to the city of Durant on the lower end of the reach and is home to the headquarters of the Choctaw Nation of Oklahoma and Southeastern Oklahoma State University. There are landowners and producers along the stretches of the Blue River who also use it for personal water supply and for agricultural purposes, as well as mining companies that utilize the waters.

Algal Bloom Impacts on Chickasaw Nation Watersheds

Within these above-mentioned bodies of water, as may be found in many others under certain conditions around the country, is the occurrence of harmful algal blooms (HABs). The National Park Service staff for the CNRA have previously confirmed the presence of HABs. Testing conducted by the Oklahoma Department of Environmental Quality (ODEQ) had shown positive results for blue-green algae (BGA) blooms in the more remote areas of the Lake of the Arbuckles. The Lake has been listed on the U.S. Environmental Protection Agency's (EPA) 303(d) list for impaired waters due to dissolved oxygen issues. These BGA are naturally present microscopic organisms found in these waters. The BGA are photosynthetic organisms that need sunlight to survive and are typically found in the warm, shallow waters that are undisturbed and receive more sunlight.

Algal bloom presence in Lake of the Arbuckles. Photo credit: National Park Service at Chickasaw National Recreation. Area)

The HABs can occur due to a number of factors, which results in rapid growth or blooming of these organisms. Potential causes of increase in these blooms are increases in nutrients (phosphorus and nitrates) stemming from fertilizer runoff from agriculture or residencies, sewage discharge, or urban and industrial facilities; low water flows possibly due to drought; increases in water temperature; or changes in the water chemistry, such as pH or turbidity. In the case of increasing HABs, there is the potential for detrimental effects to aquatic life, requiring prevention of consumption of water as well as prevention of recreation in affected areas. Increased numbers and surface area coverage of HABs can lead to blocked sunlight into the water column. As the algae continues to consume available oxygen, the resulting effects may include fish die-offs. In the event of high enough concentrations, there is the possibility that cities may issue warnings to discourage drinking water from the taps, as the water treatment plants may not be able to remove the toxins.

Watershed Groups Target Impairments with Support of the Chickasaw Nation

The Lake of the Arbuckles had been listed on the EPA's 303(d) list for impaired waters. The Chickasaw Nation helped bring together a group of local landowners and producers in order to address issues in the Lake and to implement a series of best management practices on private lands. This resulting group has come to be known as the Lake of the Arbuckles Watershed Association (LAWA). LAWA and the Chickasaw Nation have partnered together to begin best management practices (BMP) within the watershed. The BMPs include:

- removing eastern red cedar to allow for reduced uptake of water supplies to this species
- opening grazeable acres
- allowing return of native grasses
- increasing habitat for ground-nesting birds
- monitoring soil health on their respective properties to evaluate and manage soil health over time
- altering grazing practices
- altering application of fertilizers in order to reduce runoff into the waterways leading to the lake

The Blue River also has a watershed group that was created from local landowners and producers who were concerned about the diminishing quality of the Blue River. This resulted in the creation of the Blue River Foundation of Oklahoma (BRFO). The BRFO is also partnering with the Chickasaw Nation on many of the same best management practices that LAWA has implemented. Blue River has not seen the HABs issue as Lake of the Arbuckles has, but both groups are working to implement practices for the conservation and overall health of their respective watersheds for current and future generations.

Water Temperature Impacts in the Great Lakes Region

Written by: Kari Jacobson Hedin from the Fond du Lac Band of Lake Superior Chippewa

Tribal communities in the Great Lakes Region have hunting, fishing, and gathering rights that are all linked to good water quality, which includes water temperatures that allow cold-water fish populations to thrive. The Fond du Lac Band of Lake Superior Chippewa has treaty rights in parts of Minnesota, Wisconsin, and Michigan, and they partnered with the 1854 Treaty Authority to write a Climate Change Vulnerability and Assessment Plan. The plan states that cold-water fish species, such as walleye and trout, will likely experience population reductions as water temperatures warm due to warming air temperatures, and Band members may be impacted by not being able to harvest subsistence levels of cold-water fish species. This is already playing out in the restrictions being put in place on fishing activities on Mille Lacs Lake. On a broad scale, researchers are observing large, frequent, and persistent algae blooms along the south shore of Lake Superior, which is alarming given that this is a deep, cold, oligotrophic lake. Larger, more frequent severe storms are causing the near-shore environment to become warmer and more nutrient-rich, leading to an unprecedented increase in summer algae blooms. The region encompassing the Fond du Lac Reservation experienced a drought coupled with warm summer temperatures in 2020, which reduced streams to baseflow levels at midsummer for the first time in many years. Resource Management staff conducted their midsummer backpack electroshocking surveys for fish and recorded water temperatures in brook trout streams that were above the chronic lethal limit for brook trout. In keeping with the temperature observations, Resource Management staff caught very few brook trout in these streams, and they noticed changes in fish assemblages, including their first-ever recordings of nonnative brown trout.

Brook trout, which is vulnerable to climate change on the Fond du Lac Reservation. Brook trout are under threat of being extirpated, as the Reservation contains mainly cool-water streams rather than cold-water streams, so they don't have major groundwater inputs to maintain cold-water temperatures.

Manoomin (wild rice), which is also vulnerable to climate change on the Fond du Lac Reservation. Manoomin thrived in 2020 after a localized drought, after experiencing nearly a decade of above-normal high-water conditions.

Elders' Reflections on Climate Change Impacts, Crow Reservation, South Central Montana

Written by: John Doyle and Margaret J Eggers – Crow Environmental Health Steering Committee

The Crow Reservation is located in the heart of our traditional homelands; we have been here for centuries. Our Tribe currently has about 14,000 members; some 8,000 of us live on our Reservation, with many other members living nearby on historic Crow lands. Concerned about the impacts of climate change on our water resources and subsequent threats to community health, we interviewed 30-plus Tribal Elders throughout the Reservation about changes they have experienced in their lifetimes.

Little Bighorn River, during Crow Fair. Photo by Kristen Galbraith.

There are many ways that climate change is impacting Crow water resources and health, both directly and indirectly. Over the past 70–80 years, we have seen a steady decline in winter snowpack, increasingly milder winters, and hotter summers. The prairies used to be white all winter long, and we could ice skate throughout the winter—it never went above freezing. Spring break up of ice on the rivers was a major event, recognized in ceremonies. There would be colliding ice chunks the size of car hoods and a foot thick. Now the prairies are brown for most of the winter, and we have mid-winter thaws; the river ice is thin and melts quietly away. Severe spring floods and wildfires are becoming more common. The existing data from weather stations confirm our historical knowledge; these data show that the snowpack in our river valleys has been declining for more than 100 years and is now less than half what it once was.

The Little Bighorn River is the source water for the public water treatment plant in Crow Agency, the largest community on the Reservation and the Tribal headquarters. With less winter snowpack in the mountains, and hotter summers, the summer flow in the River is lower and warmer than ever, often no more than ankle deep. The intake pipe for the treatment plant can be half out of the water, and we foresee future summers in which the river dries up by the time it reaches Crow Agency. Part of the problem is that the irrigators are diverting more water than ever out of the river. The water users' associations, which control the irrigation systems on the Reservation, are run by and for the benefit of the non-Indian farmers and ranchers, with no enforcement of Tribal water rights by the Crow Tribe. So, the impacts of climate change on our water resources are made worse by lack of effective sovereignty.

Little Big Horn College students electrofishing to test fish for mercury contamination. Photographer unknown.

If we look back in time, it helps us understand the situation we are in now. Tribes have never been given the authority to tax, so we have no tax basis to fund our government. Instead, we have been selling our land, water, and coal to support Tribal operations. Many years ago, we were manipulated into selling the rights to the Bighorn River for power generation, with an illegitimate threat of eminent domain. Some 45 years ago, after lengthy debate, the Tribe entered into a contract for coal mining. Mining has since been providing the jobs and tax revenue to support our Tribal economy. Now, as other cleaner energy sources are becoming cheaper than coal to generate electricity, our income from coal mining has collapsed. In a local Tribal community of 7,000–8,000 people, we have lost more than 1,000 jobs. Our Tribal government no longer has the revenue to function as it once did. For instance, the Tribe no longer contracts for solid waste disposal. Instead, the dumpsters in our communities are burned almost daily, and we breathe that acrid smoke for hours. Coal mining and climate change have become divisive issues, so there is no consensus from which to plan for adaptation to current and looming climate impacts.

Emery Three Irons collecting home well-water sample for analysis, Crow Water Quality Project. Photo by John Doyle.

Tribal community nonprofits, the Tribal College, and other grassroots organizations are addressing some of our communities' needs. The Crow Environmental Health Steering Committee has been working to understand the nature and sources of water contamination, the associated health risks, and how our changing climate is impacting Tribal water resources. We have been able to provide free home well-water testing to rural families and home water coolers with refillable five-gallon jugs for those lacking safe well water to drink. Currently we are working on other mitigation strategies to help water-insecure

families and to build community capacity to manage home plumbing and community water supplies. Other grassroots organizations work on educating our youth about Crow traditions around water and Western water science, on management of chronic illnesses, and on mitigating widespread food insecurity greatly exacerbated by the COVID-19 pandemic and accompanying further loss of jobs.

John Doyle, Emery Three Irons, and Mari Eggers collecting spring water sample for analysis from Chief Plenty Coups State Park, Crow Water Quality Project. Photo by Antonie Dvorakova.

Eastern Shawnee Tribe of Oklahoma's Climate Change and Water Quality Challenges

Written by: Debbie Dotson, Water Quality Officer

The Eastern Shawnee were part of an original Shawnee Tribe settled mainly in the Ohio River Valley but were relocated to Oklahoma in the early 1830s. By the 1870s, Tribal membership had declined to 69 Eastern Shawnee individuals, but current membership is approximately 3,600 and growing.

The Eastern Shawnee Tribe of Oklahoma is in the far northeast corner of Oklahoma, where 22 square miles of treaty jurisdiction borders Missouri to the east and Spring River to the west. Spring River and Lost Creek are the largest water bodies within Tribal boundaries, and both originate in Missouri and flow into Grand Lake in Oklahoma.

The Eastern Shawnee have faced several adversities through the years but have striven to become resilient, including resiliency in facing the climate changes that touch northeast Oklahoma. The Tribe is

Fishing after a flood, in what used to be a parking lot.

seeking means to be more proactive in preserving future water quality and quantity, as well as protecting the health of the people, fish, and wildlife.

Climate changes affecting water quality in the region include temperature changes, variance in precipitation frequency and amounts, and an increase in severe weather events. In the past 10 years, a severe drought, record flooding, and several tornado events greatly affected the area and every facet of life.

Parameters such as pH, salinity, water temperature, dissolved oxygen, nutrient levels, and bacteria counts are vulnerable to weather and climate changes. Many water dependent species are at risk when parameters vary for longer periods of time or to more extremes. Public health threats like harmful algal blooms, pathogens and toxins from storm water runoff, and high bacteria counts can be attributed to climate changes. Tornadoes bring debris and invasive plants, break down infrastructure, and destroy riparian trees. Small tornadoes have directly affected the area recently, as well as heavy winds with storm events.

Flooding carries in runoff pollutants, deposits sediment, washes out fish and wildlife habitat, and erodes riparian zones and infrastructure. The past three years have seen extreme rainfall events become more prominent, particularly in 2019. Severe flooding closed area towns, roads, and businesses and displaced many residents, leaving extensive damages and economic hardship.

On the other end of the spectrum, there was a recent drought from 2011 to 2013 that brought surface water levels to a very low flow, was detrimental to fish and wildlife, and reduced groundwater resources, greatly impacting our local wells, economy, and agriculture. Public health issues like algal blooms and bacteria in water also became concerns when the low flow combined with high temperatures.

Tribal culture, area socioeconomics, and agriculture are vital to Tribal resiliency. All these facets are vulnerable to climate changes. Northeast Oklahoma has a large Tribal population, with nine Tribes in Ottawa County alone. These Tribes may have differences in language and origins, but all have valuable parts of their culture related to water and the environment. Gathering of medicinal and culturally significant plants and foods as well as hunting and fishing for food are affected by variances in phenology.

Lost Creek with bank erosion visible on far side of the creek.

Lost Creek flows along the Eastern Shawnee powwow grounds, adding natural beauty to the area. Many Tribal people camp out along the creek during ceremonial times. Kids from the local area enjoy playing in the water and fishing for perch. The area is key to Tribal culture and events, and much care is taken to keep the grounds set apart. The powwow grounds at Lost Creek often have swimming advisories posted due to high bacteria counts in the summer, and those are cause for great concern for those who enjoy the creek with their family.

As with all Indigenous people, natural resources are valuable parts of Shawnee culture and tradition. Water is respected as a valuable component of Creation and something to be protected for future generations. The Eastern Shawnee Tribe of Oklahoma has an advanced Water Quality Monitoring Program (WQMP) and Nonpoint Source Pollution Prevention Program dedicated to the protection and improvement of water resources in Tribal jurisdiction and the watershed. Funding for these programs is through two U.S. EPA Clean Water Act grants.

Water Quality Officer teaching students about tree rings and climate change.

Climate change monitoring for the sector of water has been included in the WQMP for the past eight years, including daily precipitation and monthly salinity monitoring, staff training, outreach and education projects with youth, drought planning, developing articles for the Tribal newsletter, informational brochures, and hosting a regional workshop. Water Quality staff have worked closely with several federal agencies and Tribes to receive training and share information about climate effects.

For several years, bacteria sampling events have been conducted twice a week from Memorial Day to Labor Day each summer at recreational sites. Swimming advisories are posted as needed. Blue green algae monitoring was included in the program for the past two summers for Spring River. Groundwater well testing is offered to residents for free to determine whether that drinking water is still safe, even after a drought or a flood. Year-round surface water monitoring data is evaluated to note changes in water quality due to climate change, particularly related to temperature and precipitation. Information and education are a key component to the WQMP to keep the Tribe and the community aware of the status of the water quality.

The Eastern Shawnee Tribe's WQMP is a respected and long-standing program in the region and continues to pursue a more resilient future for water quality through monitoring and commitment to public health protection.

Water

Key Messages

- Climate change is negatively impacting water quality, increasing ocean acidification, leading to an increase in the frequency and duration of harmful algae and biotoxin events, increasing drought, negatively impacting water and food security, causing coastal inundation, and, in places, increasing riverine flooding. Even water storage reservoirs and flood management infrastructure operations and management are impacted. Each of these impacts can threaten local economies, human and non-human health and wellbeing, and Indigenous lifeways.
- Tribes and Alaska Natives are responding to these threats by drawing on traditional knowledge; observing and monitoring water sources and the linked hydrological, climatological, and ecological systems and connections; utilizing new tools; forming partnerships; creating adaptation and contingency plans; and through adaptation itself.

Recommendation

Emphasis should be on early, meaningful, and sustained engagement and consultation by federal and state regulatory and other agencies on both water quality and availability and on the associated food and water security impacts of contamination, ocean acidification, hazardous algal and biotoxin events, and risks associated with both drought and flooding. Tribes and Alaska Natives should be supported in implementing Tribally-led planning and solutions, partnerships, and cooperative efforts.

"Water is the life of all of us." – Felix Aripa, Coeur d'Alene Tribal elder

Climate change profoundly and deeply impacts Earth's water, broadly defined to consist of water at any location or time in the global hydrological cycle. These impacts alter the quantity, quality, or character of water used, held, or valued by Tribes and Alaska Natives, their communities, and members. Water-related impacts due to or exacerbated by climate change do not necessarily have simple cause and effect. There may be synergy among impacts; one impact may catalyze another or others, and there may be other complex interactions. However, the root causes of these impacts are the changing magnitude/intensity, frequency, or duration of extreme climatic events, together with climate change–related temperature, precipitation, and humidity/aridity trends across regions and globally. Additionally, the impacts may be cumulative or overlap in space or time. In this chapter, we consider how Tribal and Alaska Native village individuals, communities, governments, and organizations are impacted and are forced to reckon with, mitigate, and adapt to this set of specific impacts. In doing so, we draw attention to the key associated organizational, community, governmental, personal, health, economic, cultural, subsistence, and other costs.

Herein we consider impacts related to overall water quality, harmful algae and biotoxin events, ocean acidification, floods, dams, drought, and water and food security. This is by no means the complete set of water-related climate change impacts, but the elements of this set are held at the present time to be

high in priority. Climate change impacts on water rights, together with water management and utilization, are also important and will be addressed in future STACC Reports.

Overall Water Quality

To assess future water quality changes, data reported under EPA's Enforcement Compliance History Online (EPA, 2017), EPA's Unregulated Contaminant Monitoring Rule, or UCMR (EPA, 2019a, 2019b, 2019c, 2019d), results from models that utilize the Water Quality Index (WQI) (Horton, 1965; Tyagi, Sharma, Singh, & Dobhal, 2013), and data from peer-reviewed journals are summarized here.

Water quality forecasts developed using a nested modeling approach that includes GCM (general circulation or climate models), emission scenarios, runoff modeling, water demand estimation, water resources management modeling, and water quality modeling are region-specific, with the most detrimental anticipated changes impacting Nevada and western Utah (up to a 26% decline in the WQI), followed by California and Arizona (up to 20% decrease in water quality) through 2100 (Boehlert et al., 2015). The remainder of the Western U.S. could anticipate up to a 14% decline in water quality. Tribes in the Central and Eastern U.S. are not immune from declining water quality; however, the IGSM-CAM (Integrated Global System Model–Community Atmosphere Model) approach, used to assess regional and global climate change, predicts a 0 to 10% reduction in the WQI scores (Boehlert et al., 2015).

The implications of the above-cited modeling predict climate change–related impacts on the WQI parameters of dissolved oxygen, fecal coliform, pH, biological oxygen demand (BOD), temperature, phosphorus, nitrogen, turbidity, and total solids. However, sustained monitoring of additional Tribal-specific regulated and unregulated pollutants will provide a more complete picture of water quality changes.

EPA's Enforcement Compliance History Online (ECHO) reports health-based water quality violations for public water systems (PWS). Focusing specifically on health-based maximum contaminant level (MCL) violations, Tribes in Alaska, Arizona, California, Iowa, Idaho, Minnesota, Montana, Utah, and Wyoming were disproportionately affected by regulated drinking water contaminants compared to non-Tribal PWS sources during 2014–2017 (Conroy-Ben & Richard, 2018). The major health-based violations included arsenic, coliform, nitrate, disinfection by-products, and the surface water/lead-copper/groundwater monitoring rules. Furthermore, unregulated drinking water contaminants and health-based contaminants under consideration for future regulation under the Safe Drinking Water Act (SDWA) were present in Tribal Public Water Systems (Conroy-Ben & Crowder, 2020).

Data from the four UCMR surveys completed to date by EPA indicate that for Tribal Public Water Systems the most frequently detected contaminants exceeding the health reference level (HRL) included 1,4-dioxane, perfluorinated chemicals (PFOS and PFOA), vanadium, strontium, chromium, and chlorate. Additionally, molybdenum, haloacetic acids (HAA5, HAA6, HAA9), germanium, and manganese were detected above the method detection limit. Sustained Tribal monitoring beyond traditional water quality parameters is necessary and should include regulated and unregulated contaminants to assess the impacts of climate change.

Additionally, unregulated drinking water sources provide water to Tribal communities, but due to the numbers of connections (< 15) and customers (< 25), these sources are not routinely monitored. Unregulated wells serve approximately 37 million Americans (Backer & Tosta, 2011) and are a source of undetected water supply contamination in Tribal communities. On the Navajo Nation, for example, up to 30% of the population is not served by a PWS (Hoover et al., 2017). There, those receiving water from unregulated sources are impacted by arsenic and uranium contamination (Corlin et al., 2016; Credo et al., 2019; Hoover et al., 2017; Ingram et al., 2020), and by many other co-occurring natural and mining-influenced metals (Credo et al., 2019; Hoover et al., 2018). These unregulated sources could see a decline in water quality with respect to metal concentration in future projections; routine monitoring in resource-limited areas will determine effects due to climate change.

In summary, Tribal water quality is complex and extends beyond standard water quality indicators. As a result of climate change, Tribes within the states predicted to have reductions in the WQI will likely also be impacted under the SDWA, UCMR, and as unregulated water sources.

Ocean Acidification

Ocean acidification is the process by which the pH of the ocean is being lowered due to the addition of anthropogenic carbon dioxide. This lowering of pH creates difficulty for calcifying organisms to form and maintain their shells (Doney et al., 2009). While the addition of atmospheric carbon dioxide is a global issue, local impacts, primarily eutrophication, have exacerbated these impacts. Given the local and global challenges, resource managers are faced with a difficult issue where changing local inputs might slow the impact on resources. Blue carbon, which is the ability for marine plants and algae to sequester carbon, is one solution that may provide help for local resource managers.

Ocean acidification has already impacted certain Indigenous food systems and has the potential to impact many more. In the Pacific Northwest, the study of these impacts has primarily been directed at important food species like Pacific salmon (*Oncorhynchus* spp.), Dungeness crab (*Metacarcinus magister*), and bivalve clams.

Pacific salmon are being impacted by ocean acidification directly and indirectly. With increased acidification, pink salmon (*O. gorbuscha*) have been shown to have significant reductions in weight and length (Ou et al., 2015). These direct physiological impacts are further amplified by the loss of prey items such as pteropods, a marine planktonic snail, a species upon which increasing acidification has been shown to have had staggering impacts (Orr et al., 2005). In the case of pteropods, these impacts are predicted to be widespread in the waters off Alaska within the next 35 years (Orr et al., 2005).

Dungeness crab is a vitally important commercial and ceremonial species among Pacific Northwest Tribes. Economically, Dungeness crab is the largest fishery for many Tribal communities in Washington state. Current levels of acidification are impacting Dungeness crab with an 8.3% increase in shell dissolution over the past two decades (Bednaršek et al., 2020). When exposed to the acidic conditions expected in the near future, larval planktonic crabs will develop more slowly through the maturation

process (Miller et al., 2016). Dungeness crab are extremely vulnerable to predation during planktonic larval periods, so any additional time spent in these stages due to slower development could greatly reduce their populations.

Bivalve mollusks are considered the canary on the beach when it comes to ocean acidification's attenuation of shell development and shell loss. Impacts from elevated carbon dioxide levels were first seen in Pacific oyster (*Crassostrea gigas*) aquaculture facilities with larval oysters dissolving in the acidic water. Under acidic conditions, larval Pacific oysters can lose over 50% of their shell mass with an overall length reduction of over 25% (Frieder et al., 2017). Ocean acidification tends to impact bivalves during their early planktonic life stages (Waldbusser et al., 2015), which will impact recruitment of new clams, oysters, and mussels. Lummi Shellfish Hatchery has been spawning, rearing, and releasing juvenile clams for decades. Most recently, their on-reservation shellfish program has been focused on the commercial manila clam harvest, with over 20 million juvenile clams outplanted every year. Additionally, they augment beaches with Pacific oysters for ceremonial and subsistence harvest. While directly outplanting juvenile bivalves is not a long-term solution, this does provide Lummi Tribal members with abundant resources to harvest, provided that the water quality is appropriate. This could potentially serve as a model for climate adaptation for other Tribes, but longer term solutions must be found for Tribal people to maintain sovereignty over their lifeways. As in the coastal Northwest, ocean acidification severely limits shell formation, leading to decreases in available shellfish stocks and reducing subsistence harvests in coastal Alaska and the coastal northeast U.S. (Doney et al., 2020).

Figure 4. The shared waters of the Salish Sea basin, Coast Salish Nations, Northwest Washington, USA and British Columbia, CAN.

Monitoring for Harmful Algae and Biotoxins in the Salish Sea

In the Pacific Northwest, harmful algae and biotoxin events are not uncommon occurrences, and Coast Salish people have been harvesting shellfish safely using traditional and observational methods since time immemorial (Lewitus et al., 2012; Williams, 2006). The many miles of coastline along the Salish Sea, which includes territories of sovereign Tribal nations, provide a wealth of subsistence, spiritual, and commercial resources and continue to be an important fishery (Figure 4). Human-related drivers, including global warming, nutrient runoff, and drought, are directly linked to increasing frequency, magnitude, and duration of harmful algae events (HAE). Shellfish safety concerns have prompted increased and adapted monitoring strategies so that Tribal nations can make appropriate management

decisions for their people. (See narratives titled *Southeast Alaska Tribes Face Climate Change with Partnership* and *Harmful Algal Blooms Targeted by Grassroots Watershed Organizations*.)

In marine ecosystems, HAE are a serious threat that cause overwhelming, persistent impacts on the environment. These can include serious health concerns for humans and wildlife, impacting the marine food web with bioaccumulation and biomagnification through shellfish and crab consumption (McCabe et al., 2016). In the Pacific Northwest, paralytic shellfish poisoning (PSP) events are considered "traditional," and Indigenous traditional ecological knowledge indicates that PSP events have been seasonal and ongoing for hundreds of years. Recent analysis of long-term harmful algae monitoring programs also indicates that both duration and frequency of HAEs are increasing, that they are linked to climate change, and that they are anticipated to cause negative impacts on tourism, local economies, and human health in the future (Gobler, 2020). While many government resource managers are aware that shellfish harvest closures have serious impacts on economic markets, Tribal managers are keenly aware that closures also have an influence on subsistence and ceremonial harvests while threatening food sovereignty.

The state of Washington and British Columbia manage PSP events by testing mussels for toxins and closing commercial and recreational shellfisheries seasonally. Both Coast Salish Tribes and First Nations have sovereignty over their shellfish tidelands and work with the respective federal and state government entities for testing, so they can then manage their shellfisheries. Since 2012, all Pacific Northwest governments monitor for three main marine biotoxins (Lewitus et al., 2012), but since the 2000s, more than a dozen emergent biotoxins have been identified as potentially impacting marine shellfish and as harmful to humans (Visciano et al., 2016). These other toxins, including freshwater cyanotoxins that can accumulate in marine shellfish, are not often monitored by state governments in the marine environment (Peacock et al., 2018; Preece et al., 2017). In response, Tribal nations have been early adaptors for monitoring and utilizing new tools while also forming partnerships with academic, state, and government entities to monitor for these emergent toxins (Figure 5).

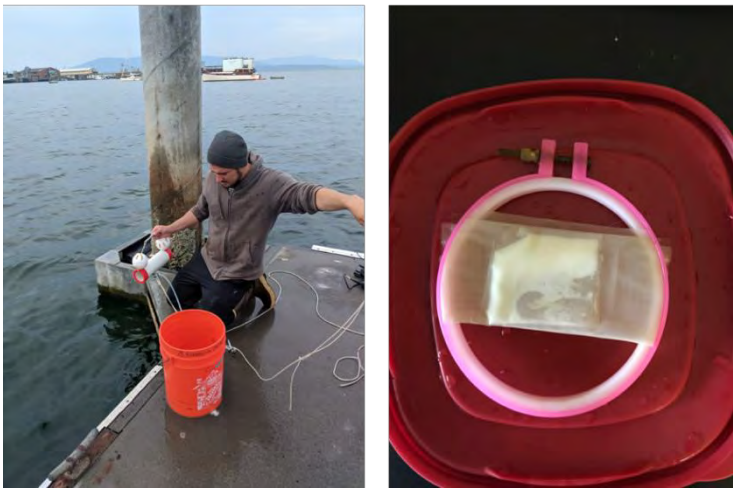


Figure 5. Sampling for marine biotoxins (left) in the Salish Sea, and Solid Phase Adsorption Toxin Tracking (SPATT) sampler (right), which is a passive, time-integrated toxin sampler used to track multiple toxins at the same time.

Monitoring is the first step to safe shellfish harvest, and management and policy decisions for shellfish closures need to be effectively communicated to respective Tribal nations (Figure 6). Many of the old adages that Coast Salish people are familiar with, such as, "Don't harvest in months with 'R,'" are no longer true. Disruption to traditional knowledge can cause harm to communities that heavily rely on

shellfish harvests, but participating in adaptation planning and monitoring to anticipate climate change impacts can increase communities' cultural resilience. Tribal Natural Resource departments provide effective communication facilitating community outreach events, K–12 school education, and supporting harvesters and families during closures to ensure that their people are aware of these changes and of why shellfish are unsafe to eat.

Figure 6. Examples of biotoxin closure signs. State of Washington Department of Health biotoxin closure sign (left). Lummi Nation biotoxin opening and closure signs including Indigenous drawings. Artwork by Thayne Yazzie, Salish Sea Research Center, Northwest Indian College.

Drought and Impacts on Water Security

Water is life. People's basic uses for water include drinking, showering, washing, cooking, and caring for animals and crops. For Tribes and Indigenous peoples, water extends beyond daily consumption and is vital for cultural and ceremonial use, including the cultivation of plants and animals. Water is heavily referenced as a living entity in stories, prayers, place names, and teachings (Chief et al., 2016) and engrained in community activities such as subsistence gathering and growing of food and medicinal plants (Chief et al., 2016). The lethal combination of increasingly prevalent drought and the corresponding reductions in water availability is having drastic impacts on the land and people, particularly in the southwest and western U.S. Increasing wildfires, lack of drinking water for flora and fauna, including humans, and increasingly common water shortages have led to uncertainty concerning the future viability of current water supplies (Wehner et al., 2017).

Approximately 97% of the world's water is contained in the oceans, and over 71% of the Earth's surface is covered in water (Shiklomanov, 1993). Yet on land, in areas of human habitation there is often water scarcity. Growing populations and rising demands from municipal, industrial, and irrigation sectors have only increased in the past two decades (Dieter et al., 2018). With climate change presenting immediate visual, physical, spiritual, and mental impacts, water remains the element that has been the most sensitive to the changes in the weather and climate. In addition, the complexity of water allocations among multiple state and federal jurisdictions has led to users experiencing the impacts differently. Users that are financially secure tend to experience or see less of the impact of drought events, whereas

low-income households and communities experience drought events more severely and profoundly (Stewart et al., 2020).

Tribes and Indigenous communities experience drought impacts in ways similar to other communities but can be "affected uniquely and disproportionately" (Jantarasami et al., 2018) based on their geography. Some communities are located in rural areas where the nearest hospital or grocery store can be more than 30 miles or minutes away. This includes the access and availability of clean drinking water for themselves, their livestock, and crops. In addition to encountering inadequate and increasingly unreliable access to sources of drinking water, many Tribal and Indigenous nations are currently involved in protracted water-rights settlement negotiations, yet across the country, growing demands for water only complicate the allocations previously secured (Jantarasami et al., 2018). Diminishing water supplies combined with increasing water demands has created water insecurity for Tribal and Indigenous nations.

Drought has been a contributing factor stressing already over-allocated water resources across the western U.S., but in particular across the arid southwestern region, which has a long history of drought. Historically, droughts in the Southwest have been primarily precipitation-dominated. However, with the observed increases in average annual temperatures due to human-caused climate change, the most recent series of droughts beginning in the early-2000s has been temperature-dominated (Udall & Overpeck, 2017).

In the northwestern region of the United States, drought may have profound impacts on Chinook salmon (an important sustenance for Pacific Northwest Tribes), which are especially susceptible to low streamflow and changes in stream temperatures (Crozier et al., 2020; Silver et al., 2020).

In the northern plains, drought is affecting the quality of soil health, rangeland productivity, and agricultural productivity (He et al., 2019). Specifically, on the Wind River Indian Reservation and the surrounding region, drought has caused significant water shortages, which in turn reduced the amount of irrigation available to maintain agricultural fields during the 2012–2013 season (McNeeley et al., 2017).

Precipitation Change

Factors contributing to drought include increased average temperatures during the winter months that pose a great concern where winter precipitation is transitioning from snowfall to rainfall. In the southwestern U.S., average annual snowpack in the headwaters of the Rio Grande Basin has decreased by nearly a third compared to the historical average (Chavarria & Gutzler, 2018). Similarly, under current and projected climate scenarios, mid-century streamflows in the Colorado River Basin are expected to decrease nearly 30% compared to the historical average (Udall & Overpeck, 2017). Additionally, the timing of snowmelt runoff events in the southwest is shifting toward earlier times of year, with complications for water allocation for downstream water users. Elders from the Navajo Nation in the southwestern U.S. remember "an abundance of snow which lasted for months and long monsoon seasons. Whereas now, the snowfall melts within the day and rainfall run-off has drastically increased"

(Tom et al., 2018). The implications of an ever-decreasing snowpack and changes in annual runoff in the Colorado River Basin, combined with increasing populations and water demand, suggest that water managers and dependent communities may be expected to do more with less. The Campo Band of the Kumeyaay Nation's Climate Adaptation Plan quotes multiple elders' testimonials that when they were children they experienced much rainier, snowier, and cooler conditions than today, and they report an overall decrease in rainfall since 1948 (Campo CAAP, 2018).

The Tlingit and Haida Indian Tribes of Alaska Climate Change Adaptation Plan (Tlingit & Haida CCAP, 2019) finds that trends indicate an increase in precipitation, but "due to rising temperatures, there will be less snow cover. Snow cover is a 'blanket' that protects fragile cedar roots from damaging freezing temperatures, and during the spring melt it provides salmon spawning streams with a clean, cool, and abundant water supply. A smaller snowpack equates to lower spring snowmelt runoff. Paradoxically, however, increased precipitation in the form of extreme rain events is a major factor in river and stream scour. These extreme increased flow events scour river and stream beds, potentially causing damage to sensitive salmon spawning grounds" (Tlingit & Haida CCAP, 2019).

Fluctuating precipitation rates and intensity, combined with precipitation that is shifting from occurring as snow at high elevations to occurring as rain, can directly impact Tribal energy security and water supplies (Scott et al., 2018). For example, the Metlakatla Indian Community of southeastern Alaska has long relied on local lakes for a combination of municipal water supply and hydropower. In recent years, the water supply of Chester Lake has at times dropped too low to support both the need for municipal water and the ability to run the hydro-generator, forcing the Tribe to choose to shut down the hydro-generator and rely on diesel generators for electricity. This imbalance between available water supply and demands for water and energy is due to a "shift in precipitation coupled with warmer winter temperatures that results in little to no snowpack coupled with increased energy demands" (Scott et al., 2018).

Water and Food Security—Impacts to Water-Dependent Subsistence, Hunting, and Gathering

Many Tribal and Indigenous communities are actively engaged in the cultivation or utilization of traditional nutritional and medicinal plants such as corn, reeds, acorns, sage, juniper (including Eastern red cedar), and many others (Native American Ethnobotany Database, n.d.; UVM Library Digital Exhibits, n.d.). Numerous other Indigenous communities subsist partly or entirely on the gathering, harvesting, fishing, or hunting of marine species. In nearly all such settings, food security is inextricably linked to stability and security of water in each and all of its forms: liquid, vapor, and solid.

Since time immemorial, these communities have relied on plant and animal species for food, medicine, ceremonies, prayers, and local economies (Lynn et al., 2013; Chief et al., 2016). Tribes and Indigenous communities view water not only as a resource but as a living entity acknowledged as a relative (Cozzetto et al., 2013). Increasing climate change threatens the valuable resources these communities depend on for the survival of their people, culture, and language and has created a worrisome future for those so dependent on water (Misra, 2014; Cozzetto et al., 2013).

For Indigenous peoples in the North, and in particular for the Inuit of Alaska, reliance upon water and the marine environment and its biodiversity has been and continues to be fundamental to their survival. The coastal seas and ocean provide essential elements of their overall wellbeing. In addition, traversing sea ice is required for most harvesting activities among Alaska Native communities. These profound relationships have economic, social, cultural, and spiritual dimensions inexplicable in the English language. Presently, the integrity and stability of ocean ecosystem dynamics are being seriously threatened by factors such as the loss of sea ice, ocean acidification, ocean warming, microplastics, coastal erosion, impacts to marine mammal habitat including whale calving areas, and subsequent impacts on food chains. Such conditions directly affect Alaska Native Tribal members that rely upon seals, walrus, whales, and other marine mammals.

Concerning the loss of sea ice in Alaska, the Intergovernmental Panel on Climate Change *Special Report on Oceans and the Cryosphere in a Changing Climate* underscored the unequivocal linkage between oceans, biodiversity, and climate change. The report highlights the essential dynamic between Arctic landfast ice and food security for Alaska's coastal Inuit communities. The report further emphasizes Indigenous knowledge and the importance of intergenerational significance of this in the context of such Arctic Indigenous coastal communities and their continued reliance upon the coastal environment as their principal food source (IPCC SROCCC, 2019). (See also *Chapter 4: Ecosystems & Biodiversity*.)

Food and medicinal plants are both seasonal and perennial, but for some Tribal communities, notably medicine people and subsistence gatherers, there is a specific timeline and protocol for proper harvesting. With dynamic shifts in weather patterns due to climate change, decreasing availability of potable water makes it difficult to accomplish ceremonial and subsistence responsibilities. If Tribal communities are unable to properly harvest plant species needed for a time-specific ceremony or event (Daigle et al., 2019), this may cause the event to either be cancelled or postponed to a later date. Due to these cancellations, it may present short- or long-term delays in the intergenerational teachings and sharing of cultural stories, practices, and languages, which in turn may have physiological and spiritual impacts (Swinomish, 2010; Donatuto et al., 2011). For example, if a specific cold-water species that is considered to be culturally significant for ceremonial and subsistence purposes is threatened due to warming water, then the Tribal community is in danger of becoming spiritually and economically stressed (Donatuto et al., 2011).

Threats to the Swinomish Tribe's traditional reliance on its salmon fishery, which is in decline, are compounded by the Tribe's vulnerability to sea level rise (Morrison & Tamayo, 2020). The Swinomish proactively created a climate action plan (Swinomish, 2010), and nearly 50 Tribes have followed suit. Water-related climate change impacts of concern to the Swinomish and other Tribes include but are not limited to increased flooding, ocean acidification, rising river temperatures, more-destructive storms, and habitat loss. Similarly, the Yup'ik and Athabascan critically depend upon salmon along the Kuskokwim and Yukon watersheds.

Increased frequency and intensity of heavy precipitation events are anticipated to impact many beings dependent on particular aquatic or soil moisture conditions for some portion of or all of their life cycle.

An example of this is wild rice, a being so central to Ojibwe culture that Tribal members fear a loss of identity if wild rice, which can be flooded or damaged if heavy rains fall at the wrong time, declines or disappears (Marks-Marino, 2019a; Marks-Marino, 2019b). Wild rice is one of the most vulnerable beings in the Midwest region, has already seen declines, and is susceptible to the changes described previously as well as to invasive species and increasing prevalence of pests and pathogens.

Lack of water availability or intense precipitation events may force Tribal and Indigenous people to make difficult decisions, some of which can be life changing. For example, if a family cannot continue to support themselves by growing crops or raising livestock or even provide potable water for themselves, they may be forced to relocate to unfamiliar urban areas. Lack of potable water resources and the ongoing decades-long drawn-out efforts to secure greater access to water rights create cumulative impacts that are detrimental to the mental, spiritual, and physical health of Tribal communities (Donatuto et al., 2011). If people are unable to continue the practice of traditional farming, subsistence gathering and hunting, and providing for their families, the traditional knowledges of Tribal and Indigenous cultures are at risk of being lost. Water and food security are important for the survival of not only the floral and faunal species but also for the spiritual and cultural survival of humans, the five-fingered beings.

Importance and Impacts of Dams for Tribes

For Tribal communities, dams and their reservoirs may be important and beneficial in terms of providing electricity, irrigation water, and drinking water (Church et al., 2015) as well as water for fire protection and recreation. Climate change may impact dam operations, specifically from diminished water supplies stemming from increased evaporation due to rising air temperatures and increasing drought (Ehsani et al., 2017). For instance, water storage in reservoirs in the Southwest has decreased since 2000 due to drier and warmer conditions (Scanlon et al., 2015). For the Colorado River Indian Tribes in Arizona, this meant negotiating an agreement with the Bureau of Reclamation to use less water (from the Colorado River) for agriculture in exchange for obtaining funding for the Tribes (James, 2020).

Climate change may also impact dam safety. The intensity and frequency of extreme rainfall events are increasing as a result of climate change, which in turn has caused a number of dams (most of which are nearly 60 years old) to breach across the United States (Fountain, 2020; Swain et al., 2020; Pearce, 2021). In addition, due to the age of dams and because most dams were originally built with concrete, earth, and masonry, they are subject to failure from decay, fissures, cracks, and seepage (Fountain, 2020). Within the U.S. Department of the Interior, the BIA is responsible for 900-plus dams on Tribal lands, and 138 of those dams are considered “high-hazard” and “significant-hazard” (FEMA, 2019). A dam is classified as “high-hazard” when there is a likelihood of a loss of one human life if it fails. It is classified as “significant-hazard” when there is a likelihood of economic loss if it fails (FEMA, 2019).

In contrast to the benefits noted above, dams have also presented a set of challenges to Tribal communities in terms of safety, water availability, impacts on river temperatures, erosion, land loss, and food insecurity (Church et al., 2015; Guarino, 2013). Entire villages and fishing sites have been destroyed due to numerous dams that were built along the Columbia River in the Pacific Northwest, resulting in

impacts to the subsistence lifestyle of the Indigenous peoples of this region (Smithsonian Institution, 2018; Church et al., 2015). Dam operations and reservoirs may lead to increased river temperatures; if temperatures reach more than 68 degrees, unhealthy environments for cold-water fish (such as salmon) are created (Smithsonian Institution, 2018; Nichols, 2020). Salmon play a key role in maintaining food security and culture for some Tribal communities in the Pacific Northwest. The construction of large Army Corps of Engineers dams in the Missouri River Basin resulted in destruction of communities and permanent loss of land, along with all of the socio-economic and cultural trauma, some lasting and permanent, resulting from displacement from familiar, traditional, and sustaining riverside homelands and environments (Lawson, 2009).

It is especially important for state and federal government agencies involved in flood control and water supply operations and management to meaningfully engage and consult with sovereign Tribal governments and affected communities so that future operation and management of this diverse set of important water infrastructure facilities will be conducted in a manner beneficial to all communities rather than to just certain communities.

Flooding Related to Climate Change

Flooding events of all manner are captured in the geologic record. Human beings continue to be afflicted by flooding; considerable resources are expended on preparing for and responding to floods. Extreme precipitation events are projected to increase in both observed total and heavy precipitation in many, but not all, regions of North America under multiple emissions scenarios (Seneviratne et al., 2012), and this will in general lead to increased erosion and flooding and to a large set of related impacts.

Flood control and mitigation of flood impacts have yielded mixed results, sometimes inducing further development and settlement in areas that continue to be susceptible to flooding (e.g., Horn & Webel, 2019; Peralta & Scott, 2019). Flood hazards in both riverine and coastal environments are exacerbated by impacts from global climate change on the hydrologic system. Drought-induced vegetation loss, coastal and river system management practices, government policies, and natural resource extractive practices are all important related factors. An especially pernicious aspect of coastal flooding associated with sea-level rise is that this impact from changing climate will continue to grow in spatial extent and magnitude over time as the climate warms and glacial ice continues to melt (see, e.g., Kirezci et al., 2020).

The Coastal Environment

The mean global trend of absolute sea level is illustrated in Figure 7. When it comes to flooding driven by climate change, there is considerable certainty concerning what has happened and what is ongoing, and this can be coupled with model-based forecasts as to what the future is likely to bring in oceanic coastal settings.

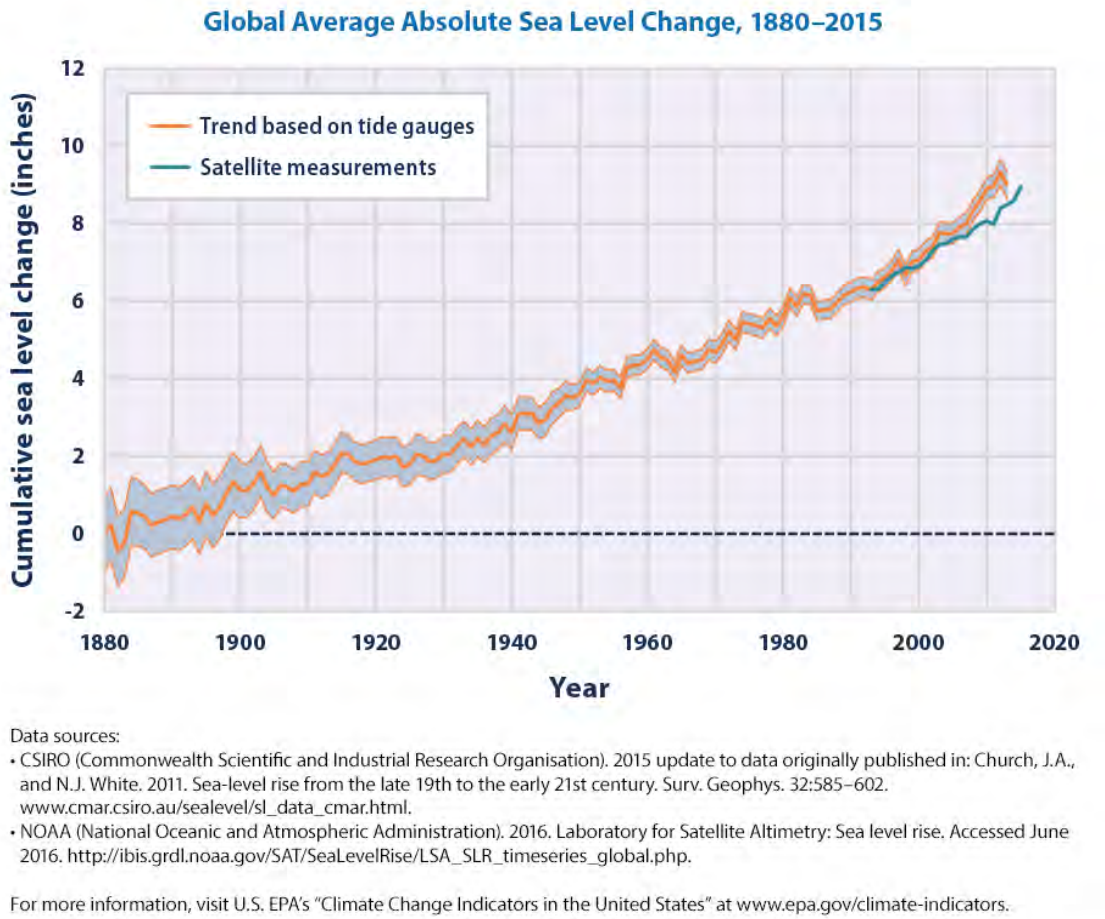


Figure 7. Global Average Absolute Sea Level Change, 1880–2015. https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level

In the U.S. coastal environment, rising relative sea level due to global warming–induced ice melting and thermal expansion of warming sea water causes inundation of areas formerly above sea level (Figure 8). This gradual inundation flood hazard is compounded by episodic landward flows of sea water caused by storm and hurricane surges. In some areas of the northwestern U.S. and Alaska, land masses may be uplifting relative to sea level due to tectonic movements. Also, in a limited number of places such as the Mississippi River Delta in the Gulf of Mexico, subsidence due to deltaic sediment consolidation, reduced sediment delivery by the river, or basement subsidence coupled with absolute sea level rise due to climate change collectively also drive coastal inundation (see, e.g., Wolstencroft et al., 2014; Turner, 2017). NOAA's Tides and Trends website[19] provides an excellent summary of sea level trends in North America and globally.

[19] NOAA's Tides & Currents Sea Level Trends: https://tidesandcurrents.noaa.gov/sltrends/

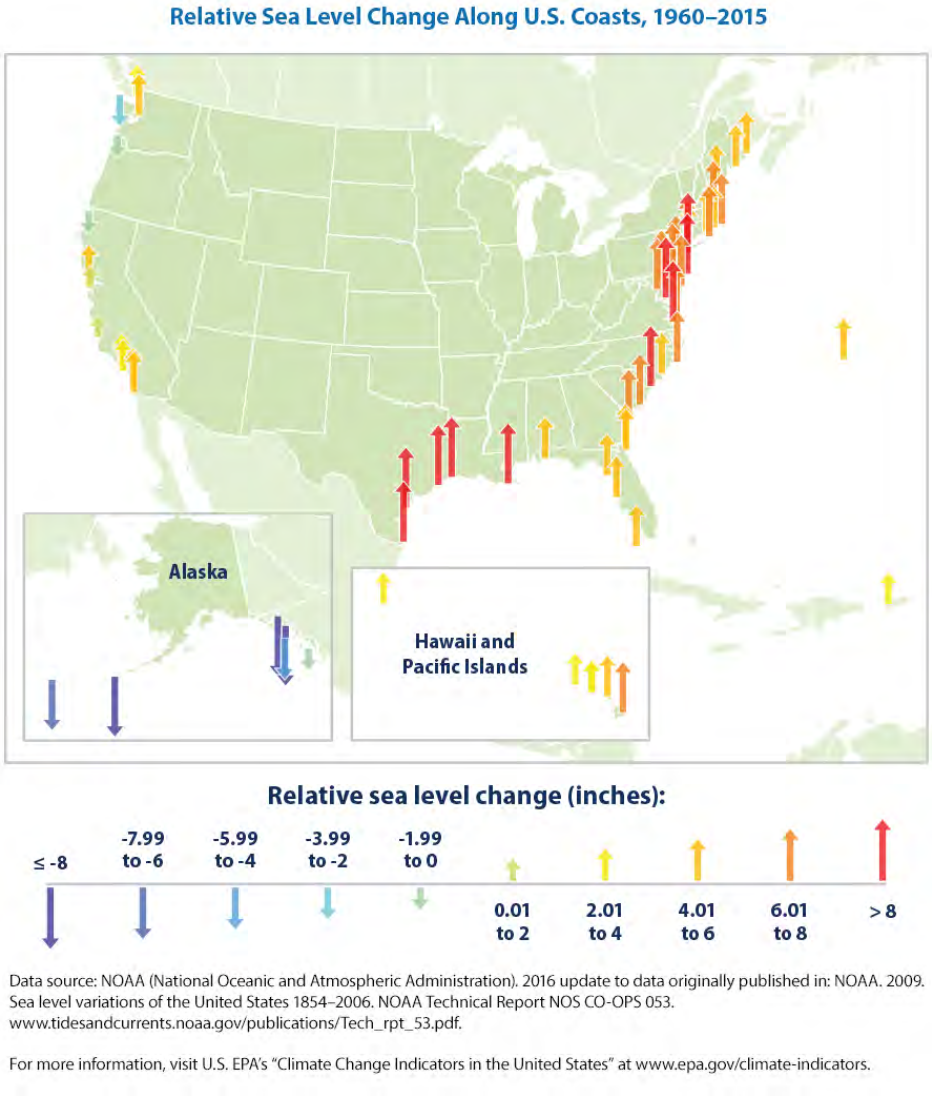
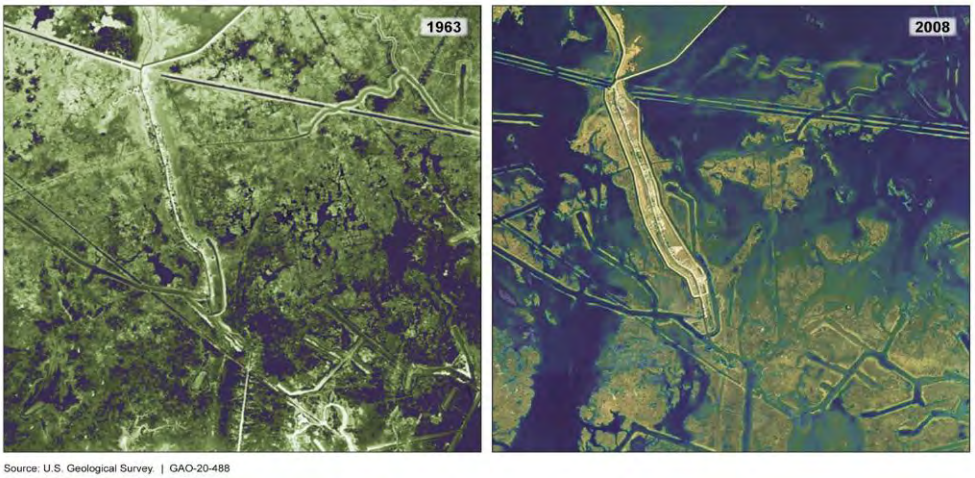


Figure 8. Relative Sea Level Change Along U.S. Coasts, 1960–2015. https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level

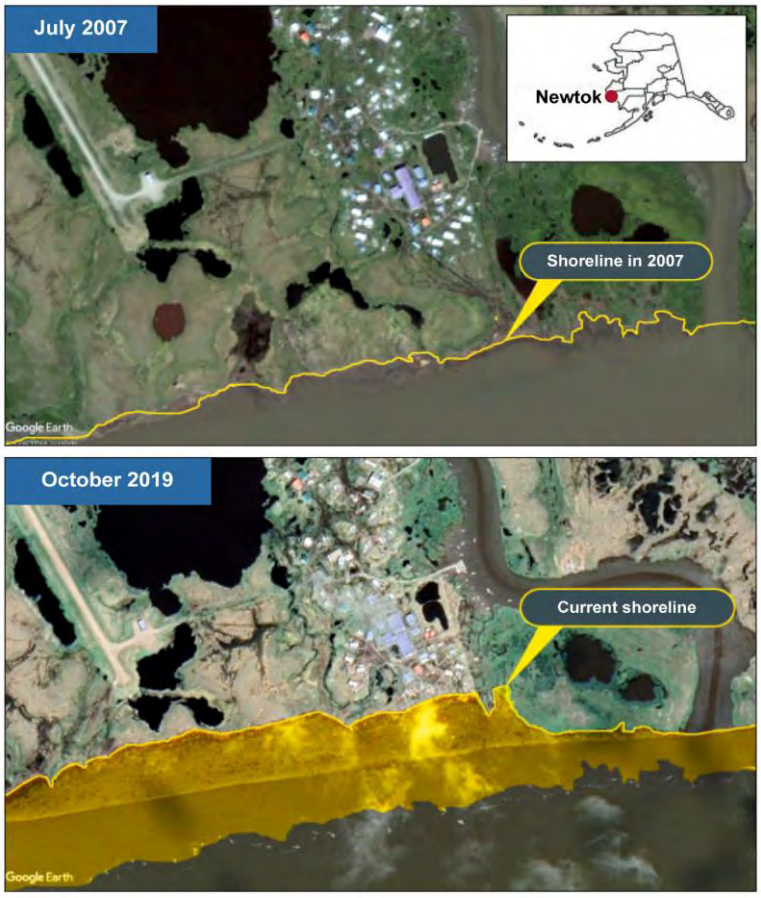
Due to their proximity to coastal shorelines, some Tribal communities—including, but not limited to, the Puyallup and Quileute Tribes in Washington state, the Isla de Jean Charles Tribal community of Louisiana, and Alaska Native villages such as Akiak, Kivalina, and Shishmaref—are especially vulnerable to coastal flooding and erosion, as they may be forced to relocate inland due to land loss, ultimately leading to loss of identity, culture, and a subsistence lifestyle (Walker, 2021; Ristroph, 2019; Puyallup Tribe of Indians, 2016; Palinkas, 2020). The remote Inupiat community in Kivalina, Alaska, is one of the most impacted coastal villages that has begun relocation, even after attempts at shoreline stabilization (Dannenberg et al., 2019). It has been observed that storm surges from strong winds combined with the increasing number of ice-free days per year are contributing to more coastal flooding in coastal Alaska communities.



Land loss at Isle de Jean Charles, Louisiana, from 1963 to 2008 (GAO, 2020).

Summarizing 2003 and 2009 U.S. Government Accountability Office (GAO) studies, the National Wildlife Federation (2011) indicated that "more than 200 Alaska Native villages were affected to some degree by flooding and erosion, and 31 villages face imminent threats that are compelling them to consider permanent relocation." Since then, the Alaska Statewide Threat Assessment (University of Alaska Fairbanks and U.S. Army Corps of Engineers, 2019) has been issued. It provides a contemporary look at threats from erosion, flooding, and thawing permafrost in remote Alaska communities, updates and supplements elements of the prior GAO and National Wildlife Federation studies, and provides risk ranking by community.

The Samish Indian Nation of Washington has observed a trend of rising sea levels over the last decade. "Intense winter storms have led to coastal flooding; king tides (which are exceptionally high tides that are both naturally occurring and predictable) have been larger than in the past (Marks-Marino, 2019c). King tides coupled with winter storms have damaged infrastructure, leading to further flooding and temporary loss of access to the mainland. Cultural sites are at great risk from the erosion caused by rising sea levels" (Marks-Marino, 2019c). The impacts of sea level rise highlight the importance of threatened communities to be considering relocation, managed retreat (Siders, 2019), or protecting existing eco-cultural resources. (See *Chapter 10: Protection-in-Place & Community-Led Relocation*.)

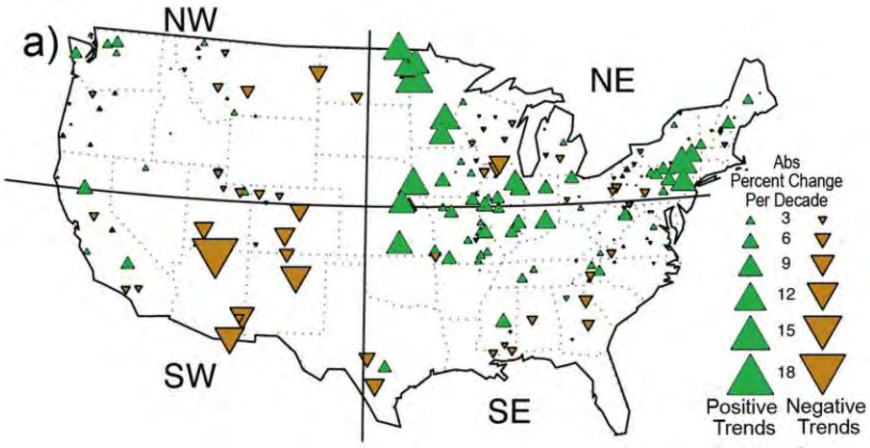


Source: Federal Emergency Management Agency analysis. | GAO-20-488

Shoreline recession (land loss) at Newtok, Alaska, (GAO, 2020) due to erosion, permafrost degradation, and storm-driven flooding.

Riverine (Fluvial) and Lake (Lacustrine) Environments

Continental U.S. decade- to century-long fluvial flooding trends (Peterson et al., 2013) indicate that the Midwest, Northeast, and upper Southeast have suffered greater flooding over time (see map below).



Recent modeling of future riverine flooding that incorporates global climate models (Hirabayashi et al., 2013; Willner et al., 2018) has yielded early results, but these forecasts have limited spatial resolution and significant uncertainty. Nonetheless, Willner et al. (2018) state that "for the United States, 42 of the 50 states, and the District of Columbia, will experience an increased flood risk if no additional protection measures are taken." These types of studies are important and will eventually become essential to inform national and regional flood planning.

Cycles of extreme flooding have severely impacted the Quapaw Nation (see narrative in *Chapter 9: Emergency Management* titled *The Quapaw Nation's Incorporation of Climate Change in Emergency Preparedness Planning*). During the 2019–2020 season, up to 80 inches of rainfall was recorded on the Quapaw Nation. The associated extreme precipitation events give rise to flooding that not only damages infrastructure and roads, but also negatively impacts planting and harvesting (Marks-Marino, 2020).

While relocation as a mitigation effort to reduce risk from riverine flooding is not a suitable approach everywhere, it increasingly makes sense to avoid the otherwise endless cycle of destruction and recovery. The Bad River Band relocated its community at Odanah, WI, to higher ground in the period 1960 to 1990 to avoid repeated devastation from the Bad River flooding (NPR, 2018). Although the cause(s) of the 1960 flooding have not been linked to climate change, the adaptation response of the Bad River Band to the hazard is highly relevant. The Band remains vulnerable to flooding. In July 2016, 10–12 inches of rain fell in the reservation area during an eight-hour period that significantly damaged transportation infrastructure and was disruptive to their access to hunting, fishing, and harvesting of traditional foods such as wild rice (Marks-Marino, 2019b).

Increasing winter air temperatures accompanying climate change may result in precipitation falling as rain rather than snow, a reduction in snowpack, and a change in timing of spring runoff, leading to flooding (Nasser et al., 2015). When snow is deposited at high elevations, it is often held for months or weeks before it runs off at a more gradual rate. However, when it is dropped as rain, the rain may quickly melt some or much of the existing snow very quickly (this is known as a rain-on-snow event), which leads to the rapid runoff into streams and rivers that causes flooding of downstream communities (Musselman et al., 2018; Puyallup Tribes of Indians, 2016). Additionally, the formation of ice dams/jams in rivers can be a major source of flooding in the spring (e.g., Rokaya et al., 2018). This can also occur in the winter due to rapid warming events, sometimes accompanied by heavy rainfall.

In recent years, rain-on-snow events have caused flooding for the Confederated Tribes of the Umatilla Indian Reservation in the Northwest. In February 2020, the Umatilla River peaked at 19,000 cubic feet per second (cfs), surpassing the previous record-high flow of 15,500 cfs recorded in 1965 (Stoelb, 2020). Immediately after the flood occurred, a state of emergency was declared for the Umatilla, Union, and Wallowa counties, including the Confederated Tribes of the Umatilla Reservation, as the flood damaged bridges, roads, homes, wastewater treatment plants, and businesses and caused major power outages (Pollard, 2020). In addition, a fish hatchery owned by the Umatilla Tribe was destroyed (Castle, 2020).

Lake-related (lacustrine) flooding and inundation occurs in addition to riverine flooding. Recent examples include high water levels in the Great Lakes area of the northern U.S. While the connection between such high water levels and climate change has not yet been demonstrated or refuted, this is an area of concern for Tribes and Alaska Native villages with lake or shoreline frontage or utilization.

For example, burial grounds with remains of Little Traverse Bay Bands of Odawa Indians' ancestors[20] were disturbed by rising Lake Michigan waters in 2020. Further to the north, the Keweenaw Bay Indian Community manages nearly 20 miles of Lake Superior shoreline, and that includes coastal roads. The lake and shore provide a fishery and drinking water and foster visits from tourists. In 2018, riverine and lake/coastal flooding impacted the Community. Recently, the Community developed a draft 2020–2025 Keweenaw Bay Indian Community Hazard Mitigation Plan,[21] which addresses both riverine and coastal flood hazards and their mitigation. For those Tribes and Alaska Native villages impacted or threatened by rising waters, a flood hazard mitigation plan is foundational to adequately address future flooding events. Such a plan can identify actions to be taken, necessary resources, individuals and organizations that will respond, and responses that can be readied for the future, etc., as these flood events are only uncertain in their magnitude, duration, and timing, and there is no question as to whether they will occur in the future.

The long-term warming of the Great Lakes is documented and significant (e.g., Anderson et al., 2021). With this warming comes a wide array of impacts to water quality, regional climates, ecosystems, and other areas, including impacts yet to be identified or quantified. Declining winter ice on the Great Lakes (Wang et al., 2017) and warmer water and air temperatures have led and will lead to increased exposure of coastal environments to cold-season wave action as coastal ice formation and duration diminishes. Warmer air temperatures will impact near-shore geomorphic slope and related processes. These impacts will be compounded when coupled with the above-described high lake water levels, regardless of the latter's cause(s).

Flood Inundation Mapping and Insurance

Regrettably, Tribes have at times borne the cost of flood-control measures implemented by other government entities, mainly the federal government. The history (e.g., Lawson, 2009) of the mid-20th-century Pick-Sloan program in the Missouri River Basin illustrates that numerous occupied, productive, and precious Tribal riverside lands were permanently taken almost entirely for the benefit of powerful external constituents, with mass displacement of individuals and communities together with lasting economic, social, food security, and cultural hardships, some permanent.

[20] Great Lakes Now, "In Michigan, rising lake levels disturb sacred ground": https://www.greatlakesnow.org/2020/09/michigan-rising-lake-levels-sacred-ground/

[21] Keweenaw Bay Indian Community Hazard Mitigation Plan: https://www.wuppdr.org/uncategorized/2020-2025-keweenaw-bay-indian-community-hazard-mitigation-plan-draft-available-for-review-open-july-1st/

Still, there are Tribes and Villages that may benefit from enhanced flood inundation mapping initiatives and possibly from flood insurance, both of which are provided at the federal level, principally through the Federal Emergency Management Agency (FEMA). The GAO (2013) reported that:

- just 37 of 566 federally recognized Tribes were participating in the National Flood Insurance Program (NFIP)
- most Tribal lands remain unmapped by FEMA for flood risk, a consequence of prioritizing urban over rural settings
- without flood hazard maps, Tribal communities may be unaware of their flood risk, even in high-risk areas
- Tribes may lack the resources and administrative capacity needed to administer NFIP requirements, and NFIP premiums are often too high for low-income Tribal members
- some Tribes do not have reservations over which they can enact and enforce the land use ordinances that are required for NFIP participation, due to individual allotment

It is not for us to say that a given Tribe or Alaska Native village should or should not participate in the NFIP. However, it could be of great benefit to Indigenous communities if FEMA would prioritize and accelerate the progress of flood risk and forecasted inundation mapping in areas where Tribal lands and Tribal communities exist. Further, FEMA, while subject to Congressional constraints on what it can do when it comes to modifying its programs and approaches, should engage with Indigenous communities to learn how its flood-mapping and flood-insurance programs could better serve them and take timely action to correspondingly improve those programs.

Landslides

Landslide, or earth-movement, hazards are very diverse and range in size from shallow debris flows and post-fire runoff to deep-seated landslides capable of moving houses or entire landscapes. Very generally, and ruling out alpine, quick clay, and other more restricted classes of earth movement, the former types of events may be relatable to existing moisture conditions combined with shorter term intense rainfall events, whereas the latter are more likely to be associated with deeper soil moisture and groundwater conditions, compounded by geologic variables that may be related to seasonal trends in (increased) precipitation or to even longer term climatic trends persisting over years or decades. The range of earth movements under consideration here is potentially relatable to climate change, as discerned, for example in southwestern coastal British Columbia (Jacob & Lambert, 2009). As an illustration, the Hoopa Valley Tribe of northern California has experienced significant damage from previous landslides and as such has devoted a significant portion of their hazard mitigation plan to this hazard class (Hoopa Tribal LEPC, 2014).

Conclusions

Climate change impacts on overall water quality, harmful algae and biotoxin events, ocean acidification, flood and landslide hazards and risk, drought and water security, dams/reservoirs and water supply management, biodiversity and landfast ice and sea ice, along with water-linked food security are priority

concerns for Tribes and Alaska Natives. Observations, experience, monitoring, measurements, and analysis (inclusive of modeling and inference) document ongoing impacts in these priority areas and provide improved forecasts as to ranges of impact(s) that may be expected.

Water quality impacts are far reaching and include ocean acidification along with increased prevalence and frequency of biotoxins that originate from algal bloom events. These climate change-induced water quality deviations from normal conditions result in a wide range of ecosystem and human impacts that include disease, illness, mortality, water insecurity, and food insecurity. Tribal and Village communities and individuals must react and eventually proact to address water quality impacts imposed by the changing climate.

Climate change–driven coastal flooding is already impacting Tribal communities. Coastal inundation will unavoidably and substantially grow both in depth and extent, given the primary cause, which is rising absolute sea level due to melting glacial ice. Increased riverine flooding in parts of the U.S. over the past several decades has been identified and is possibly linked to climate change. Forecasting of riverine flooding based on global climate models is in the early stages of development. However, the preliminary results suggest that there may be increases in riverine flooding in areas of the U.S., and some of these flood impacts will inevitably be felt and borne by Tribes and their communities. This highlights a need for improved inundation mapping by agencies such as FEMA and a focus of funding and related resources to support managed retreat for those communities in which such an approach is the preferred alternative.

Climate change–driven water-related impacts to Indigenous communities' and individuals' food and water security are real and documented. The impacts vary in location and also with time, depending on whether climate change brings higher coastal sea level, drought that is either pervasive, more frequent, or sustained ("normative drought"), or increased precipitation frequency, duration, or magnitude. Informed deliberation, decision-making, and action by Tribes and Alaska Natives so impacted require sustained efforts to mitigate and adapt. The magnitude and pervasiveness of these food and water security impacts need to be assessed and quantified on a periodic basis, e.g., every five years. A dynamic set of strategies and actions, themselves adaptive and evolving, to foster mitigation and adaptation will be necessary, as are initiatives to assess the effectiveness of actions taken. More than anything, the development and implementation of any actions taken need to happen locally, at the sovereign Tribal or Village level, and not be imposed from without.

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Chapter 4.2.1: Drinking Water Infrastructure

With the changing climate, drinking water infrastructure is a big concern for Tribes. Tens of thousands of Native American families do not have adequate access to safe drinking water. Many Tribes' water utilities lack proper operation and maintenance, adequate staffing, or sustained funding. Water infrastructure and staffing deficiencies provide opportunities to install climate-resilient projects. An example is the Chickasaw Nation and Choctaw Nation of Oklahoma: their water resources issues include extensive drought and flooding, which impact their water supply. In response, they have developed a Drought Contingency Plan and adaptation projects to address their concerns. A researched overview of Drinking Water Infrastructure as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Chickasaw Nation and Choctaw Nation of Oklahoma Leading the Way in Implementing Adaptation Projects

Written by: Chickasaw Nation and Choctaw Nation of Okalahoma

Background on the Chickasaw Nation and Choctaw Nation of Oklahoma

The Chickasaw Nation is a federally recognized Tribe located in the south-central region of Oklahoma. As a primary land holder in this 7,648 square mile region encompassing 13 Oklahoma counties, the Tribe has the potential to influence land management practices and conservation of many species in the region.

The jurisdictional area of the Chickasaw Nation includes significant water resources of importance to the diverse communities across this region. The Arbuckle-Simpson Aquifer is the principal and, in some cases, the sole source of water for 150,000 people in south-central Oklahoma, including the cities of Ada, Sulphur, Mill Creek, and Roff and the rural water districts in Murray and Johnston Counties. This aquifer is the source for more than 100 known springs, including Byrds Mill Spring, Ada's primary drinking water source. Additional water sources in the area include the Red River and the Canadian River.

The Choctaw Nation of Oklahoma is also a federally recognized Tribe and is located in southeast and east-central Oklahoma. Its jurisdictional area is 10,613 square miles and encompasses eight counties and parts of five additional counties.

The Choctaw Nation of Oklahoma is headquartered in Durant, Oklahoma. Durant draws all of its water from the Blue River, a spring-fed river originating from the Arbuckle-Simpson Aquifer (in Chickasaw Nation jurisdiction). The Blue River does not have any on-channel reservoirs, thus decreasing the potential for providing reliable supplies during periods of drought. In fact, during a drought in 2011—a year that was both the hottest and driest on record—the Blue River almost ran dry below the city's intake, and water suppliers were required to curtail use.

Climate Change Impacts to Water Resources in the Nations

The Nations are located in a region where climate models project, by mid-century, daily high temperatures to increase by up to 6°F during the summer months, 20–40 more days per year with temperatures above 100°F, and less rainfall events in general but with more intense rainfall when they do occur.

With projections of more variability in rainfall and increases in temperature, many communities already facing water scarcity could run out of water. Other communities are dealing with the intense rainfall events and the resulting flooding and soil erosion. With these intense flooding events, many communities are dealing with pollutants in the runoff and associated pressures to meet the regulatory water quality levels. With ongoing land use changes, water suppliers are focused on limitations in meeting the regulatory water quality standards on disinfection byproducts.

Nations and Consortium Members of South Central CASC

In 2012, the South Central Climate Adaptation Science Center (CASC) was funded by the U.S. Geological Survey (USGS) with two Tribal nations as full consortium members—Chickasaw Nation and Choctaw Nation of Oklahoma. As consortium members, the Nations partner with the USGS, University of Oklahoma, and other consortium members (Oklahoma State University, Texas Tech University, University of New Mexico, and Louisiana State University) on climate science research and education in their jurisdictions. They are "at the table" for strategic and tactical planning for the South Central CASC, bringing Tribal voices to the forefront of the CASC's decision-making.

Red River and Canadian River Future Streamflow Projections

The Nations led research at the South Central CASC to assess how streamflow in the Red River Basin might change in the future, given the CASC's projections of future temperature and precipitation (created by NOAA's Geophysical Fluid Dynamics Laboratory). Results showed that the western part of the Red River Basin is at the greatest risk of experiencing reduced flow. Throughout the basin, peak flows are projected to be higher and low flows to be lower, a finding that is consistent with the expectation that future floods will be more severe and droughts will be more extreme. The study also assessed the climate-induced hydrological changes on the aquatic ecosystems, including threatened and endangered species. The Nations are continuing this research in the Canadian River Basin during 2020–21 so that they have streamflow projections for all their jurisdictions.

This photo is an aquifer recharge study pond, on which the Chickasaw Nation is partnering with Oklahoma State University, East Central University, EPA Kerr Lab, and the City of Ada. Photo credit: Wayne Kellogg.

Implementation of Water Adaptation Projects

Adaptation is defined by the Intergovernmental Panel on Climate Change as "the process of adjustment to actual or expected climate and its effects" (IPCC 2014). Decisions and actions to prepare for adverse consequences of climate change are known as climate adaptation strategies.

With these and other climate-impact research results, the Nations have begun to develop water adaptation strategies. The Nations are leaders in the region, working with water providers across their jurisdictions and assisting with identifying and researching adaptation options. One project developed a drought contingency plan for the Arbuckle-Simpson Aquifer.[22] As a result of these discussions with water providers, the Nations are helping communities with many water supply planning activities that include climate adaptation, such as identifying alternative groundwater supplies for the surrounding cities. The Nations are also working with federal, state, and local partners to study opportunities for artificial aquifer-recharge options throughout their regions.

The Nations have started working with communities to examine wastewater reuse as an economically viable alternative to conventional water supply. Good opportunities for wastewater reuse by industrial users and municipalities (for example, irrigation of ball fields and parks) exist across the entire jurisdictional area. Furthermore, the Nations are partnering with communities to reduce leakage rates in water supply–distribution systems. An example of this partnership includes helping the cities of Tishomingo and Durant acquire competitive grants to install smart meters in areas known to have large water losses and increase the efficiency of their overall system. Drought contingency plans, wastewater reuse, and conservation measures are critical adaptation strategies to strengthen Tribal resiliency in the face of climate change.

[22] Arbuckle-Simpson Aquifer drought contingency plan: https://www.okainstitute.org/drought-contingency

Drinking Water Infrastructure

Key Messages

- Tens of thousands of Native Americans do not have access to safe drinking water. Climate change has the potential to exacerbate this lack of access.
- Operation and maintenance (O&M) of water systems is key to sustainability, cost effectiveness, and, most importantly, the ability to supply safe and reliable drinking water. Proper O&M require adequate funding, staffing, and technical, managerial, and financial training. Proper O&M may become even more critical with climate change as systems respond to increasingly extreme climate events and greater uncertainty with respect to water quantity and quality conditions.
- Water infrastructure deficiencies provide opportunities to install climate-resilient infrastructure.

Recommendation

Climate change is making it more urgent to increase resources for Tribal drinking water infrastructure and for operation and maintenance to eliminate disparities in safe drinking water access and increase infrastructure resilience to climate-related disasters and impacts.

Introduction

Disparities in access to sufficient, safe (meeting standards), accessible (in the home), affordable, and reliable (limited supply disruptions) drinking water contribute to health inequities and environmental injustice (Doyle et al., 2018; Roller et al., 2019). Inequities in water access have come into sharp focus in 2020, during which a record-breaking number of hurricanes have formed and millions of acres across the U.S. have burned, all amidst the COVID-19 pandemic (NOAA, 2020; NIFC, 2020). Tribes in the U.S. face disparities in drinking water access for a variety of interconnected and compounding reasons. Disparities will become exacerbated with climate change. Tribal water utilities and communities, federal and state agencies, nonprofit entities, academic institutions, and the private sector are all important partners in implementing community-led solutions to address the water-access gap for Tribal peoples and all peoples in the U.S. (Doyle et al., 2018; ITF, 2008, 2012; Roller et al., 2019).

Current State of Tribal Drinking Water

Tribal communities obtain drinking water from diverse sources, including rivers, creeks, springs, lakes, reservoirs, ponds, wells, rainwater catchments, and ice stored in cellars (Brubaker et al., 2011; Conroy-Ben & Richard, 2018; GAO, 2018). According to EPA databases, Tribes operate roughly 1,000 public drinking water systems (PWSs). The vast majority (about 97%) are small drinking water systems serving less than 10,000 customers (Conroy-Ben & Richard, 2018; GAO, 2018). Various programs within seven federal agencies provide funding for Tribal PWS construction. The agencies include the Indian Health Service (IHS), the U.S. Environmental Protection Agency (USEPA), the U.S. Department of Agriculture (USDA), the U.S. Department of Housing and Urban Development (HUD), the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, and the U.S. Economic Development Agency (GAO, 2018). The Federal Emergency Management Agency (FEMA) also provides funding to help utilities lessen impacts from future natural disasters. Once built, system ownership is typically transferred to the Tribe

(GAO, 2018). Tribal households may also obtain water from non-Tribal PWSs or private systems or may haul water.

Those who haul water face particular challenges. People hauling water from unregulated sources (e.g., livestock wells) or from regulated sources but with unsanitary hauling methods may be exposed to waterborne diseases and/or contaminants. Water haulers may also pay considerably more for water. A 2004 study on the Navajo Reservation found that haulers drove an average of 14 miles one way for water at a cost of about $1,000 per year or 5% of the average annual household income—more than double the $450 per year paid by Navajo Tribal Utility Authority customers for 10 times the water (ITF, 2008).

AI/AN Households Disproportionately Lack Access to Clean Water

Data about drinking water deficiencies in Tribal communities may come from different sources and cover different aspects of the access issue; however, all sources indicate that AI/AN households disproportionately lack access to clean water. According to the *U.S. Census Bureau's American Community Survey (ACS)*, Native American households are 19 times more likely to lack indoor plumbing than white households (Roller et al., 2019).

IHS's Home Inventory Tracking System (HITS) is the main database tracking sanitation deficiencies in Tribal homes nationwide. In HITS, the term "sanitation" includes both water supply and wastewater. According to HITS, as of March 2020, 52,000 AI/AN homes (12.5%) did not have adequate sanitation. Of these, approximately 6,600 (1.6%) do not have a safe water supply or wastewater system or both, as compared to less than 1% for the U.S. general population (IHS, 2020). A large percentage of the homes in this latter category are in either the Alaska or Navajo IHS regions (IHS, 2018).

At the start of the 2020 COVID-19 pandemic, IHS identified 9,650 Navajo homes with no running water, representing about 37,000 people or 20% of the Navajo population (Navajo Safe Water, 2020). This is higher than the 6,600 homes noted in HITS as having no water supply, no wastewater system, or both.

Safe Drinking Water Act (SDWA) violations include failing to follow monitoring and reporting schedules and violating maximum contaminant levels (MCLs). A review of EPA data for Tribal PWSs in 30 states showed that monitoring and reporting violations occurred at nearly twice the rate for Tribal vs. non-Tribal customers (Conroy-Ben & Richard, 2018). If monitoring and reporting are not done, there is no way to know whether drinking water is safe. MCL violations in Tribal PWSs differed by state. In 18 states, Tribal PWSs had 50% or more MCL violations per capita than non-Tribal customers, indicating greater consumer exposure to unsafe drinking water. However, Tribal PWSs in the remaining states had similar or fewer MCL violations than their non-Tribal counterparts. The most common MCL violations in Tribal PWSs were the coliform and revised coliform rule and arsenic, followed by total haloacetic acids and total trihalomethanes, two disinfection byproducts (Conroy-Ben & Richard, 2018). Potential emerging contaminants in Tribal PWSs include perfluorooctanesulfonate (PFOS), vanadium, strontium, and, in particular, chlorate, another disinfection byproduct (Conroy-Ben & Crowder, 2020). Addressing SDWA violations is important for reducing disparities in safe drinking water access.

Tribal Drinking Water Deficiencies May Be Underestimated or Unknown

Although the above data sources help define the scope of the drinking water access problem, they may underestimate deficiencies. AI/AN are the most undercounted racial group in the U.S. Census by an estimated 4.9%, which may mean that lack of plumbing is not being accurately estimated by the ACS (NCAI, 2020). Additionally, the ACS data do not include the unsheltered, and no data are collected as to whether plumbing functions well and is reliable and if service is affordable (Roller et al., 2019).

In addition, IHS's HITS database likely underestimates sanitation deficiencies, which, as noted above, IHS defines as including both drinking water and wastewater. HITS doesn't indicate if a home's deficiencies have been assessed, meaning that deficiencies may be underestimated for homes in the database (GAO, 2018). In addition, not all Tribal homes eligible for IHS water infrastructure assistance may be in HITS. In some cases, Tribes choose to not provide information to IHS because of cultural or other concerns (GAO, 2018). IHS Oklahoma City–area officials estimated that 100,000 homes eligible for IHS assistance may not be in the database due to challenges identifying eligible homes within communities that have a mix of Tribal and non-Tribal residents and that are not on reservations (GAO, 2018). IHS Portland–area officials estimated that an unknown number of eligible homes in their region are excluded from HITS because of difficulties identifying Tribal homes in dispersed locations removed from Tribal community facilities (GAO, 2018). Suggestions for improving monitoring and tracking of Tribal sanitation deficiencies include updating HITS to indicate whether deficiencies have been assessed, targeting homes for assessment within communities for which EPA data show that water quality standards are not being met, and leveraging opportunities for collaboration between IHS and EPA (GAO, 2018; ITF, 2008). An example of leveraging could be for EPA to collect data that could be entered into IHS's database when EPA sanitary surveys are performed (ITF, 2008).

As noted above, the rate of monitoring and reporting violations for Tribal PWSs is nearly twice that for non-Tribal customers, meaning that MCL violations may go undetected and thus be underestimated.

Finally, some water systems are not regulated. These include systems serving less than 25 people and private wells (USEPA, 2020a). Water quality monitoring in such systems is voluntary and may be irregular (Roller et al., 2019). The scope of any contamination in such systems may thus be unknown.

Identification of Infrastructure Investment Needs May Be Underestimated

Two reports describe investment needs related to drinking water infrastructure. IHS's *Annual Report to the Congress of the United States on Sanitation Deficiency Levels for Indian Homes and Communities* includes costs related to both drinking water and wastewater infrastructure, reports costs related to existing needs, and is based on data in IHS's Home Inventory Tracking System. In contrast, USEPA's *Drinking Water Infrastructure Needs Survey and Assessment* focuses solely on drinking water, projects capital improvement costs over the next 20 years (thus including existing and future needs), considers projects based on eligibility for the Drinking Water State Revolving Fund, and is based on a survey it conducts and on information in IHS's databases (USEPA, 2018).

According to IHS's 2018 report, the total investment needed to bring all homes in the HITS database to adequate sanitation levels (both drinking water and wastewater) was $2.63 billion. When allocating funds to projects, however, IHS considers whether or not a project is feasible. Projects for homes in remote locations with harsh climates, unusual subsurface conditions, and high capital costs per home may not be considered feasible. In 2018, roughly 1,300 out of 1,800 sanitation-deficiency projects were considered feasible, with a cost estimate of $985 million. Projects are re-evaluated annually to determine whether costs and/or scoring have changed. Some Tribes object to the feasibility threshold because they feel that their community projects will never rank high enough to be funded (SPPW, 2011). Infrastructure costs may be underestimated due to the deficiencies in HITS.

According to a USEPA report, "The combined American Indian and Alaska Native Village water system need estimated for the 2015 Assessment is $3.8 billion in capital improvements over the next 20 years. This need includes drinking water infrastructure to increase access to safe drinking water through compliance with EPA's drinking water regulations, as well as connection of homes without piped water to existing public water systems" (USEPA, 2018). This amount doesn't include costs related to population growth, private infrastructure (e.g., private drinking water wells), or adapting drinking water systems to be climate-resilient (GAO, 2018).

Natural Disasters Significantly Impact Safe Drinking Water Access

A 2017 USEPA report indicated that natural disasters both acute (e.g., floods, hurricanes) and chronic (e.g., drought, sea level rise) were among the most significant risks to drinking and wastewater infrastructure in the U.S. (GAO, 2020b). Between 2011 and 2018, the U.S. spent at least $3.6 billion on drinking and wastewater infrastructure disaster recovery. According to the fourth National Climate Assessment, the risk of climate- and weather-related events will likely increase with climate change, potentially exacerbating disruptions in access to safe drinking water (GAO, 2020b). Tribes often have fewer resources with which to respond to and recover from disasters.

Climate Change Impacts on Tribal Drinking Water Supplies and Systems

Climate change may decrease source water quantity, increase water demands, degrade water quality, and/or damage or overwhelm the capacity of water supply infrastructure (GAO, 2020b). The types and severity of changes may differ by region; however, all regions will be affected by climate change.

Water Quantity and Water Demands

Rising air temperatures, greater evaporation, and increasing drought may all contribute to future shortages in both surface and groundwater supplies (CCG, 2016; CSKT, 2013; CTUIR, 2015; PED et al., 2019; Peterson et al., 2017; USEPA, 2015). This could result in supply disruptions and the need to find alternative water sources. Warming air may also increase water demands for the agriculture and energy sectors contributing to water shortages (GAO, 2020b). Reduced snowpack can lead to declining streamflows in some areas and summer shortages. The Confederated Tribes of the Umatilla Indian Reservation also note that reduced snowpack can decrease aquifer recharge from slowly melting snow (CTUIR, 2015). In Alaska, reduced water availability due to surface hydrology changes could cause tundra lakes used as water supplies to dry up, and residents are concerned that thawing permafrost might lead

to the ground absorbing more water, resulting in springs going dry (Brubaker et al., 2010; Kettle et al., 2017). In the Alaska Native Village of Wainwright, thawing permafrost and erosion are ruining ice stored in cellars for drinking water (Brubaker et al., 2014). Climate change could benefit some Alaska Tribes due to longer open water seasons for drinking water collection and treatment (Brubaker et al., 2010). However, this positive may be negated by water quality impacts.

Water Quality

Climate change will likely contribute to and exacerbate water quality issues in both surface and groundwaters. The strain on existing water systems will potentially necessitate additional treatment and/or the development of supplemental or alternative water sources (GAO, 2020b). Permafrost thaw, flooding-induced erosion, and wildfires followed by flooding can all contribute to increases in water turbidity. Turbidity can interfere with the chlorine disinfection process, and associated organic matter can react with chlorine, producing harmful by-products (Brubaker et al., 2011; LNRD, 2016; WRF, 2013). Warming waters can contribute to increases in harmful algal blooms, which may produce toxins beyond the capacity of Tribal water treatment plants to remove (Karuk, Stults et al., 2016; USEPA, 2016). Wildlife shifting in response to climate change can act as vectors for waterborne diseases. Declining water quantities can concentrate contaminants and pathogens (Stanke et al., 2013). Alaska Native villages in the Norton Bay area are also concerned that sea level rise, coastal flooding, and higher storm surges might lead to saltwater intrusion into coastal streams that serve as water sources (Murray et al., 2013; Johnson & Gray, 2014).

Tribes from both coasts are concerned about sea level rise-induced saltwater intrusion into coastal groundwaters (GAO, 2020b; LNRD, 2016; Murray et al., 2013; Shinnecock, 2013). During the 2013-16 drought, the Yurok Tribe observed increasing saltwater influence in some coastal water supply wells (Cozzetto et al., 2018). Wells can be impacted by floods, which can contaminate groundwaters with pathogens or toxins. Infrastructure damage can also lead to contamination of drinking water supplies.

During a workshop, Yurok Tribe community members noted further water quality impacts stemming from drought: people may consume bottled water because water supplies have run out; those bottles may become warm, which could increase their ingestion of plastic byproducts. In addition, they spoke of emotional and spiritual consequences resulting from taking water from someone else's sacred place and where taking water may upset the balance of the place where it is needed (Cozzetto et al., 2018).

Infrastructure

Floods, wildfires, drought, permafrost thaw, and erosion can all damage water-supply infrastructure such as buildings, source water intakes, well casings, pumps, filtration, distribution lines, and water towers (Doyle et al., 2013; Brubaker et al., 2010; PED et al., 2019; USEPA, 2015). Infrastructure damage can cause treatment failures and unsafe water quality and/or service disruptions. Permafrost thaw is causing breaks in distribution lines and impacting treatment facilities in Alaska Native villages (Murray et al., 2013). Drought can lower river or lake levels below intake infrastructure and cause them to suck in mud, impacting pumps and filtration equipment (GAO, 2020b). Fire can damage well systems, allowing for contamination by chemicals, microorganisms, and fire retardants (Waksom et al., 2013).

In addition to damage, climate change can overwhelm infrastructure capacity. In Alaska, warming air contributes to algal blooms, necessitating increased filter changes and labor, resulting in greater costs (Brubaker et al., 2010; GAO, 2020b). Flood waters can infiltrate old infrastructure, overwhelming water treatment systems (Stults et al., 2016). Post-fire sediments washing down during floods can clog water intakes, shorten filter runs, and increase backwash frequency and the amounts of sludge to dispose of (Cozzetto et al., 2018). Post-fire sediments can build in and decrease reservoir capacity (GAO, 2020b).

Cascading Infrastructure Failure

Tribes have concerns about climate hazard impacts on secondary infrastructure, which could lead to cascading infrastructure failure of interconnected systems (GAO, 2020b). For instance, extreme events could disrupt power needed to operate pumps and treatment facilities or could disrupt internet needed to remotely monitor drinking water systems. These could cause service interruptions and/or unsafe water being delivered (USEPA, 2013). Extreme events like flooding could damage or overload septic systems, contaminating water supplies (PED et al., 2019; Waskom et al., 2013).

Compound Events

Compound events in which two or more climate hazards occur simultaneously or consecutively can also contribute to/exacerbate drinking water impacts (GAO, 2020b). Extreme rainfall plus storm surges can cause more extreme flooding. Drought exacerbates wildfire risk and may also contribute to flooding, as dry soils may have less capacity to absorb water (NWF, 2011). Heavier downpours after wildfires could lead to increased landslides. With limited roads on many reservations, landslides threaten water system accessibility, resulting in serious health and safety risks for whole communities.

Nonclimatic Challenges and Opportunities Facing Tribal Drinking Water Systems

In addition to climatic challenges, Tribal drinking water systems face multiple, interconnected nonclimatic challenges that may interact with, compound, or accelerate climate change impacts, and that may result in communities not receiving safe drinking water. Such nonclimatic challenges may include under-resourced personnel, legal and jurisdictional issues, infrastructural factors, financial issues, and inadequate operation and maintenance of systems. Some challenges are similar to those experienced by other small drinking water systems. Others are unique to the Tribal context (Doyle et al., 2018).

Under-resourced Personnel

Personnel running Tribal water systems face a variety of challenges. Some may be doing their work on a voluntary basis without being paid (ITF, 2012). They may have limited knowledge of and time to investigate diverse funding sources (Doyle et al., 2018). They may also have limited grant writing and administration expertise. Additionally, there are no federal requirements for water treatment plant operator certification for Tribal PWSs (Doyle et al., 2018). As a result, funding for certification may be restricted, and those hiring operators may not have a reliable way to evaluate applicants. Even if Tribal operators are interested in trainings, they may not be available within driving distance. Some repairs and upgrades may not fall within operator expertise and may thus not be completed (Doyle et al., 2013). Personnel of small drinking water systems often do not have the resources or training to address climate

impacts to their systems (Ekstrom et al., 2018). Furthermore, Tribal PWSs have challenges recruiting and retaining personnel, resulting in insufficient staff operating and maintaining critically important infrastructure (Doyle et al., 2018; GAO, 2020b). This issue often stems from limited financial resources to pay operators (ITF, 2012). An insufficient workforce increases difficulties with respect to running water systems. Limited staffing can also prove challenging during emergencies when increased personnel may be needed (Cozzetto et al., 2018). Staff turnover also often results in knowledge gaps and lost institutional knowledge (Doyle et al., 2018).

Legal/Jurisdictional Issues

Tribes face complex legal/jurisdictional issues affecting their ability to establish, operate, and maintain drinking water utilities. These include land fractionation, processes obtaining rights of way, lack of clear eminent-domain authority, and conflicting regulations with respect to Tribal hiring and contract preference (Doyle et al., 2018). Grants may require a partial waiver of sovereign immunity, which Tribes may not want to provide or which require legal counsel to negotiate for each such grant received. Tribes lack authority to create water districts to raise funds through taxes and guarantee construction loans (Doyle et al., 2018). Tribes may have a history of poor environmental enforcement, which can affect utility construction and operations. For example, finding unanticipated hazardous waste when installing distribution lines can increase costs and cause delays (Doyle et al., 2018). In addition, many Tribes have not yet adjudicated their federally reserved water rights and are still in the process of negotiating with other stakeholders to quantify those rights (Cozzetto et al., 2013). Some Tribes may have litigated and won their rights, but do not have the financial resources to build infrastructure to deliver water to their communities. Climate change impacts on water quantity, quality, and timing increase legal and planning complexities and intensify concerns that Tribal water rights may be sacrificed and that human as well as environmental water needs may go unmet.

Infrastructural Factors

Existing infrastructure in many Tribal communities is aging and may have initially been built to serve smaller populations (Doyle et al., 2018; GAO, 2020b). Infrastructure may thus already be starting to fail. Moreover, such infrastructure was designed for historic climate and may not be resilient in a changing climate (GAO, 2020b). Drinking water systems may depend on secondary infrastructure such as internet and power that is not always reliable. Finally, for communities still lacking infrastructure, installation costs may be high because of low population densities, remoteness, harsh climates, challenging subsurface conditions, and legacies from being relocated to marginal areas with fewer and lower quality water supplies.

Operation and Maintenance

The importance of proper operation and maintenance (O&M) of drinking water systems cannot be overstated. Adequate O&M can extend system lifetimes, reduce the need for emergency repairs and upgrades, increase system cost effectiveness, and increase the time a utility has to amass funds to replace aging infrastructure (ITF, 2020). Funds for emergency repairs and upgrades or for recapitalizing infrastructure before its design life are diverted from providing drinking water infrastructure for those who do not have it. Adequate O&M is also critical to a system's ability to deliver safe drinking water.

Without it, consumer health may be compromised. Proper O&M requires sufficient funding, staffing, and expertise (technical, financial, and managerial). Particular O&M challenges include high O&M costs for infrastructure serving low, widely dispersed populations in remote locations and/or challenging environmental conditions, restrictions on federal agencies with respect to using their funds for O&M, suboptimal water system operator O&M training and capacity, decreased funding for O&M training and assistance, and Tribal communities not being fully informed of the O&M costs that will be associated with new infrastructure being proposed (Doyle et al., 2018; ITF, 2008, 2011).

Financial Factors

Tribal communities are often smaller with lower population densities. Both mean that Tribes may have higher costs per household to construct, operate, and maintain drinking water systems (GAO, 2020; ITF, 2008). Tribal utilities may also face challenges with respect to charging users. Many Tribes have high unemployment and low income levels. People may not be able to afford the true costs of providing water to their homes (ITF, 2012). Moreover, some users have never had to pay for water before, having never received water from a utility, and some may have cultural objections to the commodification of water (Chief et al., 2016; GAO, 2018; ITF, 2012). Tribal politics may also affect the amount of funds available to operate and maintain water systems and the rates charged (ITF, 2012).

More broadly, federal funding for water infrastructure has decreased. In 2019, such funding was only 14% of what it was in 1977 (Roller et al., 2019). Furthermore, appropriated funding can be far below the estimated need. In 2016, for instance, Congress appropriated $99.4 million for water and sewage infrastructure, less than 4% of the $2.7 billion IHS estimated it would need to provide adequate infrastructure to all homes in its HITS database (Roller et al., 2019). In addition, the Census count is considered when distributing federal funds, including funds for water projects, and AI/AN are the most undercounted racial group (NCAI, 2020). Federal agency scoring processes may also not always prioritize water projects addressing the most severe deficiencies (GAO, 2018). Finally, with various programs within seven different federal agencies involved in funding Tribal PWS construction, it can be difficult to identify, navigate, and leverage funding sources, application processes, and funding cycles.

Recommendations

The sources reviewed above provide a large number of recommendations for addressing both the climate change related and nonclimatic challenges facing Tribal drinking water infrastructure. We have included some of the key recommendations below as well as examples of Tribally-led initiatives to address some of the drinking water challenges discussed. We refer readers to the reports themselves for further information and additional recommendations suggested.

Improving the Climate Resilience of Tribal Drinking Water Systems

- *Learn from extreme events taking place now to better prepare Tribal water utilities for the future (Ekstrom et al., 2018)*

There aren't many examples of climate adaptation among small drinking water systems. Assembling lessons learned from handling extreme events such as drought and flooding could advance climate adaptation in such systems (Ekstrom et al., 2018).

- *Make use of opportunities to upgrade or install new water infrastructure to do so in a climate-resilient way (TCCP AC, 2019)*

Climate-resilient systems provide reliable service with limited disruptions in the face of changing environmental conditions and extreme climate events. If disruptions occur, systems recover quickly (Ekstrom et al., 2018). Actions that make drinking water systems more climate-resilient include diversifying water sources, expanding storage capacity, drilling wells deeper and properly closing abandoned wells, encouraging water efficiency, upgrading water treatment, managing source watersheds to maintain clean water supplies and store water, using natural or manmade reset opportunities to elevate infrastructure above flood risk levels, installing floatable water intakes that rise and fall with reservoir levels, installing generators to provide backup power for pumps in case of power loss, and having more than one route or mode of transport to reach water treatment plants (CCS, 2011; Ekstrom et al,. 2018). Such actions include examples of both redundancy (multiple ways of accomplishing critical functions) and flexibility (ability to adjust if conditions are different than anticipated). Both are important traits of climate-resilient systems (CCS, 2011).

- *Develop and enact federal interagency climate resilience guidelines for Tribal drinking water systems (TCCP AC, 2019)*

Interagency climate-resilience guidelines could be based on already existing efforts and adapted to meet the unique contexts and needs of Tribal drinking water systems. One resource could be the USEPA's Creating Resilient Water Utilities (CRWU)[23] program.

Assisting Under-resourced Personnel

- *Provide Tribal water system operators with a paycheck and benefits (ITF, 2012)*

In some cases, Tribal water system operators may be volunteering in that role. Providing a paycheck and benefits could increase operator retention once they are trained.

- *Recruit and train Tribal members as operators (ITF, 2012)*

Tribal members may have greater incentive than non-Tribal operators to stay with a Tribal utility.

- *Increase funding for entities providing Tribally-focused technical, managerial, and financial training and technical assistance (Roller et al., 2019)*

Entities providing Tribally-focused water system training and/or peer-to-peer learning include the United Southern and Eastern Tribes, the Inter Tribal Council of Arizona, the Native American Water Masters Association, and Environmental Finance Centers (USEPA, 2020). The Rural Community Assistance Corporation hosts a Tribal Circuit Riders program. Circuit riders are water professionals who make onsite visits to help with operations, finances, and management (RCAC, 2020).

[23] Creating Resilient Water Utilities (CRWU): https://www.epa.gov/crwu

Addressing Infrastructural Considerations

- *Increase funding for operation and maintenance to extend water system lifetimes* (ITF, 2008, 2020)

Insufficient maintenance of drinking water infrastructure due to either limited financial or technical capacity can reduce system lifetimes (ITF, 2008, 2020). Increased funding for O&M could help systems to run more cost effectively and last longer.

- *Research and implement decentralized and/or alternative water treatment technologies to increase access to safe drinking water*

For communities that lack water infrastructure due to low population densities and/or challenging environments, more decentralized and/or newer technologies may provide more cost-effective options (Roller et al., 2019; GAO, 2020a). These include point-of-entry treatment (devices that treat water when it enters a home), point-of-use treatment (devices that treat water at a tap such as a kitchen faucet), remote monitoring and operation, low-pressure micro- or ultrafiltration membranes, and atmospheric water generation (producing potable water from the surrounding air) (Roller et al., 2019; GAO, 2020a). Federal, private, and nonprofit investors could support community-led research, pilot projects, implementation, and evaluation of treatment and cost effectiveness (Roller et al., 2019; GAO, 2020a). Regulators could develop standards and technical assistance for decentralized systems.

- *Make climate resilience a condition for federal funding of drinking water infrastructure* (GAO, 2020b)

A requirement to make climate resilience a condition for federal funding from programs administered by agencies such as USEPA, FEMA, HUD, and USDA could help ensure that funded infrastructure sufficiently reduces risks from climate change and limits disruptions to the provision of safe drinking water (GAO, 2020b).

Improving the Operation and Maintenance of Tribal Drinking Water Systems

Building the technical, financial, and managerial expertise of water system operators is discussed above. Various O&M financial strategies are noted below. Additional approaches include:

- *Develop partnerships with other utilities either within or outside the Tribe to reduce O&M costs and build financial capacity*

For example, the Alaska Rural Utility Collaborative partners with and supports rural communities in managing, operating, and maintaining water and sewer systems (ANTHC, 2020). It also helps communities set self-supporting rates and provides billing and collection services.

- *Allow state and federal funds to be used to support O&M costs*

For instance, in 2019, California established the Safe and Affordable Drinking Water Fund, which includes significant and continuous O&M funding for struggling water facilities (Roller, 2019).

Improving the Funding of Tribal Drinking Water Infrastructure

The Federal Infrastructure Task Force to Improve Access to Safe Drinking Water and Basic Sanitation to Tribal Communities (ITF) has developed a number of recommendations related to funding.

*Federal agency recommendations includ*e (ITF, 2008):

- Making available funding more accessible
- Using available funding more efficiently and creatively
- Improving interagency coordination to increase effectiveness of existing resources
- Collecting additional data to describe the problems and target solutions

Tribal utility recommendations include (ITF, 2012):

- Investigating whether Tribal industries or enterprises can help subsidize utilities
- Running the utility as a business and establishing fair and accepted billing and collection systems
- Maintaining utility independence from Tribal politics
- Regularly educating Tribal Councils about the true costs of providing water and educating customers that while water may be free, infrastructure to treat and deliver water is not.

Additional recommendations are detailed in ITF's 2008, 2011, 2012, and 2020 reports.

Various sources note funding priorities that include increasing federal and state funding and strategically using and leveraging funding among agencies to finance:

- Infrastructure, operation and maintenance (top recommendation of comprehensive 2008 ITF report)
- Entities providing technical assistance; technical, managerial, financial training (Roller et al., 2019)
- Community-led research, pilot projects, and implementation of alternative water treatment technologies, including evaluation of treatment and cost effectiveness (ITF, 2008; GAO, 2020)

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Chapter 5: Health & Wellbeing

The health and wellbeing of Indigenous peoples is closely tied to the health and wellbeing of the environment, and therefore climate change poses both unique threats and opportunities. First foods are a vital source of spiritual connection and have a strong history for Tribes. Climate change threatens that connection; however, Tribes like the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) of Oregon are protecting and preserving them. The Swinomish Indian Tribal Community of Washington considers the health and wellbeing of Indigenous peoples to be founded on mutually beneficial relationships among humans, nonhuman relatives, and the environment. They support and implement community-defined climate strategies and capacity building within their communities to strengthen resilience and perseverance. A researched overview of Health & Wellbeing as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Setting the First Foods Table for Climate Resilience

Written by: Teara Farrow, Wenix N. Red Elk, and Colleen Sanders

For the Indigenous Peoples of the Columbia Plateau, food is their culture, it is everything. Not just "food," but the First Foods that have supported and nourished this land's first stewards in a reciprocal relationship kept in a harmonic balance that can be traced back definitively at least 10,000 years into history through artifact evidence and much longer than that through the knowledge the Tribal culture and foodways preserve. The foodways of the *Weyíitletpuu* (Cayuse), *Imatalamłáma* (Umatilla), and *Walúulapam* (Walla Walla) people involve the gathering of many essential First Foods for subsistence, and the traditional Food table is set with fish, wild game, roots, and berries. Cultural land management practices emphasize preserving cold, clear water and forests that undergo periodic burning, providing Foods abundant in essential nutrients, rich oils, and sustaining energy. The Creator decreed to the People that they carry a promise, a reciprocal responsibility to respectfully care for, harvest, share, and consume traditional Foods, or they

First Foods Feast to celebrate the return of wapato at a CTUIR Tribal member's home. Photo credit: Teara Farrow Ferman.

may be lost. But neither can survive without the other, and if the Foods are lost, the People will be lost too; their fates inextricably linked. Since time immemorial, *tamánwit* has taken care of the traditional Foods and guided the CTUIR in preserving them. The climate crisis threatens to further untether Tribal people from their First Foods, but the promise that has sustained the people into modernity is the best—and only—path forward for climate adaptation rooted in environmental justice and the rights of nature.

For Indigenous peoples, the world has ended many times before. Cataclysmic events that have shaped the existing landscape of the Pacific Northwest are recorded in the stories and practices of Tribal people. When massive ice dams in the Rocky Mountains breached to release the torrential Missoula Floods that carved the Columbia River's first path to the ocean 15,000 years ago, people were living there. When Mount Mazama's caldera violently erupted, blanketing the world with ash and fire and forming what we now call "Crater Lake" over 7,000 years ago, people were living there. Indigenous people were witness to massive geological and atmospheric events that completely and rapidly altered their world, and they are still here today because of the resilience that is woven into the very fabric of Tribal culture and knowledge. In narratives told about the history of land management in the West, the falsehood that persists is one of conquering the unmanaged "wilderness" and is a lie that fundamentally erases the perpetual presence of Indigenous people who were there. Indigenous peoples are intertwined with the evolution of the landscape that they steward, and their management of it is integral to the way it has adapted to function. These traditional practices have been sustained through previous world-altering changes, so it stands to reason that they will again carry the people through this changing world, too.

The climate crisis threatens every aspect of modern life, exposing us to exponentially increasing amounts of risk: risk of catastrophic flooding and wildfire, of drought, disease, and conflict. Regarding the risk the climate crisis will create, it is helpful to remember that the land is a living being, an entity that we live not on, but **with**, and who has wants and needs. Thus, risk can be thought of as the interruption from what the land wants (its ecological steady state) to the way specific land management extorts it to be to facilitate construction, industry, agriculture, and other extractive colonial operations. Much of the need for "climate adaptation" is due to demand that the land be other than it energetically and ecologically desires, and the impacts of the climate crisis threaten to push it into a new steady state of existing, one that is wholly unfamiliar and frightening. Indigenous management values the land as it wants to be and prioritizes the species that are living prosperously on its landscape without extra inputs like irrigation, feed, or fertilizer, and thus the least risky and most resilient to new stressors. Climate adaptation must focus on restoring natural

CTUIR Tribal member gathering wapato. Photo credit: Teara Farrow Ferman.

connections to the land and prioritizing native species over colonizer frameworks by trusting the First Foods to guide policy decisions informed by science. The People and the First Foods have been keeping their promise to one another since time immemorial, and the best climate adaptation is to continue to trust in that promise and return to the First Foods.

CTUIR Department of Natural Resources Director discussing management plans for the Rainwater Wilderness.

CTUIR's land management strategies offer perspective on how this climate resilience works in practice. Flooding is a natural part of a river system and is only problematic when structures are built in the river's path. Reconnecting floodplains and restricting development allow the river to naturally express itself and create great potential for water storage to buffer summer drought. Wildfire is similar: cultural burning helps clear out the forest understory for the availability of big game and healthy plants, and Tribes historically burned as they migrated. This practice of prescribed burning clears the accumulated fuel and helps release nutrients stored in dead vegetation to be accessible in the ecosystem once again. By criminalizing cultural burning in 1910, Tribal people were kept from carrying out their responsibility, creating the conditions for the widespread megafires we are experiencing today. Tribal people even knew how to foster psycho-social resilience for their spiritual wellbeing, as strategies for maintaining community cohesion and providing emotional support are critical to adapting to a shifting world. Ceremonial practices in the Tribal longhouse offer opportunities for genuine connection, a space to share without judgment the weight we carry, to listen to the burdens that others endure, and to return once again to the First Foods and their stories.

Tribal people are at the forefront of the climate crisis because they are the continuation of a long and unbroken line of surviving the end of the world. The First Foods still keep their promise of providing for the People, and it is to this promise that we must all return in order to weather the coming storms of the climate crisis.

Health & Wellbeing

Key Messages

- Indigenous peoples' health and wellbeing (HWB) is founded on mutually beneficial relationships among humans, nonhuman relatives, and the environment; therefore, HWB is highly impacted by climate change
- Social-emotional health, water security, and first foods security (includes foods, medicines, and technologies) are key aspects of Indigenous peoples' health and wellbeing that merit increased attention and rapid adaptation at local scales due to Indigenous peoples' unique cultures and worldviews
- Indigenous peoples' resilience is strong; supporting community-defined climate strategies and capacity building within Indigenous communities will augment resilience

Recommendation

Accelerate incorporating Tribal HWB evaluations, priorities, and action plans into government policy, laws, and decision-making.

Health and wellbeing (HWB) is defined as a symbiotic state of being among humans, other beings, the environment, and the spiritual realm which arises when needs are met, when individuals and communities can act meaningfully to pursue their goals, and when individuals and communities enjoy a satisfactory quality of life (Breslow et al., 2016). Foundational to Indigenous views of HWB is being in positive, reciprocal relationships with other beings and the natural world.

Some of the largest scale and most devastating impacts from climate change are to the health and wellbeing of Indigenous peoples. Researchers have identified Indigenous peoples globally and in the U.S. as highly sensitive populations, due to colonialization and subsequent land dispossession, social exclusion, and discrimination, who are most often on the front lines of climate impacts because of close relationships with the natural world (Ford et al., 2020; Nakashima et al., 2018). Indigenous peoples also possess incredible resiliency borne from Indigenous knowledges and countless generations of connection to place (Ford et al., 2020).

Increases in extreme temperatures, precipitation extremes, vector-borne pathogens, poor air quality days, and extreme weather events all directly impact human health. These climate impacts disproportionately affect many Indigenous peoples who have higher rates of asthma, cardiovascular disease, Alzheimer's disease or dementia, diabetes, and obesity. For example, people with diabetes are more sensitive to extreme heat and air pollution (Vallianou et al., 2020). While physical health is a key component, it is not the only aspect of health vital to achieving HWB. This chapter focuses on three key aspects of Indigenous HWB that have achieved mention in large-scale Indigenous peoples' climate health assessments, but deserve more attention to the impacts and adaptive strategies occurring across the country on a local scale: social-emotional health, water security, and first foods security. It is important to keep in mind that each Indigenous community is unique, with their own beliefs, values, and worldviews that are founded on their own place-based experiences and that foster their own Indigenous knowledge. It is also key to recognize sovereignty as an overarching right and necessity to achieve HWB, including rights to health services, water, and first foods.

Social and Emotional Components of HWB

The social and emotional components of health and wellbeing have a particular importance for Tribal communities. The physical effects of climate change on people and the environment can be directly linked to detrimental consequences to an individual's identity and their ability to maintain traditions and uphold personal and community-held cultural values, which in turn have consequences for both individual and community social and emotional health (Adams et al., 2021; Bell et al., 2010). Increases in rates of mental-health issues, decreased cognitive function, violence, interpersonal aggression, and suicide have all been linked to elevated temperatures (Adams et al., 2021). Occurrences of climate-related extreme events (such as flooding or wildfire) can also impact mental health and can be expressed as "post-traumatic stress disorder (PTSD), anxiety, depression, substance abuse, and suicidal thoughts" (Adams et al., 2021). Tribal communities can be particularly vulnerable to these mental health impacts, due to disparities in health care, historical trauma, and other social determinants of health.

Serdeczny, Waters, and Chan (2016) identify these consequences through the concept of noneconomic loss and damage, which includes tangible impacts to landscapes, biodiversity, and cultural sites that lead to intangible impacts to intrinsic values, agency, and identity. Climate damage to traditional food species, for example, may lead to crises of identity in communities that are no longer able to gather those foods, to use their language associated with those plants and animals, or share the ceremonies, songs, and prayers with their community that are associated with that activity (Norgaard & Tripp, 2019). Thus, supporting social and emotional wellbeing in Tribal communities must include consideration of culturally-specific risks and needs.

Climate adaptation planning for Tribal communities must include social and emotional resilience strategies that are broadly applicable while being flexible enough to adapt to local needs and values. There is no one size fits all solution; instead, strategies need to reflect the place and its people, honoring what the community values and the vision they want to see moving forward into the future. Most importantly, approaches to climate change adaptation that build social and emotional resilience are needed to safeguard mental health and wellbeing (Doppelt, 2016). The World Health Organization illustrates that informal strategies focused on self-care and community care provide a broad base for supporting psychosocial wellbeing and help prevent the need for more intensive or formal interventions (Figure 9, World Health Organization, 2007). Furthermore, research on disaster recovery shows how building social and emotional resilience and reinforcing community cohesion improve recovery rates and reduce the likelihood of long-term mental health impacts (Aldrich, 2012). The most effective interventions for promoting social and emotional resilience in the face of disasters and trauma promote five essential elements of wellbeing: a sense of safety; calming; social connections; self- and collective efficacy; and a sense of hope (Hobfoll et al., 2007).

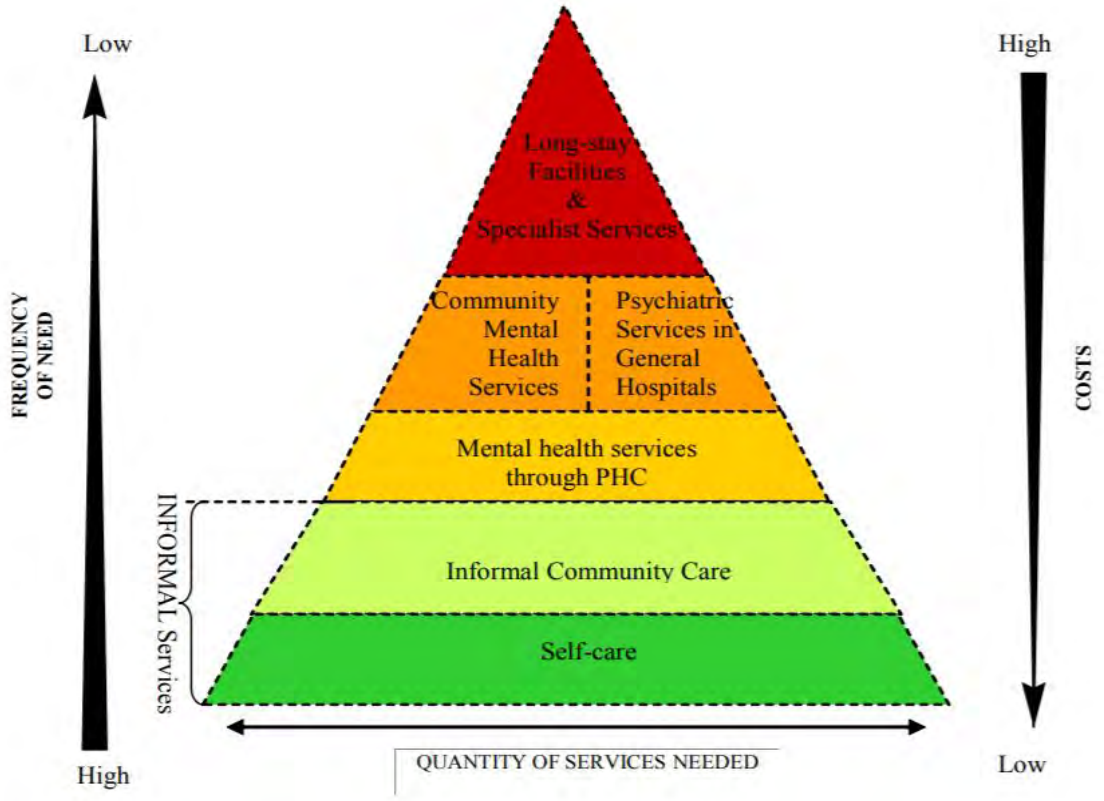

Figure 9. The Optimal Mix of Services: World Health Organization Pyramid Framework (2007).

The Pala Band of Mission Indians in San Diego County, California, has developed *Chemşhúun Pe'ícháachuqeli* (When our Hearts are Happy), a Tribal Psychosocial Resilience Framework[24] (Gaughen & Hacker, 2019) to provide an overview of several broad-based community mental health resilience approaches, using the Pala community as an example of how those approaches can be tailored. Pala's framework includes psychosocial resilience adaptation strategies that focus on coping strategies, problem-solving, self-care, and community care that incorporate the five essential elements of wellbeing. The framework is available to other Tribes who wish to develop their own psychosocial resilience strategies.

Water Security

Water security is another key facet of Indigenous peoples' HWB and is already one of the most serious environmental health issues for Indigenous peoples in the United States (USEPA, 2013; VanDerslice, 2011). The effects of climate change on Indigenous water resources are exacerbating the impacts on Indigenous HWB (Martin et al., 2020; Redsteer et al., 2013). For Indigenous peoples, water security goes beyond material definitions; water is sacred, essential to all of life. Water security also encompasses

[24] *Chemşhúun Pe'ícháachuqeli* (When our Hearts are Happy), a Tribal Psychosocial Resilience Framework: http://tribalclimatehealth.org/wp-content/uploads/2019/07/Psychosocial-Climate-Resilience-Framework_Pala-Final.pdf

maintaining relationships to safe, sustainable, traditional water sources through cultural practices and traditions which are integral to emotional, spiritual and environmental wellbeing (Cozzetto et al., 2013). As related by Apsáalooke Tribal member John Doyle:

> *This isn't just about human health, we need to ensure that all life in and along the rivers and even the water are included. This awareness is what makes us who we are as a people. We have removed ourselves and are no longer aware of how we are connected to all life. We have to remember that this is our home, and it's the home to all life.*

Climate change is having many impacts on fresh and marine waters with significant negative effects including but not limited to: ability to sustainably manage resources and infrastructure; decline and loss of culturally important aquatic species; impacts to subsistence hunting, fishing, and gathering (see *Chapter 4: Ecosystems & Biodiversity*); impacts on agriculture and ranching activities; challenges to Indigenous water rights and sovereignty; and escalated rates of land loss, erosion, and degradation. Multiple factors make Tribes more vulnerable to these impacts, including inadequate authority, lack of capacity or resources, or the power to manage Tribal lands and waters in the manner the Tribe would like (McNeeley, 2017); jurisdictional conflicts; legal and regulatory gaps; limited economic resources; poorly designed, aging, and inadequately maintained water and wastewater infrastructure; and both legacy and ongoing environmental contamination (Doyle et al., 2018; Cozzetto et al., 2013).

In Crow Agency, Montana, Tribal community nonprofits, Little Bighorn Tribal College, and other grassroots organizations are actively prioritizing, addressing, and coping with water insecurity, while upholding Apsáalooke (Crow) lifeways and values (Martin et al., 2020). The Crow Environmental Health Steering Committee has been working to understand the nature and sources of water contamination, the associated health risks, and how the changing climate is impacting Tribal water resources (Figure 10) (Doyle et al., 2013). They have been able to provide free home well-water testing to rural families, water and health education, and home water coolers with refillable five-gallon jugs for those lacking safe well water to drink (Eggers et al., 2018). Currently they are working on other mitigation strategies to help water-insecure families and to build community capacity to manage home plumbing and community water resources. Other grassroots organizations work on educating youth about Crow traditions around water and Western water science (Simonds et al., 2018), on management of chronic illnesses (Held et al., 2019), and on mitigating widespread water and food insecurity that have been greatly exacerbated by the COVID-19 pandemic and accompanying further loss of jobs (e.g., Plenty Doors Community Development Corporation,[25] The Center Pole,[26] and others). (See narrative titled *Elders' Reflections on Climate Change Impacts, Crow Reservation, Southcentral Montana* in *Chapter 4.2: Water* for more details about water security on the Crow Reservation.)

[25] Plenty Doors Community Development Corporation, http://plentydoorscdc.org/
[26] The Center Pole, https://www.thecenterpole.org/

Figure 10. Installing a weather station near Crow Agency, Crow Reservation, as part of a statewide program to provide local weather data for short-term uses and long-term climate adaptation planning.

First Foods

First foods, also referred to as traditional foods (or "our foods'' by Indigenous peoples), comprise regionally specific foods, medicines, and technologies that Indigenous peoples have relied on since time immemorial. Access to first foods, medicines, and harvesting practices is central to the health of Indigenous peoples—physically, mentally, and spiritually. Participating in first food practices has been disrupted by forced removal, relocation, assimilation, and colonial development, driving some Indigenous peoples into a nutritional transition from first foods to store-bought foods, which can be unhealthy and expensive, leading to high rates of food insecurity and chronic health problems (Fleischhacker et al., 2012; Jernigan et al., 2017). The impacts of climate change are increasing pressure on first foods systems by limiting both access to the lands and waters and the availability of the first foods (Lynn et al., 2013). Every Indigenous community across the U.S. feels the impacts of climate change on their regionally specific first foods (e.g., see narrative in this chapter titled *Setting the First Foods Table for Climate Resilience*). Below are a few of the many examples of how climate change directly affects subsistence traditions and practices.

Loss of sea ice in Alaska is one of the most drastic examples of decreasing first foods habitats, declining access to first foods, and the physical, emotional, social, economic, cultural, and environmental impacts to Alaska Native HWB (Huntington et al., 2017). The rate of climate change in the Arctic and sub-Arctic has multiple deleterious impacts upon the food security of Indigenous peoples in Alaska, such as changes in water temperatures, weather, migration patterns, and birthing success, decline in salmon returns, loss of sea ice, and threats to food preparation and storage, the safety of hunters and harvesters, and overall physical and mental health and wellbeing. These impacts and many other combined and interrelated elements require rapid adaptation to ever-changing conditions with direct,

immediate consequences for Indigenous peoples' food security. In addition, corresponding management regimes imposed and controlled by state and federal agencies lack the capacity, knowledge, and expertise to keep pace with the constant changes, thereby creating another set of rigid and adverse impacts. These forces and stressors are intimately related to overall cultural integrity and vitality of traditional economic and sustainable land-tenure practices (Inuit Circumpolar Council Alaska, 2020).

The traditional timing of subsistence activities that people typically plan for has become asynchronous with the different types of gathering efforts (Herman-Mercer et al,. 2020). Moose are an important subsistence species for Alaskan Natives and Indigenous peoples of boreal forests. However, increasing temperatures are leading to decreasing moose harvests, likely because moose prefer colder temperatures and undergo stress of their thermoregulatory and health systems at higher temperatures (Hasbrouck et al., 2020); moose also typically bed down during warmer temperatures, which decreases their movement (Hasbrouck et al., 2020) Furthermore, warmer temperatures can lead to faster spoilage of meat once hunted (Hasbrouck et al., 2020). Salmon are also a fundamentally important species to Alaskan Natives and serve as the foundation of their economic, social, and cultural systems (Bisbal & Jones, 2019). "Salmon are vulnerable to changing water temperature, acidity, and other microscopic ocean conditions and, as such, can be considered a marker species for a changing climate," and observations by the Tlingit and Haida Tribes show "a direct link between Salmon and a changing climate" (Scott et al., 2018).

Tribal nations in the Northwest have significant cultural ties to salmon, and the importance of salmon to Indigenous spiritual, mental, and physical health cannot be overemphasized. Salmon have long been considered to be the cultural lifeblood of Tribes in the Pacific Northwest. In the Columbia River Basin, they have been known to refer to themselves as "Wy-Kan-Ush-Pum," which can be translated to "the salmon people." They have stories, songs, traditions, and celebrations that are based upon the salmon, which is foundational to Tribes in the Pacific Northwest.

In northeastern Maine, the Aroostook Band of Micmacs have previously relied on subsistence food sources such as moose, fish, and other seafood (Kapp, 2019). However, warmer water temperatures and habitat loss have greatly reduced the availability of eastern brook trout, the only native trout in the eastern U.S. As a result, Tribal members have of necessity turned to increased consumption of processed foods and other less healthy food sources (Kapp, 2019).

Loss of biodiversity, increasing air temperatures, and wildfires can create the environmental conditions that lead to an increase in the frequency and intensity of vector-borne diseases (Jones et al., 2008). Specifically, infectious diseases are becoming more emergent and easily transmitted via vectors (such as mosquitoes, ticks, and fleas), as they are sensitive to climatic changes (Curseau et al., 2009; Jones et al., 2008). Vectors and their pathogens prefer a warmer and more humid climate and have the ability to survive in some areas that they were not able to survive in before (Jones et al., 2008), and those ranges are expected to expand due to climate change (Sonenshine, 2018). Indigenous peoples who hunt, fish, and gather may thus be exposed to new diseases emerging in their region.

As described above, many Tribal communities depend on the hunting of moose, deer, and other big game species for sustenance. Winter ticks (*Dermacentor albipictus*) are parasites that are an increasing concern for moose and can lead to premature loss of moose's winter coats, chronic anemia, increased

susceptibility to predation and disease, increased calf mortality, increased age of first breeding, and decreased adult fecundity (Weiskopf et al., 2019).

First foods are foundational to protecting and promoting Indigenous peoples' HWB resilience. The resilience in the context of climate change (and also in the COVID-19 pandemic) is built on countless generations of knowledge, experience, and the ability to adapt (Zavaleta-Cortijo et al., 2020). The Swinomish Indian Tribal Community (Washington state) developed a set of nonphysical, noneconomic Indigenous health indicators (IHI) to demonstrate the myriad connections between HWB and first foods.

The 6 IHI are community connection, cultural use, education, self-determination, natural resource security, and resilience (Figure 11). The Swinomish Climate Change Impact Assessment identified sea level rise, storm surge, and forest fires as the three most pressing climate impacts to the community (2009). Swinomish community members used the IHI to prioritize how the Tribal government focuses limited time and resources on sea level rise and storm surge impacts to important first foods habitats (Donatuto et al., 2020a). Based on the Swinomish community priorities, the Tribe developed and implemented the 13 Moons curriculum, a series of environmental health and sustainability hands-on activities teaching first foods harvest, preparation, and preservation practices, guided by Elders and experts (Donatuto et al., 2020b). In addition, the Tribe is building the first modern-day clam garden in the U.S. Clam gardens are an ancient Indigenous technology of creating rock walls at the low tideline

Figure 11. Swinomish Indigenous Health Indicators. This infographic depicts a scene on the beach that demonstrates all six of the IHI in action. Families are working together beach seining (fishing with nets from the beach), steaming shellfish in a fire pit, and crab fishing in the bay. Elders are telling stories to younger generations; youth are exploring and helping harvest, cook, and preserve the catch; the natural resources are accessible; people are asserting their sovereignty by being out on their lands and waters and engaged in culturally important practices, which "feed the body and the spirit" in the Swinomish way. Words at the top of each Indicator are in Lushootseed, the Swinomish language. The words in the center are most often used when speaking with people from outside of the Swinomish community. The words at the bottom are the community's words for each indicator in English.

that accrete sediment behind the wall, providing a terrace at an elevation that promotes increased populations of clams and other important first foods (Groesbeck et al., 2014). Clam gardens may also attenuate tidal surge, and the buildup of shells may buffer against acidifying oceans. The Swinomish clam garden project demonstrates the importance of supporting Indigenous community-based adaptive strategies to strengthen first foods security and HWB in the face of climate change.

Barriers and Opportunities

Many Indigenous communities are actively engaged in seeking solutions to the HWB threats from climate change. Below are barriers and opportunities to bolster Indigenous peoples' resilience and HWB:

- Increase resources for Indigenous health impact assessments, preparedness planning, and implementation of adaptive capacity programs, which are among the least funded climate change programs. Tribes do not have a tax base and therefore have limited ability to pay for public health infrastructure, education, or climate change adaptive management strategies that uphold Indigenous HWB. This is particularly true for Tribes such as the Crow and Navajo and for many Alaska Native villages who have been forced to rely on an extractive fossil fuel–based economy for survival, knowing that fossil fuels destroy their way of life but are without other options to support their families (Adams et al., 2021; Powell, 2018).
- Sustainably support multi-Tribal collaborations and Tribal government–academic collaborations that provide networks for knowledge exchange. Few such long-term collaborations exist. One example is the Climate Ready Tribes Program,[27] which is a partnership among the U.S. Centers for Disease Control and Prevention, the National Indian Health Board, and several Indigenous communities across the U.S., allowing each community to develop and implement their own priority climate HWB projects and share results with other communities (Schramm et al., 2020). With Tribal community–academic collaborative research, especially intervention research, support only federal and private funding opportunities that require that the research addresses Tribal priorities and that primarily benefit Tribes.
- Provide resources to rebuild both the physical and the legal infrastructure needed to support Indigenous models and practices of foods systems (e.g., Indigenous farming, ranching, and wild harvesting). Given support, such infrastructure—including physical infrastructure such as irrigation piping for crops, roads to drive on to access and transport foods, and wells to water livestock and legal infrastructure such as policies that allow Tribes to hunt and gather on their ancestral territories—would create jobs in rural communities, feed Indigenous peoples more nutritious food, lower the amount the federal government spends on long-term nutrition programs, and promote and protect Indigenous peoples' resilience and sovereignty (Hipp & Givens, 2020; Zavaleta-Cortijo et al., 2020).
- Build pathways for youth and Elders to develop climate adaptation and planning capacities using Indigenous knowledge. For example, schools in Alaska hired Elders and bearers of traditional knowledge to teach youth survival and cultural skills like sewing mukluks, making snowshoes, setting snares, building fish wheels, processing game, and cooking traditional foods. This intergenerational learning promoted HWB resilience through practicing traditional healing methods—keeping the mind and hands busy and taking care of the community (Ullrich, 2019).

Indigenous communities are place-based, and thus their HWB will be as unique as the places where they reside. Best practices to support increased Tribal HWB resilience and preparedness for a changing

[27] Climate Ready Tribes Program, https://www.nihb.org/public_health/climate_ready_tribes.php

climate are founded on community-driven HWB priorities. Ultimately, supporting Indigenous communities to develop and implement their own strategies will uphold and bolster Indigenous peoples' resilience.

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Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets

This chapter reviews economic development issues and opportunities that Tribes face in the age of climate change. It includes summaries pertaining to Tribal histories and trauma, harmful federal policies and subsequent land tenure issues, and the surge of economic sovereignty through renewable energy development on Tribal lands, including carbon offset markets. Recommendations are offered to reinforce and expedite Tribal economic self-determination on Tribal lands in the context of climate change. The chapter opens with the narrative of the Ute Mountain Ute Tribe of southwest Colorado, describing how this Tribe developed a large-scale solar economic development project to reduce their Tribal energy bills and decrease their dependence on fossil fuel usage. A researched overview of Economic Development as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Ute Mountain Ute Tribe's Energy and Economic Development Nexus (excerpted and adapted from ITEP's Tribes and Climate Change profile[28])

Written by: Ute Mountain Ute Tribe and Dara Marks-Marino, ITEP

The Ute Mountain Ute (or Núchíú) reservation lies in the Four Corners region of the Colorado Plateau covering portions of southeast Utah, southwest Colorado, and northwest New Mexico. Traditional Ute people were nomadic and utilized natural and cultural resources in these areas and beyond. Ute history, passed through generations, says that the people have lived here since the beginning of time.

Our Tribal reservation lands are located in the wide-open expanses of the semi-arid desert encompassing canyons and segments of the San Juan and Mancos Rivers. The dominant geographic landmark is the Ute Mountain, and the southern section of Mesa Verde National Park borders the reservation. This area, known as the Ute Tribal Park, provides opportunities for tourists to visit undeveloped ancestral Pueblo cliff dwellings with a Ute Mountain Ute guide. Other Ute initiatives include a farm and ranch enterprise, a construction company, two travel centers, and a casino with a hotel and RV park.

The majority of the 2,200 Tribal members reside in the capital of Towaoc near Cortez, Colorado, and there is a smaller community of 250 residents in White Mesa, Utah. The only school on the reservation is

[28] Ute Mountain Ute People: Preparing for a Warmer Climate. Profile on ITEP's Tribes and Climate Change website. http://www7.nau.edu/itep/main/tcc/Tribes/sw_utemountain

for early childhood education. A culturally focused charter school for kindergarten and first grade students will open in the fall of 2021. Students from 1st through 12th grades are bussed to the towns of Cortez, Colorado, and Blanding, Utah.

The Ute Mountain Ute Tribe has undertaken and is undertaking many climate change mitigation and adaptation actions that are also important economic development opportunities for the Tribe. We recently constructed a 1-megawatt (MW) community solar project,[29] which offsets a portion of our community members' and Tribal government electric bills. The reduction in energy bills is a welcome respite, as is the reduction in fossil fuel usage. Commissioned in March 2020, the 3,600 photovoltaic (PV) panel solar power system generated close to 2 million kWh of electricity in its first 10 months of operation. Additional community scale solar projects are scheduled for the White Mesa and Towaoc communities.

Towaoc Community Solar power plant—over 3,600 PV panels, creatively net-metered; Ute Peak in background.

A cornerstone of the Tribe's response to climate change is a transition from its former economic development model that relied heavily on fossil fuels (oil and gas) to a greener alternative. The Tribe has worked with the Department of Energy and its national labs: Sandia Labs assisted with energy planning and strategy, and the National Renewable Energy Lab assisted with youth outreach and other technical assistance. The Department of Energy Tribal Program cost-shared energy efficiency planning and the Towaoc Community Solar project and is poised to cost-share the White Mesa Solar Initiative in 2021. As envisioned by its Renewable Energy Team and the strategic planning with Sandia Labs, the community solar projects are a stepping stone to embrace the technology and look toward larger commercial-scale projects. The Tribe is actively working with multiple entities to plan, fund, and build commercial-scale solar and energy-storage projects thousands of times the size of the Towaoc project. The Tribal Councils have committed to cost-sharing approximately $1.5 million in community solar projects in the last five years. Commitment of land and other resources to commercial-scale renewable energy development is anticipated on a large scale in the next five years. Our Tribal Leaders are embracing the transition to greener revenue sources.

[29] The Journal, "Solar power comes to Ute Mountain Tribe": https://the-journal.com/articles/131295

Economic Development: Renewables, Sustainable Economies, & Carbon Offsets

Key Message

Indigenous science, knowledges, philosophies, and heritages guide Tribal self-determination in rediscovering economic sovereignty through pursuing, among other sustainable enterprises, renewable energy development, carbon sequestration via carbon markets, water and food security, and subsistence-based enterprises.

Recommendations

- Address complex land tenure, fractionation, and checkerboard jurisdictional boundary issues that persist on reservation lands and may constrain Tribal economic sovereignty.
- Invest in capacity building that increases in-house legal, technical, vocational, and varied fields of research expertise to strengthen Tribal economic self-determination while mitigating the effects of and adapting to a changing climate.

Early Federal Policy, Forced Assimilation, and Resurgent Self-Determined Tribal Economies

Federal policies have dramatically impacted Tribal economies. In many cases, early treaties between Tribal nations and the U.S. government dramatically reduced ancestral lands, while other legislative actions relocated Tribal nations from their ancestral homelands to reserved lands held in trust by the federal government. Such federal policies were designed to assimilate Tribal nations to resemble European culture and economies, which relied heavily on resource extraction for timber, minerals, and agricultural production (see *Chapter 7: Energy & a Just Transition*). Fueled by the industrial revolution during the Treaty-Making Era (1778–1868), these economies followed a linear flow of production, distribution, point of sale, consumption, and ultimately disposal of goods and services. Much of the economic development activity on Tribal lands was overseen by these forces and driven by a paradigm of steady increases in gross domestic product, job creation, and increased per-capita income. With increasing popular interest in the environment during the latter half of the 20th century in the Self-Determination Era (1968–present), and particularly with pressures to mitigate and adapt to climate change during the 21st century, more economists are proposing sustainable or "circular" economic activities. Such activities recirculate or recover limited resources (making them unlimited) (Steen-Adams et al., 2020) rather than dispose of or waste materials and goods (Prieto-Sandoval et al., 2018; Araujo Galvão et al., 2018; Geissdoerfer et al., 2017).

Through a resurgence of self-determination, guided by Indigenous science, knowledges, philosophies, and heritages (Whyte, 2015), Tribal nations are rediscovering their economic sovereignty through sustainable and climate-resilient enterprises. Such enterprises aim to avoid resource depletion, improve human wellbeing and social equity, and preserve their culture and the natural environment for future generations (Indigenous Phenology Network, 2020; Trosper, 2005). In fact, the relational approach of Indigenous peoples to their economies is immersed in Indigenous knowledge that is relational and reciprocal with the environment (Chisholm Hatfield et al., 2018; Pierotti & Wildcat, 2000; Trosper, 2005; Trosper, 1995).

Global interest in Indigenous science, expressed as Indigenous knowledge, to mitigate and adapt to climate change is facilitating its integration into the evolving, and increasingly mainstream, field of sustainable science and related policy (Cajete, 2012). While a reawakening of Indigenous knowledge provides opportunities for Tribal nations to innovate, transform, and sustain their community-based

economies into the 21st century (Cajete, 2012), it also incentivizes Tribal nations to take steps to protect sensitive Indigenous information (Whyte, 2015).

Property Rights and Fractionated Interests as Obstacles to Economic Development

Tribal governments have been successful in exercising self-determination legally following the 1975 Indian Self-Determination and Education Assistance Act, Public Law 93-638 (Act). This Act authorizes federally recognized Tribal nations to enter into contracts with the U.S. government, generally called "638 contracts," to support greater Tribal autonomy and responsibility for those government programs and services administered to them through the Secretary of the U.S. Department of the Interior (Bureau of Indian Affairs, 2020). The strengthening of this relationship over recent years has led to successful economic transformations that are adaptive to climate change. However, legal barriers still remain that are largely the result of 19th century federal policies implemented during the Removal (1830–1850), Reservation (1850–1887), and Allotment and Assimilation (1887–1934) Eras to relocate, dominate, and assimilate Indigenous peoples (Miller, 2006; Miller, 2012). The Dawes or General Allotment Act of 1887, for example, resulted in a complex system of property rights on reservation lands that continues to impact Tribal economies today (Indian Land Tenure Foundation, 2020; Dippel et al., 2020; Leonard et al., 2020; Anderson, 1995).

The following are examples of Tribal land tenure types:

- Tribal trust land, which is inhabited and governed by Tribal nations for their beneficial use with the legal title held by the federal government. A Tribe cannot sell or lease trust land without federal government approval. Tribes may purchase additional land that can be held in trust with federal government approval. A Tribe may assign parcels of trust land to Tribal members to use for periods that last for the lifetime of an individual or family assignee. The assignment can be passed on to heirs for continued beneficial use, with Tribal approval. These lands are exempt from state or federal property taxes.
- Allotted trust land, in which the federal government also holds the legal title, but beneficial interest of a specific surveyed land parcel is allotted to Tribal individuals and heirs per the General Allotment Act. These lands are exempt from state and federal property taxes.
- Fee-simple land, which refers to formerly allotted Tribal trust lands of individual Tribal members, per the General Allotment Act, later converted from trust status to fee-simple status. Fee-simple lands may lie within, adjacent to, or outside the boundaries of Tribal or reservation trust lands (Regan & Anderson, 2014). Tribal governments, individuals, or non-Tribal individuals or entities may purchase fee-simple lands. These lands are subject to state and federal property taxes.

The concept of trust land derives from the Trust Doctrine, which expresses a fundamental principle of 19th century federal policy that established federal rights in perpetuity to lands reserved for Tribal nations (Miller, 2012). The Trust Doctrine describes the federal government's role to act as trustee for Tribal nations and, as such, assume a fiduciary or trust responsibility for Tribes. While trust land status affords Tribes the right to occupy lands for their beneficial use, it prohibits Tribal governments from mortgaging these lands—a restriction that severely limits a Tribe's ability to secure financing for construction or infrastructure investment pursuant to economic development projects (Anderson et al., 2016; Anderson, 1995). Historical and ongoing federal oversight of Tribal lands, and related natural resource management decisions on these lands, can hinder Tribes' economic development initiatives (Anderson et al., 2016; Anderson & Leonard, 2016), including renewable energy development (Ravotti, 2016). It is challenging for Tribal governments to pursue economic sovereignty if their land and related resource assets are subject to federal intervention and approval, particularly because such oversight can complicate and delay economic development projects in many instances.

In addition, the General Allotment Act, which facilitated non-Indian settlement of high-quality agricultural lands initially reserved for Tribal occupancy, ultimately resulted in fractionated land ownership (Leonard et al., 2020; Banner, 2005). A significant developmental challenge resulting from the General Allotment Act is that today single tracts of allotted trust lands often have large numbers of undivided interests from dispersed inheritance. The term "undivided interest" means that each of the beneficiaries share the tract equally—which over time becomes a meager fraction of interest. For example, on allotted trust land tracts, which can have dozens or even hundreds of owners, the majority (51%) of interest holders must be in agreement for any decision or action to be taken on that land (Shoemaker, 2015). This can be a huge undertaking for tracts with large numbers of interest holders. This constraint on land transferability makes it difficult to acquire private financing needed for land improvements and can disincentivize investments (Dippel et al., 2020). Additionally, there is no practical way for Tribes to obtain required federal approvals for land leases for economic development that require federal administration.

Tribes encounter challenges at the allotted-tract scale while also battling barriers when performing actions on a broader scale on adjacent fee-simple lands, formerly trust lands. That is, less productive agricultural lands that were allotted to Tribal individuals, combined with a lack of access to operating capital and technologies, yielded few benefits from agriculture and forestry (Anderson & Lueck, 1992) (see *Chapter 7: Energy & a Just Transition*). Subsequently, once allotments were converted to fee-simple lands following the 25-year alienation period stipulated in the General Allotment Act, a substantial number of allotted land tracts passed out of Tribal ownership (Russell, 2000; Kappler, 1902). While reservation lands are subject to both federal law and Tribal authority, state and other local law and authorities do not apply. On the other hand, because fee lands are not held in trust, they are subject to federal, state, and other local law and authorities (Jones, 2016). On many reservations, both trust and fee lands coexist side by side, creating a checkerboard pattern of multiple jurisdictional oversight and conflicting land-holder perspectives (Miller, 2012). These checkerboard jurisdictional issues greatly limit Tribes' resource management decision-making authority on land parcels within their reservations, challenge their improvements to the ecological health of surrounding lands and waters, and can ultimately derail the sustainability of their economies (Indian Land Tenure Foundation, 2020).

Federal Policies and Energy Development on Tribal Lands

While the federal government recognizes Tribal nations as sovereign entities, their utilities (i.e., electricity, water, and natural gas) are regulated by state governments, and power interconnections may be subject to inspection by state and local authorities. This jurisdictional complexity can often delay or prevent Tribal nations' pursuits of renewable energy development on Tribal lands. To further complicate matters, the development of different types of renewable energy is governed by different laws at the Tribal, state, and local jurisdictional levels. One example impacting Tribal energy development initiatives is that, as federal tax-exempt sovereign nations, Tribes are not eligible for federal financial incentives to develop renewable energy (Jones, 2016). These federal policy barriers, and ongoing ambiguity in Tribal property rights and resource institutions, deter Tribes from pursuing large-scale energy development projects. For example, Tribes must undertake 49 steps to receive federal approval to execute energy-development projects on trust lands. Even if projects successfully complete these steps, many become stuck in the pre-development phase due to lack of financing, transmission access, and tax structures that include both Tribal and state taxation (Kronk-Warner, 2013). Thus, while Tribal governments may desire to develop and execute their own energy projects, many ultimately have chosen federally approved longer term leases with outside developers (Jones, 2016) to avoid confusing taxation structures due to checkerboard jurisdiction.

The Indian Long-Term Leasing Act of 1955 requires the U.S. Secretary of the Interior to approve Tribal trust land leases for up to 25 years, with an option to extend for an additional 25-year term, for public, religious, educational, recreational, residential, or economic development purposes (Kronk-Warner, 2013). Because this federal approval also involves a lengthy process, and in order to promote Tribal self-determination, the Indian Tribal Energy Development and Self-Determination Act (ITEDSA) was passed in 2005. This federal legislation provides a framework for developing renewable energy infrastructure on Tribal lands by allowing Tribal nations to regulate the conveyance of their own energy resources. It authorizes preapproved Tribes to enter into land leases and similar agreements without federal oversight for the construction of renewable energy networks. The U.S. Department of the Interior subsequently created the Division of Indian Energy Policy Development, while the U.S. Department of Energy created the Office of Indian Energy Policy and Programs. Authorized by ITEDSA, both programs provide grants, technical assistance, low-interest loans, and loan guarantees for Tribes to these ends. Tribes are authorized to enter into Tribal Energy Resource Agreements (TERAs) with the U.S. Secretary of the Interior as long as those projects are executed pursuant to the TERA and the terms are less than 30 years (National Archives and Records Administration, 2019). While ITEDSA removes federal approval requirements for these leasing purposes, TERAs are still required (Bronin, 2016).

Less than a decade after the passage of ITEDSA, Congress enacted the Helping Expedite and Advance Responsible Tribal Home Ownership (HEARTH) Act in 2012. This federal legislation aims to streamline the environmental review process by allowing preapproved Tribes to voluntarily execute and regulate land leases on Tribal trust lands prior to completion of a federal environmental review (Warner, 2013). To date, the HEARTH Act has been used primarily for leasing of trust lands for business, agricultural, residential, public, religious, educational, or recreational purposes. However, the legislation does not authorize Tribes to execute leases for the exploration, development, or extraction of any mineral resources on their Tribal trust lands. It also extends terms to a total of 75 years maximum on existing leases (Bureau of Indian Affairs, 2014). Between 2013 and 2020, the U.S. Secretary of the Interior approved 58 Tribal agricultural and other business leasing regulations (Bureau of Indian Affairs, 2021a).

While environmental review processes and land tenure issues continue to challenge sustainable economic development on Tribal lands, this chapter presents examples of Tribal nations pursuing their economic sovereignty. Examples focus on initiatives to create sustainable Tribal economies through the development of renewable energy and carbon offset market projects.

Sustainable Tribal Economies via Renewable Energy

Historically, energy development for the purpose of developing Tribal economies has been limited to the few Tribes and Native corporations that possess fossil fuel reserves. However, the rapid growth in renewable energy markets, including wind and solar, offers a growing number of Tribes the opportunity to participate in renewable energy markets. It is estimated that Tribal lands represent approximately 6.5% of the U.S. total national technical potential for utility-scale renewable energy development (Milbrandt et al., 2018). Figure 12 and Figure 13 demonstrate that wind and solar renewable energy resources are much more widely distributed on reservation lands than nonrenewable energy resources, affording more Tribes the opportunity to develop renewable energy as sustainable economic enterprises.

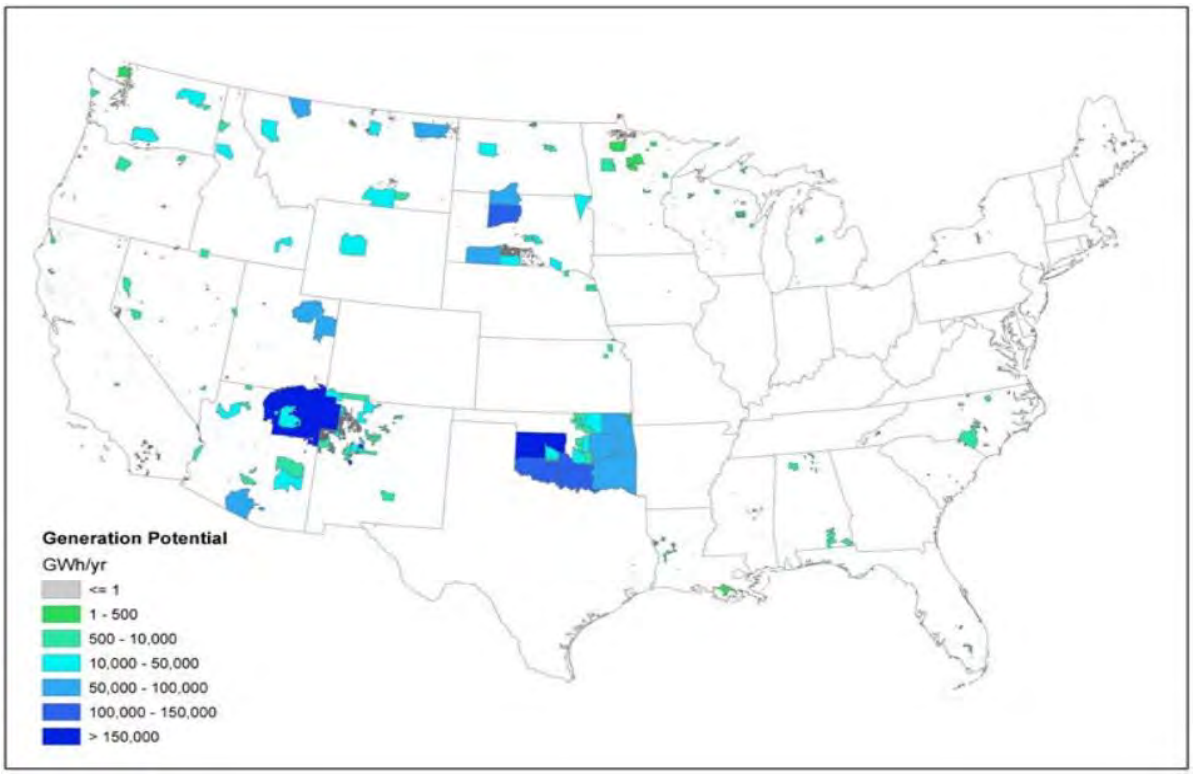

Figure 12. Wind Generation Potential by Reservation. Sources: Milbrandt et al., 2018; U.S. Department of Energy, 2018. Tribal Energy Atlas. https://maps.nrel.gov/tribal-energy-atlas/

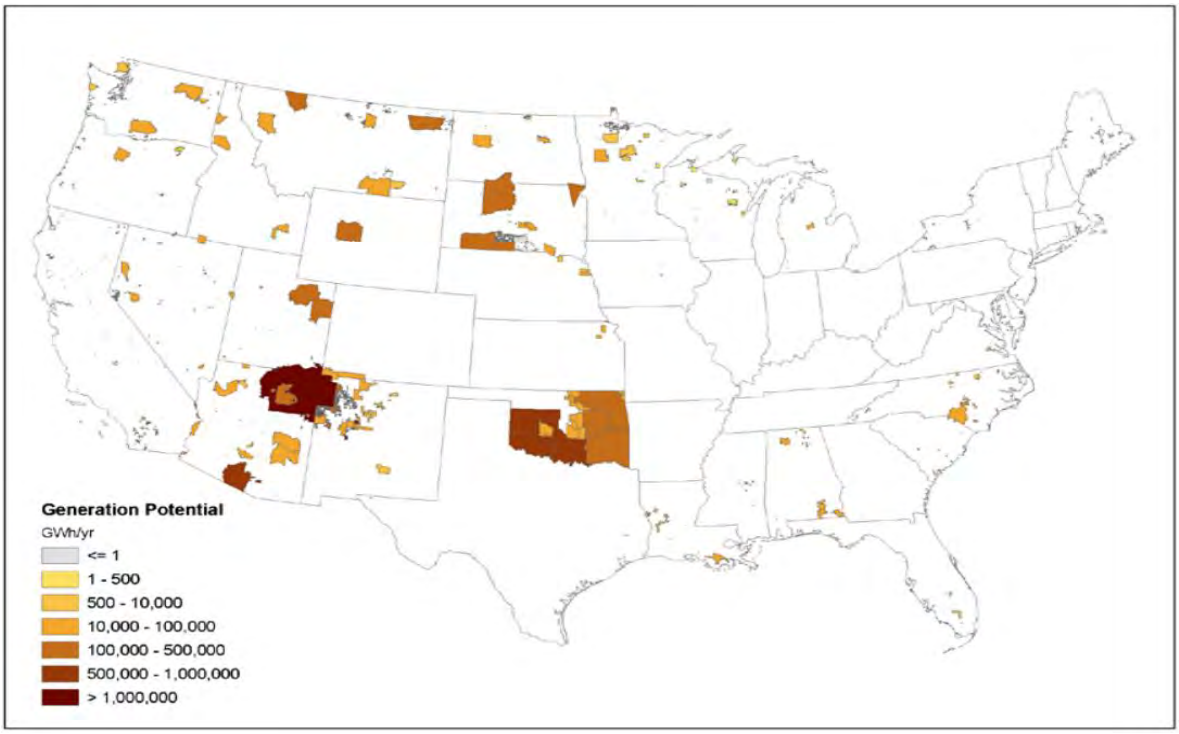

Figure 13. Solar Photovoltaic Generation Potential by Reservation. Sources: Milbrandt et al., 2018; U.S. Department of Energy, 2018. Tribal Energy Atlas. https://maps.nrel.gov/tribal-energy-atlas/

Renewable energy technologies can be developed either for self-consumption or for sale through the interconnected electrical grid. While distributed energy resources[30] and behind-the-meter[31] development each may have economic impacts, such as energy price reduction or increased energy resilience, they do not typically generate significant revenue. Utility-scale generation, however, can diversify Tribal revenue streams while helping to transition to a clean energy economy and enhance Tribal economic sovereignty. Utility-scale generation is renewable energy developed to sell at market or directly to an off-taker. The rapidly decreasing costs of solar photovoltaic (PV) technology and wind energy technologies have made this development cost-competitive when compared with conventional options such as natural gas power plants. Both an increase in available transmission line capacity due to increasing numbers of coal plant retirements and the increasing market demand for renewable energy generation from states, municipalities, and corporations have presented new economic opportunities for Tribal nations. At the same time, past investment in technical assistance and project-development education, through the U.S. Department of Energy and U.S. Department of the Interior, have prepared many Tribes to participate in larger, more complex, innovative projects to leverage the energy market for economic diversification.

One such example is the Moapa Band of Paiute Indians' solar project with First Solar. The 250-megawatt (MW) solar array displaces over 341,000 metric tons of CO_2 annually while generating new income revenues for the Tribe in the form of lease payments, consulting fees, and jobs. At peak construction, the project generated roughly 600 temporary jobs (filled first by Tribal members and then the local community more broadly), with five positions turning into long-term operation and maintenance roles (First Solar, 2020).

Solar PV can generate revenue streams at smaller scales as well. Picuris Pueblo—a community of roughly 300 members and fewer than 100 homes—has also developed solar economic enterprises. In 2015, in partnership with the Northern Pueblos Housing Authority and with grant funding from the U.S. Department of Energy, Picuris Pueblo entered into a 25-year power-purchase agreement with Kit Carson Electric Cooperative to provide electricity to the utility. The project generated over $130,000 for the Tribe in 2018 alone and provided new and likely sustainable economic opportunities for the Tribe and its communities (Kit Carson Electric Cooperative, 2017; Quanchello, 2018).

Solar is not the only opportunity for Tribal renewable energy development. In 2007, the Forest County Potawatomi Community established the goal of becoming carbon neutral in their energy generation through increased energy efficiency and the implementation of renewable energy projects. The Forest County Potawatomi Community was one of the first communities in the U.S., including non-Tribal jurisdictions, to set such a goal. Through a grant from the U.S. Department of Energy in 2010, the Tribe built a biogas facility. The Tribe worked with a local utility offtaker, which helped the Tribe reach its own energy goals while also aiding the local utility in reaching state-mandated clean energy targets. The project generates revenue through the sale of electricity to the local utility as well as through tipping fees and heat sales (Ricci, 2018; Drescher, 2020). In addition, the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians and the Coquille Tribe are pursuing offshore wind energy development in Oregon.

[30] Distributed energy resources refer to energy generation and storage technologies that are not connected to the bulk power grid and are capable of exporting active power to a local electronic power system (Institute of Electrical and Electronics Engineering, 2018).

[31] Behind-the-meter energy generation and/or storage denotes the placement of distributed energy sources that are on the customer side of the meter (Institute of Electrical and Electronics Engineering, 2018).

Sustainable Tribal Economies via Carbon Offset Market and Renewable Energy

Examples of sustainable Tribal economies include carbon sequestration via carbon markets, green or sustainable enterprises, ecosystem services, and natural resource-based or subsistence-based economic enterprises. Table 2 demonstrates 20 Tribal nations and Alaska Native corporations that have pursued economic development opportunities to execute Tribal self-determination, establishing sustainable offset and energy projects. The following list, although not exhaustive, highlights projects established as early as 2003 and includes wind, hydroelectric, methane capture, and carbon offsets.

Table 2. Tribes and Alaska Native corporation carbon offset and renewable projects, locations, and dates that agreements were either established or projects were completed.

Tribe or Corporation Name	Project Type	Location	Dates Established or Completed
Rosebud Sioux Reservation[1]	Renewables-Wind	SD	2003
Kasigluk Traditional Elders Council[1]	Renewables-Wind	AK	2006
Village of Toksook Bay[1]	Renewables-Wind	AK	2006
Confederated Salish and Kootenai Tribes[1]	Renewables-Hydro	MT	2008
Southern Ute Indian Tribe[1]	Renewables-Methane	CO	2009
Rosebud Sioux Reservation[2]	Renewables-Wind	SD	2010
Round Valley Indian Tribes[3]	Carbon Offsets-Forest	CA	2013
Yurok Tribe[3]	Carbon Offsets-Forest	CA	2013
White Mountain Apache Tribe[4]	Carbon Offsets-Forest	AZ	2014
Yurok Tribe[5,7]	Carbon Offsets-Forest	CA	2014
Confederated Tribes of the Colville Reservation[6]	Carbon Offsets-Forest	WA	2015
Confederated Tribes of the Warm Springs Reservation[7]	Carbon Offsets-Forest	OR	2015
Mescalero Apache Tribe[3]	Carbon Offsets-Forest	NM	2015
Passamaquoddy Tribe - Joint Tribal Council[6]	Carbon Offsets-Forest	ME	2015
White Mountain Apache Tribe[4]	Carbon Offsets-Forest	AZ	2015
Chugach Alaska Regional Corporation[3]	Carbon Offsets-Forest	AK	2017
Spokane Tribe of Indians[6]	Carbon Offsets-Forest	WA	2018
Confederated Salish and Kootenai Tribes[2,8]	Renewables-Hydro	MT	2020
Ahtna, Inc. (Regional Corporation)[6]	Carbon Offsets-Forest	AK	Unknown
Huna Totem Village Corporation[6]	Carbon Offsets-Forest	AK	Unknown
Nanwalek (English Bay) Village Corporation[3]	Carbon Offsets-Forest	AK	Unknown
Port Graham Village Corporation[3]	Carbon Offsets-Forest	AK	Unknown
Sealaska Regional Corporation[6]	Carbon Offsets-Forest	AK	Unknown
Seldovia Native Association (Village Corporation)[3]	Carbon Offsets-Forest	AK	Unknown
Tyonek Native Village Corporation[6]	Carbon Offsets-Forest	AK	Unknown

Sources: NativeEnergy (2018a, 2018b, 2018c, 2018d, 2018e)[1], U.S. Department of Energy (2013, 2015)[2], New Forests (2020)[3], Spatial Informatics Group (2020)[4], Yankel (2014)[5], Finite Carbon (2020)[6], California Environmental Protection Agency (2020)[7], Montana Public Radio (2020)[8].

The Alaska Native Claims Settlement Act (ANCSA) of 1971 extinguished aboriginal land title in Alaska, dividing that state into 12 geographic regions defined by Indigenous common heritage and interests.

This division initiated the creation of 12 private, for-profit Alaska Native regional corporations and 200 village corporations. Regional corporation lands are essentially fee-simple lands with individual shareholders, and therefore individual Alaska Natives who are enrolled in these regional corporations may generate revenue from land resource assets (Resource Development Council for Alaska, Inc., n.d.). Ahtna Incorporated, one of the 12 regional corporations, is Alaska Native- and shareholder-owned with more than 2,000 shareholders, the majority of whom are Ahtna Athabascan or Alaska Native descent. Ahtna Incorporated demonstrates the largest carbon offset economic development project in the U.S. to date. Utilizing more than a half-million acres of forested lands to sequester carbon, this project has sold more than 14.8 million offset credits (Finite Carbon, 2020). Its shareholders manage the carbon offset project, creating new jobs in building carbon offset markets and renewable energy markets in general, as well as increasing economic returns on investments for Alaska Natives. The potential for growth in this new field may facilitate more Alaska Natives remaining on their ancestral homelands (Finite Carbon, 2020).

A comparatively smaller example of carbon offset economic development is in progress on Round Valley Indian Tribal lands. While this project encompasses only 5,550 acres, in 2020 it managed to sell over 500,000 offset credits. The project supported ongoing sustainable forestry objectives, such as protecting old growth while improving the health of Douglas fir and pines, reducing wildfire risk, and enhancing local livelihoods and traditional cultural uses of the forests (New Forests, 2020). The success of a project this size affirms that other Tribal nations with small-forested land bases may forge collaborative agreements to achieve economically feasible and sustainable project investments and returns.

The Confederated Salish and Kootenai Tribes (CSKT) provide a prime example of renewable energy innovation via their hydroelectric project. The dam and related infrastructure to create the Kerr Project, a federally licensed hydropower project located on CSKT land within the boundaries of the Flathead Indian Reservation, was constructed in the early 1930s. One of six CSKT enterprises, Energy Keepers, Inc., was able to acquire Kerr Project interests in 2015 (Confederated Salish & Kootenai Tribes, 2014). That is, the CSKT exercised their "unilateral and exclusive right to acquire the project" through occupation and use of the project for 20 years—through 2035—as sole licensees (Energy Keepers, Inc., 2014). In February 2020, CSKT signed a 15-year contract with a Washington state utility, Puget Sound Energy, to supply the utility with hydroelectric power. Several more prospective large customers based in Montana are also seeking to secure energy from the Tribal corporation in the near future for energy supplied by the CSKT, who renamed Kerr Dam the Seli'š Ksanka Qlispe' Dam (Montana Public Radio, 2020). Recent figures indicate the hydroelectric plant has the capacity to generate 208 megawatts annually, equating to 1.1 million megawatt hours, or electricity for 100,000 to 110,000 homes (Energy Keepers, Inc., 2020).

A final example of a Tribal renewable energy project is the capture and use of methane on the Southern Ute Reservation. The Southern Ute Indian Tribe's Growth Fund Department of Energy partnered with NativeEnergy to establish emission reduction credits. The project aids in preventing the release of roughly 23,000 to 60,000 metric tons of methane annually through the implementation of 28 interceptor wells piped to a compressor station located on the reservation. These wells are tied into an existing gas pipeline, with the captured gas later injected into the natural gas distribution grid and burned for thermal energy or power energy downstream (NativeEnergy, 2018e). Between 2009 and 2017, the project captured about 379,000 metric tons of methane, or the equivalent of annual energy use for about 41,000 homes. Both Wyoming- and California-based energy development entities have considered the Tribe's project as an example that can be replicated elsewhere to balance environmental budgets in the voluntary carbon market (Mullane, 2019).

Some Tribal nations situated in more remote locations have taken part in developing renewable energy projects. In the Alaska Native Village of Kasigluk, for example, the Kasigluk Traditional Elders Council oversees three wind turbines. The developer, NativeEnergy, worked with the nonprofit Alaska Village Electric Cooperative to purchase, operate, and maintain renewable energy for both Kasigluk and the Native Village of Nunapitchuk (U.S. Department of Energy, 2009; NativeEnergy, 2018b). A combined system, incorporating a modern diesel plant with wind–diesel production, supplies power to these Alaska Native villages. High maintenance costs due to the remote location of the project include those of importing technical experts and parts needed to repair and maintain the turbines (Anonymous, 2020). Nevertheless, these and other remote communities are pursuing ways to integrate varied energy sources, reducing the overall cost of power and heating for community members. So, while some communities have faced challenges, such as maintenance costs, wind energy integration has been possible for others.

Conclusion

After two centuries of forced assimilation leading to linear economies that tend to deplete natural resources to generate jobs and income, Tribal nations are rediscovering their economic sovereignty through the pursuit of circular and self-sustaining economies. These circular economies include innovative technologies and practices for reducing and reusing waste to protect and preserve their natural environment (Prieto-Sandoval et al., 2018; Steen-Adams et al., 2020). Tribal nations are also increasingly pursuing green enterprises to enhance their climate resiliency, including renewable energy, carbon offsets, and subsistence-based trade. Such enterprises reflect the relational and reciprocal connection of Tribal nations with their environment, marking a rediscovery and resurgence of Indigenous heritages, philosophies, sciences, and knowledges (Whyte, 2015; Cajete, 2012).

While self-determination continues to transform Tribal economies, 19th century federal policies to assimilate Indigenous peoples produced a complex system of property rights on Tribal lands, challenging this transformation. For many Tribal nations, the land on which they reside, held in trust by the federal government, is the only land available to pass to future generations. The General Allotment Act (1887) in particular resulted in highly fractionated land ownership, which can hinder economic resilience on Tribal trust lands (Leonard et al., 2020; Shoemaker, 2015; Anderson, 1995; Dippel et al., 2020), disincentivizing individuals from investing in land improvements. Yet the trust relationship that the federal government established with Tribal nations early on has persisted, requiring federal approvals even today for Tribal nations to develop their energy and other natural resources on Tribal lands. Despite this federal oversight, increasing numbers of Tribal nations are pursuing substantive and innovative climate adaptation pathways, including renewable energy development, carbon sequestration via carbon markets, green or natural resource sustainable enterprises, and subsistence-based enterprises.

Recommendations

The search for solutions to enhance the world's climate resiliency is fueling research into the potential role of Indigenous knowledges to inform climate mitigation and adaptation strategies. This increased interest inspires a resurgence among Tribal nations to embrace their unique heritages in efforts to realize sustainable economies. The concern for these priorities also suggests the need for Tribal nations to formulate policies to protect and preserve the authenticity and integrity of their Indigenous knowledges (Whyte, 2015). Tribal nations will thus likely need protocols and/or internal review boards to approve and oversee all research proposed to occur on Tribal lands or that involves their citizens and traditional knowledge holders (National Congress of American Indians Policy Research Center, 2019; Steen-Adams et al., 2020). An internal review process can help Tribes determine whether it is in their

best interest to enter into legal agreements at the beginning of any research to ensure that Tribal intellectual property rights are protected. This may include requirements that researchers assign their invention and patent ownership rights over to a respective Tribal nation. It may require nondisclosure agreements, between Tribal employees and prospective research or business partners, in order to protect sensitive information. Tribal nations may also determine when and whether it is necessary to protect their intellectual property at the federal level through patents and/or trademarks (National Congress of American Indians Policy Research Center, 2019).

Public policy to increase Tribal citizen access to public collegiate and vocational education programs is key to increasing the numbers of Indigenous research scientists, educators, resource planners, technicians, and other professionals needed to support climate mitigation and adaptation (Fillmore et al., 2018). This includes training and education to provide in-house technical expertise, further advancing the efforts of Tribal communities and Alaskan Native villages to develop and maintain renewable energy projects. Yet federal funding levels for Tribal colleges and universities have remained relatively flat (Fillmore et al., 2018). These institutions require adequate funding that supports targeted student recruitment, increases graduation rates, and facilitates greater Tribal access to vocational and four-year degrees.

Additional recommendations for policy to support Tribal self-determination and secure climate-resilient economies include addressing the complex land tenure system, including fractionation and checkerboard jurisdictional boundary issues, that persists on reservation lands today. Tribal economic sovereignty might be better achieved through the freedom to establish property rights institutions that complement the cultural heritage, philosophies, and histories of respective Tribal nations while also incentivizing Tribal citizen individuals and/or collectives to invest in Tribal lands. This requires addressing equitably the pervasive issues surrounding the transferability of highly fractionated trust lands as well as the sustainable management of checkerboard lands.

Additionally, increased access to both public- and private-sector opportunities, whether financial or through procurement, may help to build the legal infrastructure necessary for Tribal-resilient economic growth. For example, Tribes may obtain a third-party analysis of potential Tribal business opportunities through the use of currently available resources, such as the Bureau of Indian Affairs' Division of Economic Development's Pathways and other such similar resources (Bureau of Indian Affairs, 2021b). To reduce the impacts of checkerboarded lands, Tribes may desire to acquire fee-simple lands to convert to trust status through the Bureau of Indian Affairs federal fee-to-trust conversion program. The benefits of converting adjacent fee-simple lands to trust status can include granting rights-of-way; entering into leases necessary to negotiate the use, sale, or protection of natural resources; developing renewable energy resources; and protecting subsistence, hunting, and traditional agricultural practices. All of these goals can benefit long-term climate-resilient economic development projects. In general, interagency collaboration can assist Tribes in leveraging funding for their economic development opportunities by providing a comprehensive inventory of available funding and technical resources, particularly those resources dedicated to renewable energy, offset markets, or other sustainable enterprise opportunities.

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Chapter 7: Energy & a Just Transition

The narratives that follow provide an overview of the issues of climate, energy, and the just transition that Tribes are implementing in their communities. The Citizen Potawatomi Nation of Oklahoma completed a comprehensive energy-utilization study that led to their expansive geothermal energy production. The Hopi Tribe of Arizona is working with partners to develop utility-scale solar PV projects to utilize the Tribe's land base and solar resources. The Red Lake Nation of Minnesota is constructing a renewable energy distribution system as a microgrid for their community and has also started a food sovereignty program. A just transition allows Tribes to be treated equally and included in the energy transition from fossil fuels to renewable energy to strengthen their sovereignty and achieve economic independence and stability. A researched overview of Energy & a Just Transition as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Geothermal Operations in the Citizen Potawatomi Nation[32]

Written by: James C. Collard from the Potawatomi Nation

A reverence for the land has always been a critical feature of Native American life. From earliest times, the Indigenous people of North America have regarded not only the land, but also water, minerals, plants, animals, and indeed the air we breathe as being resources that are available for all to use, forever. This holds true with the Citizen Potawatomi Nation as well. Sustainability is not just a passing gesture for our Nation; rather it is a guiding principle of our development strategy. This is evidenced in our desire to gain the most value from the land while ensuring its long-term viability.

The Citizen Potawatomi Nation (CPN) knows that there need be no conflict between economic development and environmental protection. Indeed, the benefits to our people of sustained economic growth cannot be maintained unless we protect the natural resources that serve as the source of our prosperity. Geothermal energy production is one of the three focal points of the CPN's natural resources management program.

[32] The information in this document is drawn from the Citizen Potawatomi Nation Integrated Resource Management Plan.

For many years, under the guidance of Chairman John Barrett, our Nation has been on the forefront of efficient and effective energy utilization. In 1999, the Chairman directed the installation of the CPN's first geothermal application at the CPN Health Clinic. In 2004, the Nation worked with the Department of Energy to produce a comprehensive study of our energy utilization. The purpose of the study was to provide an in-depth examination of our government's utilization of electric, gas, and other energy sources. This included an analysis of how to best reduce energy usage while providing quality energy services to members and creating revenue-generating energy enterprises.

The areas that were investigated included:

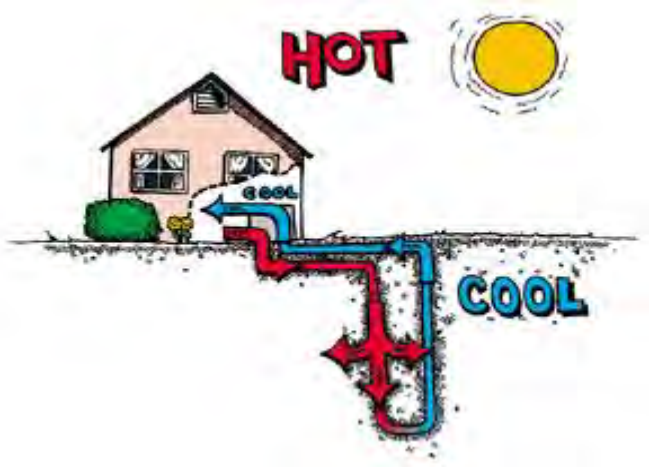
- Diversification of electric loads and changing service levels to lower electric costs;
- Heat recovery from the grocery store and casino as an energy source for adjacent buildings, a greenhouse, and possibly a car wash and laundry; and
- Integration or sharing of HVAC loads.

In addition, other possibilities were examined for their viability as alternative energy sources. These included:

- Growing, harvesting, and transporting biomass to gasification-fermentation plants being developed by Oklahoma State University
- Wind power using microturbines
- Groundwater development for water source heat pumps
- Geothermal heat pump installation
- Solar

After careful analysis it was determined that Chairman Barrett's expertise and the CPN staff's prior knowledge of ground source heat pump (GSHP) installation and operation are an asset that gives us an edge in expanding the application to Tribal facilities and also the background to begin a new enterprise in GSHP systems.

GSHPs are electrically powered systems that tap the stored energy of the greatest solar collector in existence: the Earth. These systems use the Earth's relatively constant temperature to provide heating, cooling, and hot water for homes and commercial buildings.



The campus-style arrangement in the headquarters area contains significant numbers of the CPN buildings, thereby allowing the integration of systems to produce greater efficiency. This is accomplished by installing geothermal heat pump loops to transfer energy from one building to another.

For example, one possibility is to transfer the excess heat produced from the refrigeration systems in FireLake Discount Foods to the headquarters building across the street using convective coils.

Chairman Barrett and others with CPN have experience with drilling wells and horizontal boreholes. There is also a commitment to expand this experience to installing GSHP. Revenue-generating activities that CPN currently owns provide funding to implement others when cost-effective projects are identified.

Implementation of a GSHP program reduces a number of challenges faced by the CPN when compared with other renewable energy technologies. For example:

- Tribal human and financial resource development: volatility of fuel prices leads to businesses that are unable to control energy costs and puts them at a disadvantage. GSHP is within the Tribal human and financial resources of the CPN and encourages both job development and energy-usage reductions. New business opportunities that employ Tribal members and contribute to energy control are an asset.
- Tribal renewable resource quantification: geothermal heat pumps have an inexhaustible supply of solar energy in the Earth's surface. Other renewables such as wind and surface solar are intermittent, have a higher upfront cost, require backup or storage, and have higher maintenance costs.
- Private investment vs. private developer regulations: CPN Tribal investment is sufficient for GSHPs.
- Tribal utility policies and Tribal utility formation: not required for GSHPs.

Satisfied with the results at the health clinic and curious whether or not geothermal could benefit the Tribe in future projects, Richard Kunze, the CPN Director of Public Works, contacted geothermal experts Drs. Jim Bose and Marvin Smith at Oklahoma State University. Following their advice, CPN utilized a pond on the first tee of the golf course as the heat exchanger for its second geothermal installation at the cultural heritage center. Well water used to irrigate the golf course was routed to that pond to create a constant flow.

FireLake Grand Casino is the Tribe's largest and most recent geothermal project. The 200,000-square-foot facility houses 1,800 Vegas-style games, three restaurants, and an entertainment venue.

Even with their gained experience and confidence in geothermal, CPN knew that the installation at FireLake Grand Casino would be like nothing they had ever done before. The 1,000-ton system required more than 35 miles of pipelines and ground heat exchangers that were buried in soil and submersed in water. The Tribe utilized a lagoon that holds treated wastewater to submerse the pipes. In addition, they needed 100 boreholes drilled to 400 feet deep. A third set of pipes is also submersed in the basin of

a fountain located at the entrance of the casino. Installation was completed entirely by Tribal employees.

With the installation of the ground heat exchanger complete, the Tribe then began the interior installation process. The Tribe opted to hybridize the system, installing two 500-ton chillers to heat and cool the facility. A single 50-ton GSHP unit serves the administrative offices located inside the casino.

Kunze said when the project began CPN expected to save about 30% per year on energy costs and pay off the system installation in just under four years and that those estimations are holding true. Using Tribal employees helped offset the upfront costs to the Tribe. Estimated savings appear to be about $20,000 a month.

The opening of FireLake Grand Casino completes the first of a three-phase construction project for the Tribe. Plans call for the addition of a hotel and a larger events coliseum. CPN plans to incorporate geothermal for both. The hotel's geothermal system will tie into the casino's existing ground heat exchanger. Two fluid towers added during construction of the casino should prevent the need for more drilling.

With successful past projects and current ones coming online smoothly, the future for geothermal at CPN looks bright. We recently completed 25 new duplex housing units with two-ton GSHPs on each side; we are in the process of building a geothermal system that will include the FireLake Grocery Store as well as the Events Center and RV park; and we are planning to construct industrial facilities outfitted with geothermal. Our future plans are to build geothermal systems for all our new facilities, if at all possible.

The Hopi Tribe: Working Toward a Renewable Energy Future

Written by: Hopi Renewable Energy Office and Hopi Utilities Corporation

The Hopi Tribe has relied on coal as a main revenue source for half a century, just as the Southwest region relied on Hopi and Navajo coal for electricity. The coal industry provided well-paying jobs for Hopi communities, and royalties from coal mining and coal-fired electricity generation provided over 80% of the Tribe's annual budget in recent years. In return, Hopi workers used their coal and water resources to provide reliable electricity for growing cities such as Phoenix.

Hopi landscape during a rainstorm.

At first glance, this seems like a fair trade. But in fact, Hopi workers and communities have borne the brunt of health and environmental impacts from mining and coal-fired generation for decades, only to be left in the proverbial dust as the Navajo Generating Station and Peabody Mine were prematurely closed in 2019. The closure had no major impact on electric utilities or their consumers in the region, but it has left the Hopi Tribe with a massive budget deficit and a significant number of direct and indirect job losses. The plant owners gave little notice for this closure and provided no meaningful assistance for the communities that helped them operate for decades.

This is not what a just transition looks like.

The Hopi Tribe understands that the decision to retire coal plants and move toward cheaper natural gas and renewable energy is an economic one and agrees with the importance of transitioning toward renewable energy. Certainly, it is important that we transition to a clean renewable energy future—but communities impacted by coal closures should not be left behind in the process.

The Hopi Tribe is working to create new revenue and new jobs and looking toward renewable energy as a solution. Staff are exploring opportunities to develop solar projects, both as revenue generators and to improve electricity access to underserved parts of the reservation. Utility-scale solar projects are in the works, as are smaller, more distributed projects that will directly provide power to Hopi communities.

Tewa CD, community scale, ~30 kW.

Meanwhile, the same utility companies that are closing coal plants in the region are now seeking to add renewable energy generation to their portfolios. To facilitate a just transition, they should purchase this renewable energy from Hopi and other coal-impacted communities.

Utility companies can participate in a just transition that is mutually beneficial, one where communities that helped produce coal-fired electricity for so long can be included in the transition to renewable energy. Rather than being left behind as coal plants are shuttered, these communities should be empowered as partners in this transition.

Thankfully, many coal-impacted communities have the potential to produce and sell renewable energy at competitive rates. For example, the Hopi Tribe has extensive renewable energy resource potential and is currently working with partners to develop utility-scale solar PV projects to utilize the Tribe's land base and solar resources.

Residential PV, with Sandia National Laboratories Tribal tour participants.

For the sake of future generations, it is critical that we deploy renewable energy to replace dirty power plants that cause catastrophic environmental damage, drain one of the world's most precious resources (water), and heavily contribute to climate change. But it is important that coal-based communities are not forgotten in pursuit of this goal. With this in mind, the Hopi Tribe is working diligently to transition to a clean, renewable energy-based future.

Renewable Energy Development at the Red Lake Nation

Written by: Robert Blake

The Red Lake Nation (Tribe) is constructing a renewable energy distribution system, and it is kind of like a microgrid for the community. This development was approved by the Tribal council about three years ago now and was pushed for because the Tribe was finding high amounts of mercury in its walleye population. Mercury comes directly from the burning of fossil fuels.

The Red Lake fisheries is the Tribe's oldest business, and it really was because of the discovery of high mercury levels in the fishing supply that the Tribe started down this road of transitioning off of fossil fuel energy and into a renewable energy future. The Tribe has since realized that the benefits don't just end with a cheaper electricity bill; the technologies that are currently being used for the construction of the solar systems in the community can also be connected and possibly run someday by the Tribe. Now the discussions are around creating a utility for the Tribe that will work alongside the current provider but eventually be our own supplier of energy in the future. The Red Lake Energy Vision Advisory Committee is the founding board for the Red Lake Power Utility, which will not only help create the utility but will also offer a crash course on climate change impacts and adaptation policies.

The Tribal utility is also going to be the driving force around employment and entrepreneur opportunities for the community. A K–12 STEAM education program is now being developed to include the youth in this transition to renewable energy. The idea is to prepare the youth now so they have the tools to deal with climate change and take advantage of the jobs that will be created by this new renewable energy power utility.

There are also programs such as the one I collaboratively founded with the Minnesota Department of Corrections that are addressing the dual issues of workforce development and recidivism rates by training former inmates in solar installation. Although this effort is separate from the Tribe's workforce development efforts, it is an integral part in connecting social and environmental justice.

There has been a movement by the Oshkimiijiitahdah program (which is the workforce development center) to start construction of a net-zero building that would also be a training center. Red Lake would like to be the training center for northern Minnesota around renewable energy and other green technologies.

The Tribe has started a food sovereignty program and is currently growing vegetables and hemp to hopefully create a network within the community to be more self-sufficient. Tribal members want to be a climate-smart community, which has led to discussions on creating climate change adaptation plans.

If we can get the entire community moving in one direction toward a just transition off of fossil fuels, then maybe we will see the disparities that have been plaguing our community start to fall to the wayside.

Red Lake is no different than any other community trying to prepare for the climate crisis. I think what makes Red Lake unique is that we can move faster than other communities because we don't have all the gridlock like other towns, cities, states, and the federal government has. Red Lake and other Tribal communities can actually help with the adoption of new technologies and other strategies around climate change.

We Native people have always been resilient and adaptive people: assimilation, genocide, and reorganizing have not stopped us. The climate crisis is different; I fear it threatens our existence like nothing else we have ever seen. We need to be at peace with this planet and not at war with it. Living in harmony and being at one with the environment is what has allowed Indigenous people to persevere. We must put our Mother first and treat her with respect once again if we want to continue to exist. I believe this with all my heart.

Energy & a Just Transition

Key Messages

- An Indigenous just transition is an Indigenous-led transition to an Indigenous-based, nonextractive, regenerative economy that transforms community planning and ecosystem restoration.
- Indigenous peoples have been deeply affected by extractive industries such as the fossil fuel and uranium mining industries.
- Tribal lands have tremendous renewable energy development potential, which could help Tribes achieve energy and economic independence, sovereignty, and stability.

Recommendation

Remove barriers to renewable energy development, while supporting Indigenous people in a just transition, to reduce reliance on and negative impacts from fossil fuels and nuclear energy. The most significant barriers to the development of renewable energy on Tribal lands are a lack of financing, infrastructure, training in renewable energy careers, resources to access that training, and inadequately supported Tribal leadership and staff.

Introduction

Due to land dispossession and historical federal policies, many Tribal nations have been forced, coerced, or given no better options other than to participate in extractive industries that may excessively consume resources, severely disrupt ecosystems, and/or exploit workers. The fossil fuel and nuclear energy industries, timber harvesting resulting in the deforestation of vast tracts of land, and intensive agriculture that relies on the use of pesticides and fossil fuel–based fertilizers are examples of industries that can be extractive, pollute the air and water, contribute to climate change, damage communities, and be unsustainable. Although some Tribes have benefitted economically from extractive industries, these gains are short term and not supportive of Tribal lifeways. Many Tribal nations are thus working to transition away from such extractive economies toward regenerative economies through the embodiment of the principles of a just transition. In regenerative economies, resource consumption is reduced, biodiversity is restored, and Tribal lifeways and cultures are preserved for future generations. Such economies may include renewable energy, either at the utility or distributed scale; regenerative agriculture that promotes soil and water health, biodiversity, and the wellbeing of animals; and/or forest management that protects natural and cultural resources and promotes soil carbon sequestration. This chapter focuses on the energy aspects of extractive and regenerative economies. It explores how extractive fossil fuel and nuclear energy industries have become embedded in the economies of many Tribal nations and the repercussions this has had. It also describes the components of an Indigenous just transition and renewable energy potential and actualization on Tribal lands.

A Just Transition

An Indigenous just transition is an Indigenous-led transition to an Indigenous-based regenerative economy (see below) that transforms community planning and ecosystem restoration. This means protecting Tribal sovereignty by addressing and healing broken promises made by the U.S. government and that same government investing in an Indigenous-led just transition that recognizes Indigenous

people's laws, traditions, customs, and lands. A definition provided by *A People's Orientation to a Regenerative Economy (United Frontline Table, 2020)*[33] states:

> *Just Transition is a framework for a vision-led, unifying, and place-based set of principles, processes, and practices that build economic and political power to shift from an extractive economy to a Regenerative Economy. This means approaching production and consumption cycles holistically and waste free. The transition itself must be just and equitable, redressing past harms and creating new relationships of power for the future through reparations. If the process of transition is not just, the outcome will never be. Just Transition describes both where we are going and how we get there. The Just Transition framework focuses on stopping the bad to build the new by divesting from the exploitation of labor and extraction of resources and investing in cooperative labor and regeneration. Just Transition challenges the dominant worldview of colonialism, consumerism, and the concentration of power governed through violent force and advances a worldview of sacredness and care, as well as ecological and social well-being governed through deep democracy.*

The Indigenous Environmental Network hosted an Indigenous Just Transition Assembly,[34] the first of its kind, in 2019. The assembly, which consisted of Indigenous peoples from across Turtle Island, discussed what "just transition" means to Indigenous peoples, which led to a list of place-based principles. In summary, a just transition restores Indigenous lifeways; acknowledges the rights of nature; preserves and revitalizes our Indigenous languages; recognizes our rights, sovereignty, self-determination, and traditions; acknowledges Indigenous voices and the need for Indigenous ingenuity (Indigenuity); and ultimately recognizes that Indigenous peoples honor and accept their responsibility to the rights of the generations to come that allows for a world with harmony, peace, equity, and justice.

The idea of a just transition stems from labor unions around the world, advocating on behalf of generations of livelihoods and built infrastructure that is already in place. Tribes and labor unions can learn much from each other as they attempt to address the issue of an abrupt shift toward renewable and sustainable energy vocations in the broadest sense and the acknowledgment of the massive amount of groundwork to be laid out in order to achieve this shift. Just transition frameworks and guidelines have been supported by Indigenous networks and initiatives and also global organizations such as the International Labour Organization, addressing labor market policies for communities whose livelihoods are being affected by climate change (International Labour Organization, 2015).

In the context of a just transition away from fossil fuels, the term *regenerative economy* refers to the "democratization of primary production and consumption" that reduces resource consumption and restores biodiversity (Climate Justice Alliance, 2018; Front and Centered, 2020). *Extractive economies*, in contrast, are economies that extract resources, such as labor, natural resources, and culture from a community (*Id.*). Regenerative economies are "ecologically sustainable, equitable and just" and serve to "address the root causes of climate change by changing the system" (Indigenous Environmental Network, 2020). Regenerative economies are not new to Indigenous peoples, but in fact recognize the

[33] *A People's Orientation to a Regenerative Economy* (United Frontline Table, 2020): https://climatejusticealliance.org/wp-content/uploads/2020/06/ProtectRepairInvestTransformdoc22x.pdf

[34] Indigenous Environmental Network's Indigenous Just Transition Assembly (Indigenous Environmental Network, 2020) https://www.ienearth.org/first-indigenous-just-transition-assembly/

fundamental interconnectedness of all life on the planet and have laid the foundation for Indigenous lifeways since time immemorial.

Fossil Fuels

Indigenous peoples were dispossessed of the majority of their homelands. These dispossessed lands have been degraded by pollution stemming from industrial sources, such as facilities involved in the extraction, processing, transportation, and delivery of coal, oil, and gas. Such facilities form the basis for the United States' industrial economy. Examples of U.S. policies that facilitated dispossession and degradation of Indigenous lands are the General Mining Act of 1872, the Mineral Leasing Act of 1920, and the Omnibus Tribal Leasing Act of 1938 (Mills, 2017; Royster, 2013).

Indigenous lands also became deforested and transformed into commercial agriculture, mining areas, parks, towns, suburbs, and major metropolitan areas. The ecosystems and biodiversity that Indigenous peoples stewarded became assets for the development of the U.S. economy, serving as another form of energy from natural resources. In states like Michigan, for example, major 19th century deforestation and mining furnished the basis of the industrial infrastructure needed for U.S. settlement to grow its population and economic footprint. Relevant acts of Congress include the Timber Culture Act (1873), the Desert Land Act (1877), the Timber and Stone Act (1878), and the Homestead Act (1862) (Cohen, 1958). At the same time, the U.S. incentivized many Tribes to adopt farming practices tied to the intensive agricultural methods burgeoning in the U.S. in the 19th century. The General Allotment Act of 1887 was part of sweeping efforts to liquidate reservation land into private property (see *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets*). One of the goals of the General Allotment Act was to force and incentivize Indigenous persons to become commercial farmers with nuclear family–based, monocrop farming operations (Fixico, 2011).

Federal policies widely understood as establishing government-to-government relationships between the U.S. and Tribal nations were often premised on enabling Tribes and Indigenous persons to host or lease their lands for fossil fuel extraction and transportation. Examples of such acts are the Indian Reorganization Act (1934) and the Alaska Native Claims Settlement Act (1971), among other statutes and policies to host coal, oil, and gas industries as Tribal enterprises (Philp, 1995). In the 1920s, for example, the U.S. targeted the Navajo Nation for hosting the coal industry, and scholars have widely criticized the fairness of the agreements made in terms of safety and profitability for the Tribe (Edmunds et al., 1995). (The Navajo Nation has also been heavily impacted by uranium radiation stemming from uranium mining operations that employed Tribal members; see below and Brugge et al., 2009; McElroy, 2006.) Additionally, Tribes such as (but not limited to) the Crow Tribe and the Mandan, Hidatasa, and Arikara Nation entered into the fossil fuel industry and continue advocacy for the perpetuation of these industries today (Fixico, 2011; Allison, 2015; Jorgensen, 1978). Despite the complex bureaucracy raising the costs of energy development on Tribal lands (Regan, 2014), of all trust resources, fossil fuels have provided the most economic benefit for particular Tribes engaged in those industries compared to other trust resources, including forestry and agriculture.

Given the economic benefits of fossil fuel industries, Tribes have organized to provide support and empowerment to engage in these industries more safely and consensually. The Council on Energy Resource Tribes formed in 1975 as an advocacy organization for Tribes with substantive portfolios in the fossil fuel industry and has more recently pursued sustainable energy projects. Groups like the National Tribal Environmental Council provide training and other services to Tribes in terms of their operation of

energy infrastructure. The National Congress of American Indians (NCAI) has advocated for policies that support Tribal sovereignty on a number of different energy dimensions, ranging from support for Tribal development of fossil fuel resources to climate change mitigation through renewable energy (National Congress of American Indians, 2013).

At the same time, many Tribes, Alaska Native corporations, and other Indigenous peoples' governments and organizations have advocated for the continuation or reform of fossil fuel energy (Skinner, 2019). The U.S. government has largely put many Tribes in the position of having few options for dealing with economic needs (Wilkinson, 2005; Crepelle, 2018). Several Tribal governments have worked with U.S. and state politicians to endorse the deregulation of fossil fuel energy projects for Tribal governments, or for projects occurring on lands held to be sacred or economically viable by Tribes (e.g., the Arctic National Wildlife Refuge).

The U.S. government has permitted fossil fuel industries to operate in close proximity to Tribal nations and on ancestral homelands, and there is a large body of literature documenting such histories and how Tribes worked to establish greater self-determination and ownership in the development of their energy resources (Allison, 2015; Fixico, 2011; Jorgensen, 1978; Mills, 2017;). At the same time, these non-Tribal fossil fuel–extraction industries have been widely criticized by Tribes, and taken to court or administrative adjudication, for the public-health risks they pose to Tribal nations, including associations with high rates of sexual exploitation and violence in extraction zones (Deer & Kronk Warner, 2019; Deer & Nagle, 2017). The environmental and social risks have formed a cornerstone of the rationale behind the U.S. adopting Executive Order 12898 on environmental justice (U.S. Department of Energy, 2012).

Not only is the proximity to fossil fuel and other extractive industries a concern for Tribes and other underrepresented communities, but adding onto this is the colossal burden of retiring these industries on Tribal lands. The testimonial in this chapter from the Hopi Tribe stresses the long-term impacts from an abrupt mine closure, leaving the Tribe with a "massive budget deficit and a significant number of direct and indirect job losses" (see narrative above titled *The Hopi Tribe: Working Toward a Renewable Energy Future*). The International Labour Organization's *Guidelines for a just transition towards environmentally sustainable economies and societies for all* suggests that national and local governments be leaders in local active labor market policies (International Labour Organization, 2015). For an Indigenous just transition, an example could be providing access to new jobs by laying a foundation of both training and employment opportunities in technical careers for Tribal professionals. In many cases, it is not feasible in remote locations to consistently outsource or contract technical experts to maintain green industry equipment, such as wind turbines, for long-term sustainability. Technical expertise should exist from the inside out to support green industry and Tribal enterprises. Capacity is only built systemically through changes in the Tribal workforce; this means building capacity through increasing the amount of opportunities in Tribal technical career employment opportunities to support and serve Tribal and Indigenous communities.

Despite the attraction of the potential economic benefits in the fossil fuel industry, there has been a Tribal trend toward renewable energy and the curbing of dependence on fossil fuels (Norton-Smith et al., 2016). This is evidenced by actions, policies, and resolutions of numerous Tribal governments, NCAI (2013; 2019), intertribal organizations like the Affiliated Tribes of Northwest Indians, and treaty organizations like the Great Lakes Indian Fisheries and Wildlife Commission and Northwest Indian Fisheries Commission. Indigenous peoples have widely contested coal terminals and new and aging

pipelines, among other cases, whether these aspects of energy infrastructure are Tribal enterprises or operations that occur near reservations or on ancestral homelands. The Lummi Nation has fought against the Pacific Gateway Coal Terminal (Williams-Derry, 2016). The Standing Rock Sioux Tribe has fought against the Dakota Access Pipeline (Fredericks & Heibel, 2018). Numerous Anishinaabe and other Tribes in the Great Lakes region are resisting Enbridge Lines 3 and 5 (Knoblauch, 2021).

Nuclear Energy

American Indians and Alaska Natives currently show no enthusiasm for nuclear energy development. It is impossible to find a Tribal government supporting the development of nuclear energy on their lands today. No energy technology has a more troubling legacy for Indigenous peoples of the United States than nuclear power. The Navajo Nation, Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe were and continue to be directly and negatively impacted by the dream of cheap nuclear energy production from the 1940s to the 1960s. While some energy-system planners and policy makers see a role for nuclear energy in a U.S. carbon-free energy future, many Indigenous peoples remain wary of nuclear energy because so much of its implementation was short-sighted and continues to place their lands and peoples at great risk.

Few citizens in the U.S. want nuclear energy production, especially in their "backyard," until long-term solutions for nuclear waste storage are solved (Ramana, 2018). Of the array of safety and health issues associated with nuclear energy, the continuing problem of what to do with the waste produced by nuclear reactors remains unresolved. A case in point are the threats posed by the failure to solve the radioactive waste storage problem on the Hanford Nuclear Reservation (HNR) established in 1943 on the banks of the Columbia River in Washington (Niles, 2014).

The HNR (586 square miles) was established as a part of the Manhattan Project and became home to nine nuclear reactors and five plutonium-processing complexes. This site was created on lands identified by treaties (such as the Yakama Nation Treaty of 1855) to be used by the three federally recognized Indian Tribal nations of that area for customary hunting and fishing activities (Baptiste, 2005). Although most reactors were shut down by the early 1970s, pollution damage and problems persist today. It remains one of the largest toxic environmental cleanup sites in the world (Niles, 2014). Millions of gallons of dangerous radioactive waste remain on the site, and the U.S. Department of Energy (DOE) is responsible for cleaning up the site (U.S. Department of Energy, 2020a). Tribes continue to press the DOE to do more to stop ongoing contamination and threats to their customary hunting lands, fishing waters, and people (Tolson, 2014).

For the Navajo Nation, the legacy of nuclear energy is also tied to the Manhattan Project and the Hanford Nuclear Reservation: the Navajo people mined the uranium located on their lands that was used as fuel in the Hanford nuclear reactors, which has left a deadly and painful legacy (U.S. Department of Energy, 2020b). The rush to lead the world into an era of inexpensive nuclear energy demonstrated that, especially in uranium mining activities, too little was known about the deadly threats this posed for those in contact with the uranium. No place is this story more poignant than in the homeland of the Navajo Nation (McElroy, 2006). Cancer, birth defects and disabilities, and stillbirths and miscarriages related to uranium mining activity remains years after the mines were shut down (Brugge et al., 2009).

Few people are as aware of the very real threats anthropocentric climate change poses to our planet as the First Peoples of this land; few people want to find zero-carbon emission energy solutions as much as

American Indians and Alaska Natives. While some environmentalists and energy experts are seriously advocating consideration of nuclear energy development, because of the history and the still-unresolved issues of how to handle nuclear energy production waste, there remains little enthusiasm among most Tribes for addressing climate change through the use of nuclear energy. The legacy of nuclear energy has been one filled with death, danger, and threats to American Indian Tribal sovereignty, cultural traditions, health, and identity. Currently funds are available to begin the assessment and cleanup process at 219 of the 523 abandoned uranium mines. This still leaves over half of these uranium mines open and exposed (U.S. Environmental Protection Agency, 2021). The DOE's Nuclear Energy Tribal Working Group has promoted Tribal outreach, STEM (science, technology, engineering, and math) education, research opportunities around nuclear fuel and high-level radioactive waste management, as well as support for the design and construction of microreactors and small modular reactors (U.S. Department of Energy: Office of Indian Policy and Programs, 2016). Considering that sites contaminated with radioactive material involve multisectoral cleanups, increased access to a variety of leverageable resources for Tribal governments is needed (U.S. Environmental Protection Agency, 2019).

Renewable Energy

While industrialized countries rely heavily on fossil fuel energy to power global economies, there is an untapped potential of renewable energy resources, particularly within Indian Country. Tribal lands account for 5% of the total area of the U.S. and 10% of the country's renewable energy resources (National Wildlife Federation, 2010). "There are just over 400 MW [megawatts] of installed capacity of renewable energy projects on land belonging to federally recognized Tribes, including 297 MW of solar, 67 MW of wind, 31 MW of biomass, 6 MW of geothermal, and 0.5 MW of hydropower" (Institute for Energy Economics and Financial Analysis, 2019)[35] (see also *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets*).

Biomass energy is created through an assortment of sources, including wood and wood processing wastes, agricultural crops and waste materials, animal manure, human sewage, and biogenic materials in municipal solid waste (U.S. Energy Information Administration, 2020). The Bureau of Indian Affairs, in partnership with the Bureau of Land Management, promotes Tribal biomass energy production through its Tribal Biomass Demonstration Project (U.S. Bureau of Indian Affairs, 2020).[36]

While many notable Tribal biomass feasibility studies have been conducted, the Huslia Tribal Council and Menominee Tribal Enterprises (MTE) have created a unique project. Owned and operated by the Huslia Tribal Council, this biomass project provides its community with job opportunities and cost savings on heating and contributes to meeting the Tribe's Renewable Portfolio Standard (RPS) by 2025 (U.S. Department of Energy: Office of Indian Energy Policy and Programs, 2017). The MTE project is an example of an existing biomass project that was upgraded in 2013 to improve efficiency by 35% and provided the Tribe with annual savings of $462,227 and 159 tons of emissions reductions (Menominee Tribal Enterprises, 2017).

[35] For a more detailed look at the renewable energy projects on Tribal lands, refer to the U.S. Department of Energy: Office of Indian Policy and Programs (2018) National Renewable Energy Lab's Tribal Energy Atlas https://maps.nrel.gov/tribal-energy-atlas/?aL=urhvHj%255Bv%255D%3Dt%26vg4pmh%255Bv%255D%3Dt%26vg4pmh%255Bd%255D%3D1&bL=clight&cE=0&lR=0&mC=39.57182223734374%2C-100.8984375&tour=splash&zL=4

[36] Tribal Biomass Demonstration Project https://www.bia.gov/bia/ots/dfwfm/tbdp

Geothermal is another renewable energy source that Tribes are harnessing to achieve energy independence and economic growth while also preserving Earth's natural resources. The Citizen Potawatomi Nation embodies these economic and cultural ideals in their geothermal operations (see narrative titled *Geothermal Operations in the Citizen Potawatomi Nation*). The Tribe's staff have had the opportunity to gain crucial experience in developing skills necessary to implement the sustainable system themselves, thus promoting Tribal sovereignty. This is a prime example of addressing the need to form a foundation of employment in renewable energy careers in Indigenous and Tribal communities. It is worth noting that this type of renewable energy does not require Tribal utility policies or Tribal utility formation—another workaround for barriers preventing Tribes from long-term renewable energy projects. Additionally, as they have mentioned, Tribal staff have gained these skills when cost-effective projects have been identified for the Tribe. Thus, when resources are accessible, Indigenous peoples have proven their ability to take the initiative in just transition actions.[37]

There is tremendous solar energy potential on Tribal lands. For example, "the Cherokee Nation is making efforts and strides to decrease [their] carbon footprint. Cherokee Nation is utilizing solar to offset charging of electric vehicles and to power facilities. Some facilities currently being looked at for solar supplement are community buildings, charging stations, and elder homes" (personal communication, P. Manes, 2020). Similar to the Cherokee Nation, the Standing Rock Sioux Tribe is utilizing nonprofit startup funds to invest in solar panels for the Tribe. The energy harnessed from these panels will then be sold back to the state's energy grid, which could provide a cost savings of $10,000 a year for the Tribe (Kolpack, 2019). The Moapa Band of Paiute Indians is undertaking a slightly different model, as they are investing in the first utility-scale project approved for Tribal lands, which will provide power off of the reservation (Kolpack, 2019). Called the Arrow Canyon Solar Project, it is a 250 MW project anticipated to power an average of 64,000 Nevada homes (First Solar, 2020).

Wind is the most common renewable resource used on Tribal lands and is typically produced on a utility scale (Global Energy Network Institute, 2016). One example is the Oceti Sakowin Power Authority, which is comprised of six Tribes (Cheyenne, River Sioux, Flandreau Santee Sioux, Oglala Lakota, Rosebud Sioux, Standing Rock Sioux, and Yankton Sioux) and is on track to be the largest wind power development in the U.S. (Oceti Sakowin Power Authority, 2013). Initial planning for two wind installations has been completed: a 450 MW project on the Cheyenne River Reservation and a 120 MW project on the Oglala Pine Ridge Reservation (Oceti Sakowin Power Authority, 2019). Not only is the six-Tribe collaboration unique, but the governance structure is a mixture of board members and elders who speak on behalf of their respective homelands (Robertson, 2019). Another example of wind development on Tribal lands is the 25-turbine, 50 MW wind installation owned by the Campo Band of Kumeyaay Indians. In their power purchase agreement with San Diego Gas and Electric, the Tribe is earning 5% of fees from the contract (Campo Kumeyaay Nation, 2013).

The narratives included in this chapter are a testimony to the restorative and progressive strides of Tribal communities working toward a just transition. The Hopi Tribe in northern Arizona, who have historically looked to coal as a main part of their economy (see Fossil Fuels section, above), have taken it upon themselves to strategically transition from a fossil fuel economy to a renewable energy economy

[37] For more information on Tribal geothermal resource potential, review the map created by the National Wildlife Federation: The New Energy Future in Indian Country: Confronting Climate Change, Creating Jobs, and Conserving Nature https://www.nwf.org/~/media/PDFs/Global-Warming/Reports/03-23-10_NWF_TribalLands_LoRes.ashx

after the closure of the Peabody Coal Mine. The Hopi Tribe has assessed their renewable energy resource potential and have found extensive opportunities to develop utility-scale solar PV projects in their movement toward a just transition (see also the narrative titled *The Hopi Tribe: Working Toward a Renewable Energy Future*). The Red Lake Nation in Minnesota understands the intersectionality of their renewable energy development and that their microgrid for the community not only provides cheaper electricity, but also positively influences educational programs, workforce development, recidivism rates, and food sovereignty, which all encourage a climate-smart community (see narrative titled *Renewable Energy Development at the Red Lake Nation*). Although the Red Lake Nation does not have a fossil fuel-based economy from which to transition, they are developing their economic vitality through innovative business models.

Although the renewable energy potential on Tribal lands is vast, Tribes face significant energy development barriers. The most significant barriers to the development of renewable energy on Tribal lands are a lack of financing, infrastructure, training in renewable energy careers, resources to access that training, and inadequately supported Tribal leadership and staff (Jones & Necefer, 2016). Economic factors associated with financial and funding barriers are "small-scale projects are not economically feasible as an alternative to grid connection, large-scale projects require significant outside capital, and high infrastructure costs are necessary to reach remote locations" (Jones & Necefer, 2016). While renewable energy development aids Tribal sovereignty, this sovereignty renders Tribes tax-exempt, which ultimately disqualifies them from receiving tax incentives such as the Federal Production Tax Credit associated with wind development (Zimmerman & Reames, 2021). Further, high turnover in Tribal leadership and staff has proven to be another significant barrier for energy development because of the instability turnovers create within the progression and vision of a project (Zimmerman & Reames, 2021; Jones & Necefer, 2016; Congleton, 2013). Although many Tribes have shown time and again that renewable energy projects and sustainable systems can be effectively implemented and maintained, these barriers should be addressed through the creation of practical policies that will benefit disparately impacted Tribal and Indigenous communities. For further information on barriers to renewable energy development, see the *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets* section titled, "Federal Policies and Energy Development on Tribal Lands."

Conclusion

The principles of a just transition can—and should—be applied to a transition away from fossil fuels and toward energy sources that are regenerative, place-based, reciprocal, and restorative to Indigenous communities' wellbeing. The principles above that broadly define the scope and scale of a just transition stand in contrast to other more limited definitions that solely involve creating greener jobs (Bainton et al., 2021). To move beyond the more limited definition of green jobs, a just transition can provide a framework for analyzing the fairness and equity of the energy transition (McCauley & Heffron, 2018). Restorative justice, which focuses on repairing past harms and preventing future harm rather than on punishing the offender (*Id.*), can help to address past damages to Indigenous peoples, their lands, and environment and help ensure that a more equitable and reciprocal approach to energy development occurs.

In contrast to how the closure of the Peabody Mine on Hopi land was handled (see narrative titled *The Hopi Tribe: Working Toward a Renewable Energy Future*), when utilities and mining companies close the fossil fuel operations that are economic drivers in some Tribal communities, they have a moral imperative to ethically phase out their operations by including job training and placement, financial

support during the transitional period, environmental cleanup, and a commitment to purchasing renewable energy from communities that choose to develop that energy. This is what a just transition looks like.

In addition to the examples discussed in this chapter, there are multiple examples of Tribes who are currently advancing economic development through the active use of renewable energy and their own Indigenous regenerative or circular economic models. These Tribes include the Standing Rock Sioux Tribe of North Dakota,[38] the Winnebago Tribe of Nebraska,[39] and the Moapa River Indian Reservation.[40] The actions being taken by these Tribes illustrate tremendous opportunities for Tribes to more fully implement a just transition that speaks to the issues of equity, inclusivity, and intersectionality.

Extractive industries such as the mining of fossil fuels and uranium have damaged Tribal communities while at the same time bringing short-term economic benefits. As those industries come to an end (e.g., the closure of coal mines), Tribes are often left with the lingering health and environmental impacts, but without the continued financial benefits. Tribes are finding ways to exert their sovereignty and have agency over their futures through developing renewable energy and reclaiming their original, regenerative economies, but the industries and government that created these injustices must be part of the process in implementing restorative justice and removing barriers. The voices and leadership of Tribes and Indigenous peoples must be heard and elevated, for they can and do provide models of sustainable, reciprocal, and regenerative economies.

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Chapter 8: Cultural Resources

Cultural resources are threatened by climate change. The narratives in this chapter explain how several Tribes in California are developing initiatives to protect their cultural resources from climate change impacts. The Twenty-Nine Palms Band of Mission Indians has initiated a planning process to assess these sectors' vulnerability to impacts and develop climate change–resilient strategies to protect their cultural resources. Similarly, the San Manuel Band of Mission Indians has created and implemented a landscape stewardship program for fire management and cultural resource protection. The Santa Ynez Band of Chumash Indians Environmental Office also developed a comprehensive climate adaptation plan with a focus on Chumash cultural sites and resources across traditional Chumash territory. A key recommendation from this section is to integrate the tangible and intangible cultural, spiritual, and traditional significance of plants, animals, ecosystems, and landscapes into analyses of the consequences of climate change. A researched overview of Cultural Resources as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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Summary of Climate Change Cultural Resources Survey

Written by: Sara Bliss from the Twenty-Nine Palms Band of Mission Indians

The Twenty-Nine Palms Band of Mission Indians (Tribe) recognizes the scientific consensus that the Earth's climate is changing due to anthropogenic activities on the planet. Greenhouse gasses emitted into the atmosphere from human activities have created a global warming trend that continues to alter the Earth's climate. The consequences of this worldwide trend are apparent on the Tribe's Reservation and ancestral territory of the southwest United States, manifested as highly variable temperatures and precipitation rates. The increasing variability of these climate indicators has led to extreme drought and extreme precipitation events becoming more common, resulting in higher wildfire and flash-flooding risks. These impacts pose direct and indirect threats to public health, infrastructure, and natural systems. With this understanding, the Tribe has initiated a planning process to assess these sectors' vulnerability to impacts and develop climate change–resilient strategies. The Tribe has made considerable progress in this effort; however, Tribal cultural resources have not been addressed in this context. The Tribe's cultural resources are invaluable, as they are a vital connection to traditional lifeways and ancestral stories. These cultural resources are diverse and encompass landscapes, archeological sites, flora and fauna, and spiritual practices. Climate change impacts can degrade and

destroy these precious resources through acute and chronic exposure. A comprehensive assessment and adaptation plan for cultural resources is currently being developed from funding from the Bureau of Indian Affairs' Tribal Resilience Program. The Tribe is currently developing a comprehensive adaptation plan specific to its diverse cultural resources. To accomplish this, the Tribe will conduct an inventory of its cultural resources and analyze their vulnerability to climate impacts. The resulting work will be incorporated into an adaptation plan that will inform management measures for cultural resources in the context of climate change.

In our original proposal, we proposed to conduct inventories and site visits with Tribal members and elders. Since this grant was awarded in the early onset of the coronavirus pandemic, there have been many hurdles to figuring out how to receive training and meet with these important cultural knowledge bearers. Since that time, we have been researching other climate change adaptation plans and putting together a survey to understand and identify significant cultural resources to Tribal council members, Tribal members, Tribal elders, Tribal youth, agency representatives, and cultural Informants. Once we receive the survey results, we can focus our adaptation plan on these specific resources that need protection from threats of climate change. To create the survey, the information from the National Park Service Climate Change[41] research was used to formulate a table with known threats that pertain to the desert environment. These known threats include increased temperature, wind, flooding, and wildfires. Other threats include changes in seasonality, species shifts, invasive species, drought, pollution, and development. The categories affected by these threats are divided into Cultural Resources, Cultural and Natural Landscapes, and Museum Collections. This table of information is in the beginning of the survey and can be referred to during the question portion.

The online survey format helps the transition from face-to-face communication to a virtual and digital platform of gathering information. There are beneficial impacts to having digital records of communications, which can aid in long-term cultural preservation. An online format also ensures the protection of health and ease of communication between the Tribal Historic Preservation Office and the Tribal community. This is especially important during the current situation of COVID-19 and social-distancing measures. The Tribal community's health is the most important aspect of culture preservation, especially for Tribal elders and the traditional knowledge they may have. The ease of communication will enable faster results and solution-based planning like the Climate Change Adaptation Plan, which is the project the survey results are intended for. There is an office phone number listed in the survey, just in case there is confidential information that cannot be listed on the online format; the office number is also listed for any concerns and/or questions.

The survey questions are broad and open, so that communication can start from the appropriate perspective. The survey questions are first based on the known threats and then secondarily focused on the categories of cultural resources. The first section of questions asks how concerned the respondent is about each one of the known threats and gives options for Not Concerned, Neutral, Concerned, or Very

[41] National Park Service's Cultural Resources Climate Change Strategy: https://www.nps.gov/subjects/climatechange/upload/NPS-2016_Cultural-Resoures-Climate-Change-Strategy.pdf

Concerned. There is a blank paragraph at the end of this first portion for writing in additional threats and/or concerns. The second portion of the questions focuses on the categories of cultural resources: ceremonies, cultural items, landscapes, plants, sites, trails, and wildlife. The questions for each category ask, “Are there any specific resources in that particular category significant to you that need protection from the effects of climate change?” Each question leaves blank space for specific resources to be written down.

The results from the survey will be incorporated into a broad Cultural Resources Resiliency Plan. The Plan will guide the Tribe in managing its cultural resources in response to climate change impacts. This plan will prioritize the inventoried resources for action based on their significance and vulnerability. Goals will be developed for the resources that may be qualitative, quantitative, or both, with an associated timeframe for completion. Adaptation- and resiliency-focused options will be created and customized to achieve the Tribe’s goals. These options may be technological or policy-based or be derived from traditional ecological knowledge and organized according to constraints and opportunities. This plan is intended to be a living document, subject to review and revision based on current information.

An Ethos of Partnership: Stewardship of Serrano Ancestral Territory in the Midst of Climate Change

Written by: The San Manuel Band of Mission Indians

Since time immemorial, the Serrano people have maintained a close relationship with their ancestral lands, entrusted by the Creator to steward these lands in meaningful ways. Thus, the San Manuel Band of Mission Indians (SMBMI) has created and implemented a landscape stewardship program that is reflective of the Tribe’s Vision, Mission, and Values. As a part of this program, the Tribe engages in landscape stewardship efforts in a multitude of ways, including the Tribe’s partnership with government agencies as it relates to fire management and cultural resource protection.

For many years, SMBMI has made various efforts to better guide fire-related land management processes governed by their partners to include fire prevention, fire suppression, and post-fire landscape assessments. In order to contribute to prevention efforts, SMBMI has participated in archaeological surveys; performed data retrieval from various repositories; researched within the Tribe’s own records, histories, and knowledge; and decolonized these various data sets to ascertain boundaries of different types of Tribal cultural resources. These resources include but are not limited to archaeological sites, gathering areas, hunting areas, viewsheds, and ceremonial spaces. As the Tribe has become more and more equipped with this knowledge of their ancestral landscape, they have offered stronger guidance to their partners related to avoiding areas of cultural importance during various fire-prevention projects that could potentially harm resources. Such efforts include culling and removal of dead or dying vegetation, controlled burning of vegetation, weed abatement, and planning dozer lines for suppression use during a fire.

However, while the Tribe has seen success in these early planning efforts, it has become apparent in recent years that issues related to climate change are ever-increasing, making cultural resource protection that much more difficult. The number of fires that occur in the forests near the San Manuel Reservation has increased exponentially over the years, and the Tribe's partnering agencies continue to fall further and further behind in their prevention efforts. Long-term drought has led to increased bark-beetle infestation. Such infestations were predominantly in pine trees in the past, but as of 2020, there is now a surge of oak deaths due the introduction of a new species of oak borer in the area. The introduction of a new species is hardly surprising given how many tourists, unaware of the dangers of introducing nonlocal wood, are heading to the mountains and forested communities in droves to escape the frequent, increased heat in the urban areas of southern California. Further, there is a lack of education regarding vehicle fires caused by off-roading, as well as campfire safety, and the forests in the area were recently closed off to public access as a fire-prevention method. This measure was a desperate act, and it became abundantly clear that agencies, even with local assistance, are unable to sustain the increasing workload related to fire management.

This workload is further burdened by the fact that the fire season gets longer each year. Seasons previously focused on fire-prevention activities are now consumed by active fire suppression, with agencies oftentimes battling multiple fires at once. As agencies do not have the resources to handle these fires alone, SMBMI has made it a point to offer assistance wherever possible. Not only has the San Manuel Fire Department offered on-the-ground support to agency partners during active fire battles, but the Tribe has also offered real-time assistance to their cultural preservation efforts, with archaeologists and Tribal monitors actively leading dozers around culturally significant areas and implementing fast-tracked mitigation for archaeological sites that were inadvertently damaged in the initial chaos of fire-suppression mobilization. However, the Tribe's resources are often stretched thin through the bulk of fire season, and there is a concern that fire activity will only increase and the level of support the Tribe hopes to provide will become unsustainable. To further complicate matters, post-fire season lends itself to an extra set of environmental concerns, as increased, though short-lived, precipitation has made its way to the region in recent years, causing mudslides and rockfalls in areas cleared of vegetation by fire. Such acts of nature are incredibly destructive to various resources, most particularly archaeological sites subject to erosional impacts and gathering areas that managed to survive the fire. While numerous efforts are made with the Tribe's partners to identify these areas as culturally sensitive and in need of mitigation, suitable and effective actions can oftentimes take too long to implement and/or cost money the agency simply does not have.

Given the overall lack of staff and funding resources that land managers and Tribes have to address these fire-related issues, cultural preservation may very well fall to the wayside, and highly sensitive resources necessary to the overall cultural wellbeing of the SMBMI community could be lost. As a result, the Tribe has ramped up their planning efforts, working with agency partners to not only identify areas of low cultural sensitivity that are suitable for long-term, repeated dozer trenching, but also to better streamline communication processes between cultural resource managers, incident commanders, and on-the-ground fire personnel during suppression activities. Further, the Tribe is looking to expand their current monitoring support by certifying additional archaeological staff and monitors for work on the

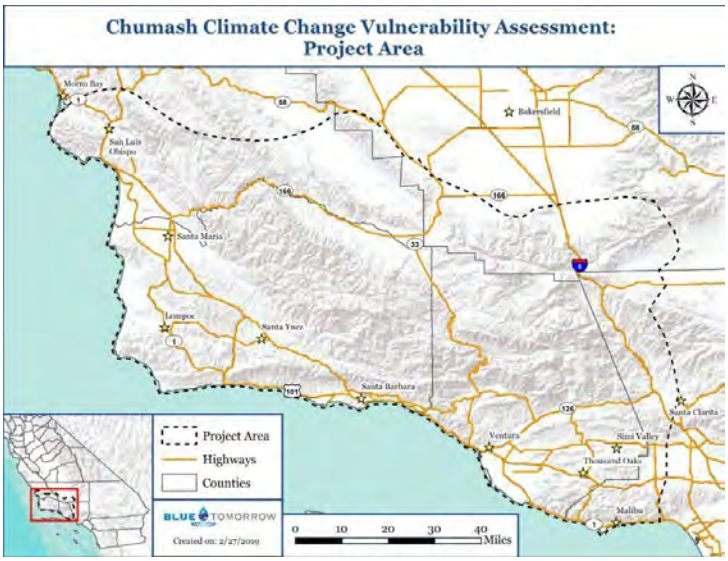
fire line and even provide real-time, remote GIS support to agencies. It is with great hope that improved communication and GIS support will also roll over to the post-fire effort, allowing SMBMI to rapidly provide robust information related to foreseeable cultural resource danger and increasing the possibility that this resource damage can be effectively mitigated earlier in the post-fire review process.

Overall, the Tribe has been able to effectively and efficiently communicate information relating to Serrano culture, history, and resources, engage in a way that greatly supports the efforts of their partners, and ensure that the efforts result in cultural resource protection for the benefit of the Tribal community. Moving forward, the SMBMI hopes for continued success in co-stewardship efforts associated with fire-related land management within Serrano ancestral territory and will continue to engage in this process in a way that honors the Tribe's Vision, Mission, and Values.

Santa Ynez Chumash Cultural Resources and Climate Threats

Written by: Teresa Romero

The Santa Ynez Band of Chumash Indians, the only federally recognized Chumash band, is undertaking a number of projects and programs, both on and off Tribally owned lands, aimed at protecting cultural resources from climate change effects. This includes a comprehensive climate adaptation plan with a focus on Chumash cultural sites and resources across traditional Chumash territory. The Santa Ynez Band of Chumash Indians Environmental Office (SYCEO) is leading the efforts in collaboration with other Chumash bands.



Climate Change Effects in Chumash Traditional Territory

Throughout the traditional Chumash territory, the natural landscape has provided sources of food, medicine, building materials, and ceremonial regalia for the Chumash people. In order to evaluate climate change vulnerabilities of the Chumash community, an inventory was conducted of Chumash

artifacts, cultural sites, and culturally important flora and fauna. Transportation modes used by the community were documented to determine accessibility to these cultural sites and resources.

Flora

Plants are foraged by Chumash for a variety of purposes, including food, tea, spices, medicine, and ceremonial purposes, and for materials for making baskets, canoes, and other items. A database of native plants used by the Chumash has been developed by SYCEO for 325 different species. This database contains information on plant species and cultural significance, including which plants were found pre- and post-Spanish contact, the usage of the plants (medicinal, ceremonial, material, and edible), fire-follower and fire-treatment plants, and whether these are currently being used by the Chumash community. Within this database, 207 individual plant species were noted as having cultural significance. Information collected from interviews and surveys included 74 plant species that were identified by the Chumash community as having traditionally been and/or are currently being gathered.

Approximately 76% of respondents (22 of the 29 respondents that answered this question) said that they have experienced changes in the availability of plant and animal resources in recent years, with 20 respondents experiencing a decrease in availability. For those respondents who experienced a negative change in plant- and animal-resource availability, common reasons for declines include loss of access, overharvest, drought, lack of instream water availability, and development. Shared knowledge provided by the Chumash community identified 19 plant species that have cultural uses for medicinal, ceremonial, material, and edible purposes. Of these species of cultural importance, the predominant vegetation classes include California forests and woodlands, California chaparral, California annual and perennial grassland, and California coastal scrub.

Fauna

The Chumash consider many animal species to be culturally important. These include terrestrial and marine mammals, saltwater and freshwater fish, marine invertebrates, reptiles, amphibians, and bird species. These animals were traditionally used for food, clothing, and ornamental material (such as the shells of clams) or regarded as culturally or spiritually important (e.g., coyotes, bears, and eagles).

Similar to the Tribal records for plant species, SYCEO maintains a working database of animal species with cultural significance to the Chumash. This database includes 22 different fish species, 42 reptiles, and 16 amphibian species found in the Chumash territory. Also included in this database are 46 different bird classifications from the Samala language, spoken by Chumash in the Santa Ynez Valley. Through community

outreach, 48 different marine and terrestrial animals were identified as having cultural significance. Many of the animals that were highlighted by the community survey are found on the coast, including fish and invertebrate species used for food.

Summary of Climate Exposure and Impacts

Climate change effects are anticipated throughout the Chumash traditional territory. Temperature and heat waves are expected to significantly increase. Communities along the coast will experience sea level rise, coastal erosion, and an increase in flooding. Wildfires will vary from year to year, but the average annual area burned is expected to generally increase. Precipitation will also be variable from year to year, but droughts are expected to increase in the latter half of the century.

Both primary and secondary climate change effects are threats to traditional sites and artifacts. Sea level rise poses risks of damage or loss of these sites from inundation and, when combined with high-intensity precipitation events and storm surges, can lead to further threats from cliff erosion and coastal flooding. Increased wildfire prevalence and intensity also threatens traditional places throughout the region.

Other cultural impacts resulting from potential disturbances to plant and animal communities result from a multitude of primary and secondary effects, including changes to temperature, precipitation, sea- level rise, wildfire, drought, and debris flows. These in turn have the potential to alter traditional hunting and gathering practices, timing of spiritual practices, loss of local food sources, loss of traditional medicinal plants, and loss of traditional materials used for jewelry, sculptures, ceremonial pieces, basketry, nets, and lodgings.

Chumash Projects and Programs

In addition to developing the climate adaptation plan, SYCEO leads a native plant propagation program to help promote a healthier, more diverse landscape by encouraging the proliferation of native plants and organic food cultivation. SYCEO developed the first Chumash Community Garden in 2012. The garden is intended to be a demonstration of sustainable gardening techniques that expand the knowledge and palate through the plethora of vegetables and fruits grown there.

SYCEO has supported a number of projects related to the management and restoration of habitat in and around the Santa Ynez Chumash Reservation. The plant database includes native plants to use for restoring the Zanja de Cota Creek, other habitat on Tribal lands, and fire-following and fire-treatment plants. SYCEO has monitored the water quality on Zanja de Cota Creek since 2008 to evaluate overall ecosystem health and to identify sources of pollution into the creek.

Off-reservation projects include working with the U.S. Forest Service to perform on-the-ground surveys and invasive species removal in parts of the Los Padres National Forest (LPNF). An assessment is being conducted to evaluate the recovery of conifer stands burned by wildfire and to develop a restoration plan in the LPNF wilderness. These projects provide some level of adaptive capacity for protecting plant communities and habitats of Tribal importance. One of the challenges for protecting sites and resources off Tribal-owned lands is that it is dependent upon collaboration with external stakeholders.

Cultural Resources

Key Messages

- Tribal cultural resources include intangible cultural beliefs, practices, and traditions as well as tangible physical sites, landscapes, plants, and animals.
- Tribal climate change mitigation strategies should include considerations of both tangible and intangible cultural resources.

Recommendation

Integrate the tangible and intangible cultural, spiritual, and traditional significance of plants, animals, ecosystems, and landscapes into analyses of the consequences of climate change.

Indigenous peoples have lived, hunted, gathered, settled, traded, and traveled throughout North America since time immemorial. The modern descendants of those First Peoples continue to survive and thrive in the lands of their ancestors, and they maintain stewardship of what have come to be known euphemistically as "Tribal cultural resources." Tribes have long faced many challenges in protecting and preserving these resources, including from the multiplying effects of climate change. From the erosion of ancient burials out of coastal bluffs on the Pacific coast to the disruption of habitats and life cycles for traditional subsistence foods and medicines in the Great Plains and the weathering and loss of ancient petroglyphs and pictographs in the Southwest, climate change is threatening Tribal cultural resources ranging from tangible archaeological sites to intangible cultural beliefs and values (Chang et al., 2020; Tsosie, 2015).

Tribal cultural resources are threatened by the impacts of climate change, but quantifying, managing, and adapting to those threats require a discussion of what constitutes a Tribal cultural resource in the first place. At the most essential level, cultural resources and natural resources—air, water, and earth; plants, animals, and people—are not separate. Thus, any discussion of Tribal cultural resources necessarily encompasses the natural resources on which they depend. Further, Tribal cultural resources cannot be defined in a vacuum, absent the specific cultures and histories from which they obtain their significance. The Western point of view that derives from the long history of colonization and the displacement of Indigenous peoples in North America has historically dominated the way Tribal cultural resources are identified, valued, and protected. One need only review the four criteria for listing on the National Register of Historic Places[42] to see that "significance" largely hinges on what "data" can be preserved or extracted from a "historic" site and that a cultural resource of immeasurable value to a Tribe may not qualify as significant using this Western colonial framing (King & Parker, 1998).

Cultural resources are commonly defined as having a discrete physical location, material composition, and describable, tangible characteristics, but for Tribal cultural resources this is not always the case. Tribal cultural values, practices, and traditions are grounded in both physical and metaphysical realms

[42] National Register of Historic Places: https://www.nps.gov/subjects/nationalregister/upload/NRB38-Completeweb.pdf

that encompass deeply specific and culturally distinct belief systems. For Tribes, it is not just the physical places and objects that are imbued with significance; it is the entire circle of connectedness between Mother Earth and all her children. This connection is so close that many Tribes refer to these connections as kinship relations and reference the denizens of the natural world not as what, but as who (Kimmerer, 2013). This connection is a vitally important consideration for management purposes, yet it is not always fully recognized by non-Tribal entities. For example, the U.S. Forest Service issued a General Technical Report for the Intermountain Region in 2018 that broadly defines cultural resources as "archaeological sites, cultural landscapes, ethnohistoric and historic structures and artifacts, and ethnographic resources" (Flanigan et al., 2018). This definition encompasses Tribal as well as non-Tribal cultural resources, but focuses primarily on resources that can be tangibly identified. In the case of ethnographic resources, the report acknowledges that landscapes are linked to traditional cultural uses and recommends integrating those uses with management plans, which is a good first step; however, Tribal landscape values often go beyond just the physical resources those landscapes may provide. Furthermore, the very use of the term "resources" derives from a Western framework of use and extraction that does not reflect Tribal ways of knowing, understanding, and situating themselves in both the material and the spiritual world.

Tangible Tribal cultural resources extend beyond archaeological sites, artifacts, and landscapes to encompass the plants, animals, and geographies of those places. Climate change impacts habitat and gathering areas for culturally significant species, such as wild rice in the Great Lakes, salmon in the Pacific Northwest, and oak trees in California. It also impacts geographically linked cultural practices; for example, ceremonies based on the changing of seasons and events such as the first snow on a sacred landscape may be disrupted as climate change pushes back or even prevents these events from occurring (Heinsius, 2019).

The values, traditions, histories, and knowledge associated with physical Tribal cultural resources extend the impacts of climate change from the tangible to the intangible. While these effects may not be as visible, they are just as important. In Alaska, for example, as ice melt and sea level rise accelerate, some Alaska Native villages are being forced to relocate to higher ground. This loss of place is the loss of multiple and intertwined Tribal cultural resources. Homes, buildings, structures, cemeteries, and other physical attributes of these villages are connected to cultural values, practices, and knowledges. The loss of places and the concomitant loss of the traditions, histories, and stories associated with those places are losses of immeasurable significance (Maldonado et al., 2013).

Given the tangible and intangible nature of Tribal cultural resources, developing adaptation and mitigation strategies to address the impacts of climate change presents a significant challenge. While federal agencies such as the National Park Service (NPS) are beginning to recognize the effects of climate change on cultural resources, it is instructive to note that the NPS's "Cultural Resources Climate Change Strategy"[43] includes the word "tribal" a mere eight times in 60 pages; yet, the report is illustrated with

[43] NPS's Cultural Resources Climate Change Strategy: https://www.nps.gov/subjects/climatechange/upload/NPS-2016_Cultural-Resoures-Climate-Change-Strategy.pdf

multiple photographs of Tribal cultural sites (Rockman et al., 2016). Much like the National Register of Historic Places listing criteria, this reveals yet again that Tribal cultural resources are generally defined physically and archaeologically, with a failure to consider Tribal traditions, knowledges, and values associated with places that cannot be defined in a material way.

To adequately adapt and mitigate climate effects to Tribal cultural resources, intangible values must be considered. To that end, Tribes themselves have been the best stewards of their own tangible and intangible resources and are developing climate change vulnerability assessments and adaptation strategies that explicitly include measures for the protection of Tribal cultural resources. The Makah Tribe, for example, established the Makah Climate Change Workgroup to develop the Makah Traditional Knowledge and Cultural Resource Assessment, which is an effort to identify and create solutions to climate change effects on the Tribe's tangible and intangible cultural resources (Chang et al., 2020). The Makah's assessment suggests focusing on traditional knowledge and community participation to establish historical baselines, identify critical resources, and suggest adaptation strategies, rather than rely solely on Western frameworks and approaches that can omit or ignore the power imbalances and inequalities that are a persistent consequence of colonialism.

Tribal traditional practices can also be used to help mitigate the effects of climate change on Tribal cultural resources. In California, climate change–driven increases in wildfire frequency and severity are being answered by programs to reintroduce traditional land stewardship practices such as cultural burning (Sommer, 2020). Tribes used cultural burning practices prior to European colonization to manage landscapes and promote healthy habitat for important plant and animal species (Anderson, 2013). For the Karuk and Yurok Tribes in the Pacific Northwest, understory fire management has reduced wildfire risks and enhanced the productivity of the California hazelnut, a vital ecocultural resource that is threatened by climate change (Marks-Block et al., 2019).

While the consideration of Tribal cultural resources is broad and inclusive of nearly every aspect of Tribal cultures, traditions, and knowledges, many Tribes are explicitly considering the effects of climate change on classically defined archaeological resources. The Navajo Nation's comprehensive climate change adaptation planning report[44] includes a chapter that considers how climate change will affect the Tribe's multiple significant archaeological sites and provides suggestions for preservation and management. It is important to note that these resources are important not just for their archaeological components but for their cultural and historic significance to the Navajo people—again, combining the tangible and intangible aspects of Tribal cultural resources (Nania et al., 2014).

Appropriate consideration of Tribal cultures, values, traditions, histories, stories, and practices is a vital component of climate change adaptation and mitigation planning. Unfortunately, since the arrival of European colonizers in North America, Indigenous peoples have borne the brunt of colonial practices and Western values that privilege an ethic of dominion over lands, waters, plants, and animals, in deep

[44] Considerations for Climate Change and Variability Adaptation on the Navajo Nation: https://www.bia.gov/sites/bia.gov/files/assets/public/pdf/idc2-060732.pdf

contrast to Tribal ethics of stewardship and communion with nature. Tribal cultural resources, defined only from the Western epistemological frame, have been valued merely for what they can reveal to science rather than by their timeless value to the peoples connected to and culturally sustained by them. Cultural and environmental justice movements are only now starting to grapple with the centuries of harm that have been done to Indigenous peoples and the places, practices, traditions, and values they have managed to maintain. Climate change is a severe threat to Tribal cultural resources that can only be mitigated if Tribal definitions of those resources are included in proposed climate solutions. Tribes must be invited to the table as full partners and not just as tokens to justice, equity, diversity, and inclusion. That means integrating Tribal knowledges and perspectives as the primary drivers of solutions and strategies for the protection of Tribal cultural resources.

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Chapter 9: Emergency Management

This chapter examines the evolution of Tribal emergency management programs and how Tribes apply emergency management principles to climate change initiatives. Some Tribes have qualified for unique funding through the Federal Emergency Management Agency (FEMA). For example, the Quapaw Nation of Oklahoma incorporated climate issues into their FEMA Hazard Mitigation plan. The Standing Rock Sioux of North Dakota detail their fight against the Dakota Access Pipeline and Keystone XL Pipeline, and the Santee Sioux Nation of northeast Nebraska describes how historic flooding caused severe damage. These Tribes stress the importance of storytelling in Tribal emergency management. A researched overview of Emergency Management as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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The Quapaw Nation's Incorporation of Climate Change in Emergency Preparedness Planning

(excerpted and adapted from ITEP's Tribes and Climate Change Profile[45])

Written by: Craig Kreman, Environmental Engineer – Quapaw Nation and Dara Marks-Marino, Institute for Tribal Environmental Professionals

The Quapaw Nation has been seeing the impacts of climate change primarily by way of increases in extreme weather patterns: years with extreme rainfall (365 consecutive days from 2019–2020 saw over 80 inches of rainfall, which was 30 inches above average) are then juxtaposed with seasons of drought. The overarching approach that we are taking to account for climate change is in our emergency management planning.

In 2016, Quapaw's Department of Public Safety Emergency Management officer applied for and received a FEMA grant to create a hazard mitigation (HazMit) plan. This grant allowed us to hire a consultant to develop the more technical aspects of the plan, such as elements

[45] ITEP's Tribes and Climate Change profile of the Quapaw Nation: http://www7.nau.edu/itep/main/tcc/Tribes/plns_Quapaw

involving in-depth GIS mapping, data collection, tabulation, and graphing. FEMA had recently begun requiring the inclusion of a climate aspect in HazMit plans, and by October 2017, we achieved the significant accomplishment of becoming one of the first to incorporate climate into a HazMit plan and have it approved.

Chapter 5 of the Quapaw Nation's HazMit Plan[46] is dedicated to climate change and defines the relationship between climate change and hazard mitigation, the current indications of climate change, the projected future impacts and responses to climate change, and the potential of climate change to impact hazards. Many of the identified impacts of climate change are felt across the region and the world (such as the potential for drought, flooding, severe weather, and wildfire), and others are less common (such as the unknown impact of climate change on earthquakes, which "could be exacerbated as a result of increased liquefaction, due to increased flooding issues. Such scenarios also have the potential to increase the development of sinkholes or mine collapses.") (Bridgeview Consulting LLC, 2017)

Quapaw Powwow Grounds Flooded December 2015. Photo courtesy Quapaw Nation.

Including climate risks in our HazMit Plan has brought significant opportunities for the Quapaw Nation. From a monetary point of view, it has opened the door to receiving other grants from FEMA that can be directed toward pre-disaster mitigation, and, importantly, these grants have either limited or no matching funds requirements. This is critical for many Tribes because matching funds (which are often 40–50% of the project cost) can be a prohibitive factor in embarking on these investments. It is also a win-win situation: grants from FEMA allow the Quapaw Nation to prepare for, mitigate, and address disasters, elevating our sovereignty and reducing the need for a FEMA response when the inevitable emergencies arise.

[46] A copy of the Quapaw HazMit Plan can be obtained by contacting Craig Kreman at ckreman@quapawnation.com.

Just as importantly, including climate risks in our HazMit Plan has deepened the collaboration across Tribal departments. Our Environmental Department and Department of Public Safety have long had a close working relationship, each valuing the synergies between them, and the Quapaw Nation has long been supportive of addressing climate related issues, but this plan has introduced sustainability and climate considerations into the vision of all Tribal functions. This extends to the Quapaw Cattle Company, which is currently working with the Tribe to return mine-altered landscapes back into agricultural fields to better grow corn, beans, and wheat, as well as grazing pasture for cattle. Our Environmental Department also works with the Tribal Historic Preservation Office and Tribal elders to ensure that cleanups of Superfund sites do not impact cultural aspects and that subsistence foods like wild onion, wild asparagus, arrowhead root, and duckweed are all considered when planning for climate and hazard mitigation.

Photo courtesy of Craig Kreman, Quapaw Nation Environmental Office

Another advantage of including climate in our HazMit Plan is that planning for emergency response and hazard mitigation reaches across boundaries that can otherwise be prohibitive for getting buy-in from important stakeholders. For example, although our Tribal elders and leadership are cognizant of climate change, there can be resistance from other sectors on taking climate action. But no one in the area is resistant to incorporating specific preparations and planning to mitigate hazard risks, especially as it relates to flooding. As demonstrated by the steps of the Quapaw Cattle Company, even ranchers in the area are discussing permaculture, silviculture, sustainable agriculture, and using biochar to enhance soil and vegetation.

The Downstream Casino Resort resides along the tri-state marker of Oklahoma, Kansas, and Missouri. Photo courtesy of Quapaw Nation.

The Quapaw Nation's ultimate goals are to not only plan for future risks and mitigate them to the greatest extent possible, but also to become as self-sustainable as we can. Our efforts on self-sustainability have ramped up in the last 10 years and include raising and processing our own meat to supply food for Tribal members, youth in their educational centers, and those who eat at the casinos; raising bees and harvesting the honey to be used in menu items in the casinos as well as selling the honey locally, which has the added benefit of aiding those in the area

with allergies; processing and roasting our own coffee; brewing our own beer (another use for the local honey!); and simply utilizing as much of our local products, materials, and plans as possible.

Climate change is a risk multiplier, so framing emergency management planning with the anticipated—albeit unpredictable—impacts at the forefront is one of the keys to our resiliency.

Standing Rock Sioux and Emergency Preparedness

Written by: Doug Crow Ghost from the Standing Rock Sioux Tribe, Great Plains Water Alliance

As the Water Administrator for the Standing Rock Sioux Tribe, I wear a lot of hats. A big focus of the Water Administrator's office is to review, issue, and monitor water permits. We review water projects, maintain fluidity, and ensure that the reservation has water to meet the needs of the people. I'm also the Chairman of the Great Plains Tribal Water Alliance and the liaison between the Army Corps of Engineers and the Standing Rock Sioux Tribe to deal with impacts of the dams and other projects throughout the region. This means that much of my time in the past several years has been fighting the Dakota Access Pipeline and also the Keystone XL Pipeline. Dealing with the Corps is a full-time job, since everything they do impacts our lands and our resources. As water levels fluctuate, we see erosion of cultural sites, especially burial sites in the riparian areas that were flooded or impacted during the Sloan-Pick Plan. Permitting of pipelines by the Corps directly impacts our sovereignty, our safety, and our health, since an oil spill would be disastrous for our communities.

Now, as we experience climate change, we're seeing dryness across the landscape and big changes in the normal water cycle, which in turns affects wildlife migrations, sacred plants, and culturally significant species across the area. This is impacting cultural activities for our Tribal members, since these resources are more difficult to find and less abundant than ever before. Climate change is impacting our water tables and our surface water availability and is creating added challenges in working with the Corps. For example, during the Bomb Cyclone in 2019, they couldn't manage the amount of water coming through the system and ended up flooding several Tribal Nations, including Cheyenne River and Pine Ridge. We are also seeing increasing uncertainty for how pipelines will function in a changing climate. The dryness of the soils and the extreme weather we get mean that pipelines have increased friction and instability and are more likely to burst. This is why it's so important that we continue to fight pipelines and assert our sovereignty over our resources.

Added to all these challenges are things like the current COVID-19 pandemic. Fortunately, here at Standing Rock we haven't had any serious outbreaks, but we are remaining vigilant. We do regular testing, and we have plans in place to deal with these situations. In fact, we modelled our COVID Response Plan off our emergency response plan that was put in place several years ago to deal with a disaster such as a flu epidemic or even a train derailment. I'm part of the incident command team, and I'm currently the acting commander, since I have disaster training and experience from my time in the military. So now we are dealing with responding to a pandemic, fighting pipelines, dealing with the Corps, and trying to plan ahead for the impacts of climate change. As you can imagine, we're pretty busy these days.

Santee Sioux Nation and the Flooding of 2019

Written by: Paige Hingst from the Santee Sioux Nation

The Santee Sioux Nation reservation sits in a beautiful area of northeast Nebraska along the Missouri River. The Village of Santee is the focal point of the reservation, housing Tribal Headquarters and administration buildings. Roughly 1,000 members live on the reservation, with 333 members living directly in Santee.

In early March of 2019, a bomb cyclone hit northeast Nebraska, raising temperatures to 60 degrees Fahrenheit and dumping 1.5 inches of rain. The quickly melting snow and the inability of the frozen ground to absorb the precipitation led to unprecedented runoff into local streams and rivers. Many of the rivers were still frozen over with a thick layer of ice that was broken up and dislodged by the powerful flow of water, thus creating massive chunks of ice that traveled downstream, taking out anything in their path.

Trooper Viterna #480 standing next to ice chunks from the Niobrara River that were left behind after causing all kinds of damage.

Santee was not spared from the destruction of this flood. Five power lines were toppled by floodwaters and ice, leaving the community without power for six days. In addition, damage to the town's main water line caused a break that left the village without water for several days. Several families and elderly citizens had to be evacuated to the casino. The Tribe would eventually shut down to deal with the destruction of the flooding.

All services that the Tribe would usually provide had to be put on halt. For eight days, no waste collection services were available. Roads and bridges were flooded, damaged, or completely destroyed, limiting access to residential and business locations that relied on this service.

Highway 12 at the western edge of the Santee Sioux Reservation. Road completely destroyed by the flooding of 2019.

Not only did the Tribe have to deal with the catch up of day-to-day waste collection, they then had to deal with the debris left over from the flooding. According to studies regarding waste management during floods, two to three times more waste is generated and collected after floods than during normal operations. This can be very overwhelming

for a small Tribe that only employs two full-time waste collectors.

With resources being limited, this historic flooding caused major issues for the Tribe. It took several months after the flood to assess damage, clear debris, and clean inundated homes of flooded materials. The high-water table led to wastewater backing up in 13 homes, causing a lot of damage and increasing solid waste materials that needed to be disposed of. With only two employed waste collectors, the collection, transportation and disposal of waste was severely hindered. Tribal members had to wait weeks or even months before their waste was collected due to damaged roads and bridges.

After months and months of assessments, cleanups, and debris clearing, the Tribe finally was able to move on from the flooding. The Tribe is currently working on a Climate Adaptation Plan and hopefully will have something in place by 2021. But how does one prepare for a disaster like this when it was so unexpected, especially when it comes to solid waste management? When roads and bridges are damaged, access is limited to certain areas of a reservation. For Tribes, flooding can have severe impacts to their economy, infrastructure, culture, and environment.

March 14, 2019. Highway 12. About ½ mile is the turnoff to go to Santee. Access was completely blocked by large chunks of ice and floodwaters. The white house in the picture belongs to the Santee Sioux Nation Land Manager. He lost everything in this flood.

Over the last century, Nebraska has seen an increase in annual precipitation totals of about an inch (Shulski & Williams, n.d.). This increase is due to more precipitation in the spring. Future modeling projections show a general wetting trend, with changes in timing and intensity. By mid-century, winter and spring will be 15–25% wetter, summer will be 5–15% drier, and fall will be 5% wetter. Heavy precipitation events along with multiday precipitation events will increase by 25% by mid-century. This shows a need for stormwater management and flood planning and response. We anticipate that climate change will continue to intensify storms and flooding events. But the Santee Sioux Nation is resilient and will continue to find ways to prepare for this, and other, climate related emergencies.

Emergency Management

Key Messages

- It is estimated that currently less than 25% of all Tribal nations have an Office of Emergency Management, and less than 10% of those have full-time emergency managers. Without a Tribal emergency management program, it is deeply challenging to implement and adhere to a number of federal mandates and policies.
- Native Americans have a long and varied history of storytelling and culturally unique ways of communicating with one another and with other communities. When seeking to communicate with Tribes, this rich tradition of storytelling and oral histories should be incorporated.
- Barriers such as a lack of effective leadership at state and federal levels of government have prevented Tribal emergency management programs from making greater progress on responding to and mitigating climate-driven hazards.

Recommendation

Increase resources and support at the state and federal levels to develop Tribal emergency management programs across Tribal nations. Increase coordination with Tribal nations to respond to and prepare for climate-driven hazards.

This chapter explores the relationship between climate change and that of emergency management by looking at the history of emergency management and then addressing the evolution of Tribal emergency management programs. The last part of this chapter will cover the intersection of these two realms, with specific examples of the impacts of climate change in American Indian and Alaska Native (AI/AN) lands.

The History of Federal Emergency Management

On March 31, 1979, President Jimmy Carter signed Executive Order 12127, creating the Federal Emergency Management Agency (FEMA). FEMA coordinates the federal government's role in preparing for, preventing, mitigating against, responding to, and recovering from all domestic disasters, whether natural or manmade, including acts of terror (FEMA, 2020a). FEMA is relatively young, celebrating its 42nd anniversary this year. Tribal nations, on the other hand, as Indigenous residents of the regions, have been practicing emergency management since time immemorial.

The Importance of Storytelling in Tribal Emergency Management

In research conducted by the Pacific Northwest Seismic Network (PNSN), scientific recognition of the earthquake hazards presented by the Cascadia Subduction Zone (CSZ) is relatively recent. Yet Native Americans have been aware of this fault for centuries, as the Native populations have lived on the Cascadia coast for thousands of years, transferring knowledge from generation to generation through storytelling (Ludwin et al., 2005).

In 2007, the United States Geological Survey (USGS) identified a massive earthquake that spawned a huge tsunami that occurred in 1700 (Satake & Atwater, 2007). Across the ocean, Japanese seismologists

documented a tsunami in 1700 without any accompanying earthquake. Modern seismologists have attributed this tsunami to a 9.0 earthquake generated by the Juan de Fuca plate. This occurrence has long been documented by Indigenous peoples of the Pacific Northwest (PNW) in traditional stories passed down through the generations.

In a peer-reviewed paper, seismologists emphasized the probability that the Cascadia Subduction Zone would yield tremendous earthquakes (Heaton & Kanamori, 1984). Heaton followed this paper with another about PNW Native American stories that inferred their people were impacted by tsunamis in the past. In the 1990s, a PNSN research scientist began collecting and organizing other Native American stories and traditions that seemed to be related to earthquakes and their effects on the people of Cascadia before westerners arrived (Pacific Northwest Seismic Network, 2019). Native traditions tell of shaking and flooding along the Cascadia coast and estimate the date and time of day of the last earthquake by using stories that count the number of generations since its occurrence. These stories are common among the Native people in the Pacific Northwest. The Tribal elders tell the stories:

"The tide came in but never left. There was a whale in the river, and the people couldn't figure out how it got there." Makah Elder Helma Ward (Paulson, 2002)

The Hoh and Quileute Tribes tell the story of a thunderbird–whale battle that caused the "trembling of the earth beneath and a rolling up of the great waters." The Makah talk of canoes in trees, homes destroyed, and lives lost (People—Run to High Ground, 2018). The Tribal elders related more recent stories of standing in the waters off the Washington coast fishing and watching the waters recede quickly, exposing their nets on dry land, followed by the quick return of the waters, strong enough to knock them over. These stories led to the subsequent correlation of an earthquake off the coast of Japan with the tsunami-like activity off the Washington coast (Zambrano et al., 2019). These stories are not unique to the Pacific Northwest. A collection of stories by Dr. Betty Mae Jumper, a legendary storyteller of the Seminoles of Florida, includes the story of the little frog that tells us to pay attention to the frogs singing, as a warning that the rains are coming soon (Jumper et al., 1994; Seminole Tribe of Florida, n.d.). Recently, Inuit Elders, of the Canadian Arctic, Greenland, Siberia, and Alaska, have told NASA that the Earth's axis has shifted (Dagan, 2015).

Native Americans have a long and varied history of storytelling and culturally unique ways of communicating with one another and with other communities. When seeking to communicate with Tribes, this rich tradition of storytelling and oral histories should be incorporated (NCAI & Pyramid, n.d.). Research has been conducted to examine the way Tribes communicate; the work has been done to collect these stories, and yet not enough has been done to share and incorporate these important findings. There remains a strong disconnect between the way the federal government continues to communicate with the Tribes. While FEMA has improved its Tribal curriculum to include some story telling, it continues to focus on PowerPoint and the loading dock methodology, which is often foreign to Indigenous education. The development of Tribal emergency management curriculum that incorporates storytelling as a means of communicating with Tribes could help the Tribal emergency management and higher education communities bridge this gap.

The Current Environment of Tribal Emergency Management

As of the date of the issuance of this report, the FEMA website does not acknowledge Tribal emergency management agencies in its database (FEMA, 2020b). The closest database that could be found that reflects the number of Tribal emergency management agencies was located at the National Tribal Emergency Management Council's website and is reflective of only those agencies that self-report or are publicly listed for information sharing (NTEMC, 2011). It is estimated at this time that less than 25% of all Tribal nations have an Office of Emergency Management, and less than 10% of those have full-time emergency managers (Zambrano et al., 2019).

Without a Tribal emergency management program, it is impossible to implement and adhere to a number of federal mandates and policies imposed upon the Tribal nations, such as National Incident Management System (NIMS) compliance, mandatory hazard mitigation plans (HMPs) to receive hazard mitigation funding, and the important work that must be conducted to address climate change. If found noncompliant, Tribal nations are susceptible to a loss of funding or ineligible to apply for a disaster declaration.

The Context of Emergency Management Related to Climate Change

To understand the intersection of climate change and Tribal emergency management in the U.S., it's critical to understand the context. This includes understanding the organizational structure of FEMA within the Department of Homeland Security as well as the National Response Framework (NRF) (2019), which dictates how FEMA operates (see Figure 14). Under the existing paradigm, FEMA and the NRF are necessary for effective Tribal emergency management and are increasingly relevant for addressing climate change impacts. It's been shown that climate change is exacerbating natural hazards, including the frequency, intensity, and severity of events such as coastal and riverine flooding, heat waves, wildfire, and hurricanes (Abatzoglou & Williams, 2016; Emmanuel, 2017; Walsh et al., 2018).

The NRF provides foundational emergency management doctrine for how the federal government responds to all types of incidents. The NRF is built on scalable, flexible, and adaptable concepts identified in the NIMS to align key roles and responsibilities across the U.S. The structures, roles, and responsibilities described in this framework can be partially or fully implemented in the context of a threat or hazard, in anticipation of a significant event, or in response to an incident. Implementation of the structures and procedures described herein allows for a scaled response, delivery of specific resources and capabilities, and a level of coordination appropriate to each incident (Department of Homeland Security, 2019).

The NRF also advances progress under the National Security Strategy of the United States of America. The framework helps achieve the strategy's first pillar: to "protect the American people, the homeland, and the American way of life." To accomplish this goal, the strategy calls for initiatives to strengthen the United States' ability to withstand and recover rapidly from attacks and natural disasters (President of the United States of America, 2017).

The NRF is a framework for all types of threats and hazards, ranging from accidents, technological hazards, natural hazards, and human-caused incidents. This framework is utilized to implement NIMS and describes whole community coordinating structures and response activities. The framework outlines government, private sector, and nongovernmental roles to reinforce the National Response Framework for collaborative incident response (Department of Homeland Security, 2019).

In the NRF, the term "incident" includes any occurrence, natural or manmade, that necessitates a response to protect life or property and includes planned events as well as emergencies or disasters of all kinds and sizes. The NRF's structures and procedures address how federal departments and agencies coordinate support for local, state, Tribal, territorial, and insular area governments and how governments at all levels work in unity with private sector and NGOs (Department of Homeland Security, 2019).

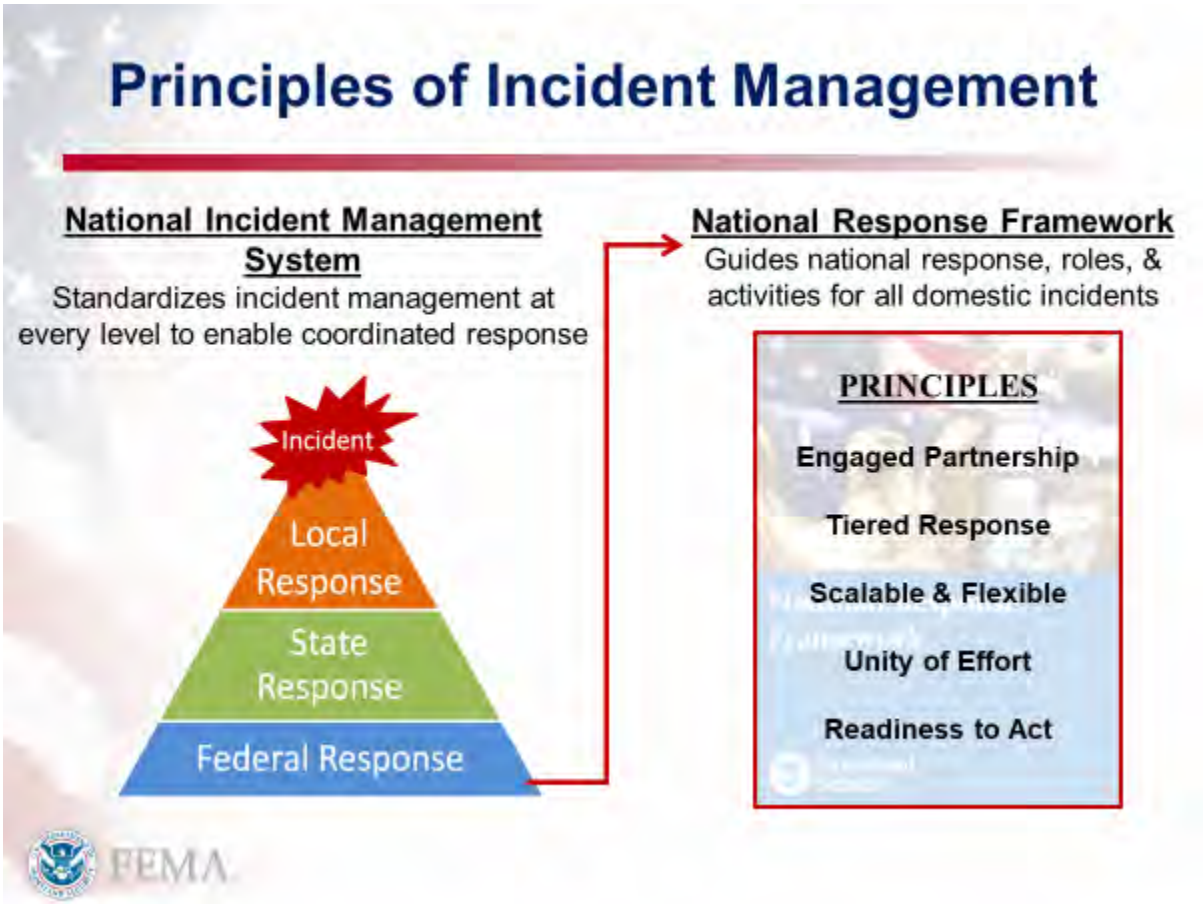

Figure 14. The Principles of Incident Management under FEMA and how the National Incident Management System operates under the National Response Framework. The principles and the framework are increasingly important as climate change is exacerbating hazards and increasing the scope of Tribal emergency management.

Tribal Managed Response

The United States has a trust responsibility with federally recognized Indian Tribes and recognizes their right to self-government. This trust doctrine requires the federal government to protect Tribal treaty rights, lands, assets, and resources while providing support through statutory authority and other

programs. Under the Stafford Act (1988), federally recognized Indian Tribes may directly request their own emergency and major disaster declarations, or they may request assistance under a state request. In addition, federally recognized Indian Tribes can request federal assistance for incidents that impact the Tribe but do not result in a Stafford Act declaration. Given their unique position, Tribal governments often have planning and response requirements that are the equivalent to state and local operational coordination during an incident. For example, there are 21 healthcare coalitions that are multiagency coordination groups (MACS) that integrate member organizations with the jurisdictional agencies in the geographic areas in which they operate. Healthcare coalitions are invaluable as public–private partnerships integrating healthcare facilities with emergency medical services, public health, and emergency management. Many Tribal nations have developed coalitions with groups of Tribal governments for the purposes of pursuing funding opportunities, addressing federal government mandates, and addressing emergency management, including the impacts of climate change. One of the largest coalitions conducting this type of work today is the National Tribal Emergency Management Council (NTEMC).

Tribal coordinating structures vary depending on a variety of factors, such as individual Tribal capabilities, population size, and economic circumstances. Tribal nations may have internal coordinating structures and facilities for incident response as well as others that include bordering states and neighboring jurisdictions.

Emergency support functions (ESFs) are included within the National Response Framework to "describe federal coordinating structures that group resources and capabilities into functional areas most frequently needed in a national response" (FEMA, 2020c). ESFs cover 15 different areas of emergency management, including transportation, communications, information and planning, search and rescue, and more. It is important to understand the ESF structure because climate change has a unique impact on each and every one of them. (See Table 3.)

A Tribal Nation's Work on Climate Change Looking through the Lens of ESFs

Over the past decade, for example, the Swinomish Indian Tribal Community has been addressing the impacts of climate change on ESF #8, Public Health and Medical Services. In 2008, the Tribe received a two-year grant from the U.S. Department of Health and Human Services, Administration for Native Americans. In year one, the Tribe conducted an impact assessment, outreach, and strategy (Swinomish, 2009). In year two, the Tribe developed recommendations and an action plan (Swinomish, 2010).

The Tribe reviewed climate data and conducted broad impact analysis, risk-zone mapping, inventory of at-risk assets, and vulnerability and risk analysis. As this work unfolded, the Tribe found the data pointing to direct health impacts caused by increasing wildland fires (ESF #4: Firefighting), which have been exacerbated by climate change. The Tribe chose to produce an impact assessment regarding wildfire risk zones on the reservation (Swinomish, 2009).

Emergency Support Functions (ESF)	Description
1. Transportation	Coordinate the opening of roads and manage aviation airspace for access to health and medical facilities or services.
2. Communications	Provide and enable contingency communications required at health and medical facilities.
3. Public Works & Engineering	Install generators and provide other temporary emergency power sources for health and medical facilities.
4. Firefighting	Coordinates federal firefighting activities and supports resource requests for public health and medical facilities and teams.
5. Information & Planning	Develop coordinated interagency crisis action plans addressing health and medical issues.
6. Mass Care, Emergency Assistance, Temporary Housing, & Human Assistance	Integrate voluntary agency and other partner support, including other federal agencies and the private sector, to resource health and medical services and supplies.
7. Logistics	Provide logistics support for moving meals, water, or other commodities.
8. Public Health & Medical Services	Provide health and medical support to communities, and coordinate across capabilities of partner agencies.
9. Search & Rescue	Conduct initial health and medical needs assessments.
10. Oil & Hazardous Materials Response	Monitor air quality near health and medical facilities in close proximity to the incident area.
11. Agriculture & Natural Resources	Coordinate with health and medical entities to address incidents of zoonotic disease.
12. Energy	Coordinate power restoration efforts for health and medical facilities or power-dependent medical populations.
13. Public Safety & Security	Provide public safety needed security at health and medical facilities or mobile teams delivering services.
14. Cross-Sector Business & Security	Be informed of and assess cascading impacts of health or medical infrastructure or service disruptions, and deconflict or prioritize cross-sector requirements.
15. External Affairs	Conduct public messaging on the status of available health and medical services or public health risks.

Table 3. Emergency Support Functions and Descriptions

Examination of these data revealed that impacts on human health from climate change included heat-related illness (exhaustion, stroke), respiratory problems (asthma, air quality), opportunistic viruses (West Nile, flu), emerging health threats (fungal), and toxins/pollutants (food, air, water). All of these dramatically impact Swinomish Tribal traditions and culture, including but not limited to beach seining, fishing, native plants harvesting, shellfish harvesting, and cultural sites (Swinomish, 2009, 2010).

The Swinomish Tribe determined that there were several major challenges in responding to climate change that have become focal points for implementing their action plan:

- Many disciplines and many moving parts
- Data uncertainties and gaps
- Complex issues and changing circumstances
- Public perceptions and communication
- Funding opportunities, sources, and availability
- Long, indefinite timeframes for impacts

Climate Change and Tribal Lands

Tribal nations have been cognizant of human-caused climate change for several decades. However, many barriers have prevented Tribal emergency management programs from making greater progress to address climate impacts. Chief among these barriers is the lack of resources and support at various levels of government, especially at the federal level from 2016–2020. The lack of leadership at the federal level led to minimal coordination at multiple levels of government, including local, state, federal, and Tribal. Due to this lack of leadership and coordination, Tribal nations are seeing increasingly severe impacts related to emergency management, including coastal erosion and flooding, wildfires, and extreme weather events.

Alaska is often considered ground zero for climate change in the U.S., and the implications for emergency management are stark. Thawing permafrost, shifting animal migrations, melting glaciers, eroding coastlines, increasing wildfires, and many other impacts are making it increasingly challenging to address emergency management in Alaska Native communities (Zielinksi, 2015). For example, the impacts of the encroaching Bering Sea on many villages are of utmost concern for human life and safety. The photo below of Kivalina shows the community's threatened coastline and efforts to address this issue through shoreline protection. In many cases, the only means of transportation in and out of rural Alaska Native villages is in jeopardy, as damage to critical infrastructure such as airport runways are eroding or are being swallowed by the rising seas. Homes, community buildings, and other critical infrastructure are severely at risk from climate-related impacts in rural Alaska, making emergency management a key department in the effort to address climate change (Bronen & Chapin, 2013; USACE, 2009).

The picture above shows the community of Kivalina, located on the coast of northwest Alaska. The shoreline armoring in the foreground is evidence of extensive efforts to reduce erosion and protect the community from further impacts. Credit: ShoreZone Survey

Wildland Fires in the West

In the past two decades, many Western states have had their hottest summers on record, including the warmest August on record in 2016 (NOAA, 2020). In 2016, snow levels were well below average and snowmelt in the mountains occurred much earlier, leading to the largest decline in end-of-season snow water equivalent since 1980 (Easterling et al., 2017; Hayhoe et al., 2018). In 2015, millions of trees had died in California alone, pushed beyond repair by the record-breaking temperatures and dryness, which reached so far into the soil that even deep-rooted trees could not find moisture. By the next year, the mortality count soared to 100 million (USDA-FS, 2016). High elevations saw nearly 80% tree mortality with 150 million trees dead since the drought's onset (Cal Fire & USDA-FS, 2019). Similar conditions could be found throughout Oregon, Washington, Idaho, and Montana. Higher temperatures and drought continue to increase the frequency of wildland fires (see *Chapter 4: Ecosystems & Biodiversity* for more).

Climate change continues to create exceedingly dry trees and vegetation, fueling some of the largest and most intense wildland fires in recent history (Inciweb, 2020a; Inciweb, 2020b). The Confederated Tribes of the Colville Indian Reservation reported consecutive years of Washington state record-breaking wildland fires. In September 2020, the Cold Springs Fire, one of five major fires burning on the reservation simultaneously, grew to 189,923 acres or approximately 296 square miles. On the

reservation, 78 primary structures and 60 secondary structures were lost to the fire (NWPB News, 2020).

In the 2020 fire season, fire radiative power (FRP), defined as the rate of radiant heat emitted by a fire, was measured in the California and Oregon fires. This FRP was reported to be the highest fire intensity in the past 18 years (Borunda, 2020). Across the West, state health departments were overloaded distributing personal protective equipment to residents due to the smoke, contaminants, and poor air quality deemed unsafe to breathe. This was exacerbated by the COVID-19 pandemic, which was already maxing out resources across local, state, and Tribal governments. All of these impacts have serious implications for Tribal emergency management departments directly and indirectly through near-term hazard mitigation, emergency response, and the long-term health and safety of Tribal communities. As multiple emergency incidents are compounded, as they did in 2020, the coordinating structure under NIMS becomes completely compromised, increasing the exposure for at-risk populations.

Extreme Weather in the South

As discussed, extreme weather events are becoming more prevalent, more frequent, and having greater and longer lasting physical, ecological, sociological, cultural, and economic impacts than previously documented (Abatzoglou & Williams, 2018). In the Southeast, many Native American communities have been subject to increasing frequency and severity of hurricanes and flooding events. Recent hurricanes have devastated many parts of the United States, but the U.S. Gulf Coast has been particularly vulnerable to tropical storms and hurricanes. Recent studies have shown that one of the many impacts of climate change on this region has been the greater frequency and intensity of extreme weather events (Carter et al., 2018). In the summer of 2020, the National Weather Service ran out of letters in the alphabet to use for naming Atlantic tropical storms and hurricanes, an event that has only happened once before, in 2005 (Helmore, 2020). The increase in the intensity and frequency of extreme weather exacerbated the ongoing effects of the COVID-19 pandemic, causing tremendous loss of housing, increased homelessness, food insecurity, and economic losses, particularly across minority and Indigenous communities. There remains a strong need for long-term, justice-centered recovery support (Dermansky, 2020; Maldonado & Peterson, 2021). Many southeastern Tribes have been severely impacted by climate change due to the continued colonial-driven injustices, coupled with limited Tribal emergency management programs in this region. Yet Tribal communities are leading actions to protect their lands and lifeways from the rising seas and extreme weather events (Baniewicz, 2020; see also *Chapter 10: Protection-in-Place & Community-Led Relocation*).

In the U.S., Indigenous communities and nations are represented by diverse groups of 574 federally recognized Tribes, 66 state-recognized Tribes, and around 400 Tribes that exist outside either jurisdiction (Government Accountability Office, 2012; National Conference of State Legislatures, 2020). The majority (approximately 80%) of state-recognized Tribes live in the southeastern U.S., with over half of these state-recognized Tribes residing on the Gulf Coast or hurricane-prone areas (McKinley et al., 2019). State-recognized Tribes, as well as unrecognized Tribes, often have decreased access to many resources available to federally recognized Tribes and do not have reservation land (National Conference on State Legislatures, 2016). Federally recognized Tribal members are eligible for healthcare

through Indian Health Service (IHS) as part of the trust responsibility and supported through many treaty agreements, case law, Congressional acts, and executive orders, whereas state and non-federally recognized Tribes do not receive these services.

Indigenous communities in the bayous of Louisiana and the Gulf Coast bear particular risk to hurricanes and tropical storms (McKinley et al., 2019; Soqo, 2020). For example, Isle de Jean Charles Biloxi-Chitimacha-Choctaw Tribe's land area has shrunk by 98% since 1955, forcing many Tribal members to move inland and "causing mass changes to Island life." (See narrative titled *Preserving Our Place: Isle de Jean Charles* in *Chapter 10: Protection-in-Place & Community-Led Relocation*.)

There are limited studies on hurricane impacts on state- and non-federally recognized Indigenous peoples that reside in the southern Gulf Coast region (McKinley et al., 2019). One exception is a study where a group of researchers utilized the Framework of Historical Oppression, Resilience, and Transcendence (FHORT) to examine ways that historical oppression and other factors may further affect the livelihoods of and increase adversity for Indigenous peoples as compared to other ethnic groups of this region. Results from this study showed that because most of the southeastern Tribes are state-recognized or unrecognized, their ability to access emergency funding and other resources following natural hazard and extreme weather events such as flooding and hurricanes is limited, and therefore the overall wellness of these Tribal communities is impacted (McKinley et al., 2019). Despite these barriers, many of the Tribes continue to be leaders in coastal restoration and adaptation efforts (Baniewicz, 2020).

In 2016, Hurricane Matthew brought unprecedented flooding to the Lumbee River basin, home to the state-recognized Lumbee River Indians of present-day North Carolina, and may be a preview of the trend for future hurricanes in the region (Emanuel, 2018). Model projections of the combined forces of future flooding from hurricanes, declining water availability along the Lumbee River, and more frequent and intense droughts in the southeastern U.S. suggest changing conditions never experienced by ancestors of the Lumbee. These climatic changes and the lack of federal resources create numerous barriers for adapting to climate change. Yet the Lumbee are confident that, even in the absence of federal recognition, they can adapt to climate change and other 21st-century challenges by using their Indigenous knowledge and their connection to place (Emanuel, 2018).

Conclusions

Across the United States, Native communities are being disproportionately impacted by climate change due to a legacy of colonization, land theft, and broken treaties. This legacy is perpetuated by policies that create haves and have-nots across Tribal nations based on federal recognition status. Under the current emergency management paradigm, most Tribal nations do not have adequate resources to deal with increasing wildfire and hurricane seasons or the damaging effects of widespread riverine and coastal erosion, among other hazards. Tribal emergency management is embedded under FEMA, which requires working directly with federal, state, and local government before, during, and after times of crisis. Yet the lack of flexibility and direct support across these levels of government creates barriers that prevent Tribal emergency managers from having the resources and capacity they require. Native

peoples have been practicing emergency management and adapting to a changing climate since time immemorial, but under the current paradigm these historical practices and institutions have been altered and destroyed. A new paradigm must be established in which federal and state partners support Tribal nations through an increase in resources, improved coordination across all levels of government, and respecting Tribal sovereignty. This will benefit Native and non-Native communities alike, and, importantly, it will empower Tribal nations to continue their deep connection to the land.

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Chapter 10: Protection-in-Place & Community-Led Relocation

Climate change is forcing Tribes to pursue protection-in-place and community-led relocation. The narratives that follow reflect the difficulties faced by communities, the strategies being implemented, and the resilience of affected Tribes. The Isle de Jean Charles Biloxi-Chitimacha-Choctaw Tribe of Louisiana has developed a Tribal Resettlement Plan with the vision of their Tribal resettlement acting as a living and active bridge to their ancestral Island, and the Yup'ik people of Kotlik, Alaska, are in the process of a community relocation due to the lack of sea ice no longer protecting their coast from sea surges. A researched overview of Protection-in-Place & Community-Led Relocation as they relate to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendations that the authors have identified.

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Adapted from "Preserving Our Place: Isle de Jean Charles" (Originally published in The Nonprofit Quarterly, 19 October, 2020[47])

Written by: Chantel Comardelle

Isle de Jean Charles is a small ridge of land in southern Terrebonne Parish, Louisiana. "The Island" is home to the Isle de Jean Charles (IDJC) Biloxi-Chitimacha-Choctaw Tribe of Louisiana. The IDJC Tribe settled the Island in the early 1800s, having been pushed into "uninhabitable" lands by European settler colonialism, slavery, and social inequality.[48]

The IDJC Tribe adapted to the changes of living on a secluded island accessible only by boat,[49] living solely off the land and surrounding waters. Soon after settling, the Tribe began farming rice and corn and raising cattle to provide for their families. The Tribal children were denied public education until 1952. In

[47] Preserving Our Place: Isle de Jean Charles: https://nonprofitquarterly.org/preserving-our-place-isle-de-jean-charles/

[48] "The Island," Bienvenue, Halito, Welcome to Isle de Jean Charles, accessed August 17, 2020, www.isledejeancharles.com/island.

[49] "Isle de Jean Charles wasn't always an island. Residents who didn't want to row a pirogue—a flat-bottomed canoe—across the water to nearby town Pointe Aux Chênes could take the wagon trail through the marsh if the tide wasn't high," from Yawn, A.J. (2020, March 3). "As Gulf swallows Louisiana island, displaced tribe fears the future." The American South.

the 1930s, a missionary school was developed on the mainland, in Pointe-aux-Chênes, to which the children went by pirogue; and in the 1940s the Baptist Mission built a church on the Island, which was used as a school.[50]

Island Road August 2020 one day after Hurricane Laura. Photo: Chantel Comardelle

The "Island Road" connecting the Island to Pointe-aux-Chênes was built in 1953, opening the IDJC Tribe to a new world. Crossing the marshland, and wide open to erosion and flooding, this narrow roadway is considered to be both vulnerable and to have added to the Island's erosion[51]. Since 1955, the Island has experienced a 98 percent erosion rate, causing mass changes to Island life. Family homes have flooded and been destroyed by hurricanes.[52] In 2011, the road underwent restoration and elevation; the Tribe was told this would be the final fix. Since 2017, the road has regularly flooded due to the increasingly extreme weather patterns.[53]

The IDJC Tribe has enjoyed generations of bountiful provision from the Island from seafood, agriculture, livestock, and trapping, and the Island has been rich in Native traditions and culture. But our Island is now unable to sustain life fully for our entire IDJC Tribe because of climate change-induced sea level rise, environmental disasters, and subsidence due to levees on the Mississippi River.[54]

The IDJC Tribe has slowly begun to leave the Island due to loss of houses, loss of work, and repeated flooding, starting with Hurricane Carmen in 1974.[55] With each storm, more families have left. Hurricane Lili, in 2002, brought the greatest loss—over fifty families, due to severe flooding and damage.[56] As a result, we are separated, displaced, and losing the ways in which we transfer our knowledge.

Grandparents and Elders are not spending daily time with the children. Younger families are choosing to move off the Island for sustainability. We are losing our survival skills, our sustainable ways of living with and off the land and marsh. The fisheries are not producing the same quality and quantity of catch as decades before. Marsh grasses are dying, and the estuaries are becoming more salt based. Additionally, crude oil from the 2010 Deepwater Horizon Oil spill disgorged into our marsh, closing off our traditional fishing grounds and forcing young folks to change careers in order to provide for their families.[57]

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[50] See "Education," www.isledejeancharles.com/island.
[51] See "The Road," www.isledejeancharles.com/island.
[52] Robynne Boyd, "The People of the Isle de Jean Charles Are Louisiana's First Climate Refugees—but They Won't Be the Last," Natural Resources Defense Council (NRDC), September 23, 2019.
[53] "The Road," www.isledejeancharles.com/island.
[54] "Land Loss," Restore the Mississippi River Delta, accessed August 21, 2020.
[55] Boyd, "The People of the Isle de Jean Charles Are Louisiana's First Climate Refugees."
[56] Yawn, "As Gulf swallows Louisiana island, displaced tribe fears the future."
[57] Chelsea Harvey, "The gulf oil spill literally caused wetlands to sink beneath the waves, scientists say," *Washington Post*, November 21, 2016.

The crafts, traditions, and how we live together with what is around us are disappearing. Basket weaving, which has been a strong connection to our ancestors, is declining—only a handful of Elders are still able to engage in the craft. Our lifeways that make the IDJC Tribe who we are have been cut off. Our younger generations are no longer here to learn from the Elders. The slow exodus of people forced to leave has caused a rift blocking our natural flow of history and cultural transfer.[58]

Aerial image of Isle de Jean Charles 2018. Photo: Isle de Jean Charles Biloxi Chitimacha Choctaw Tribe

We have long held hopes of reuniting our IDJC Tribe in a safe, sustainable, new community, and putting our traditions and culture back together. In 2000, and then in 2002, Tribal council members advocated for the U.S. Army Corp of Engineers and local government officials to help our Tribe overcome the changes. Attempts to help our Tribal citizens move were stalled, due to outside forces and social injustice;[59] but continued planning for resettlement and to reunite the Tribe proved to be helpful when the state of Louisiana applied for the Housing and Urban Development (HUD) National Disaster Resilience Grant in 2015, which included our Tribal Resettlement plan, and then when the state of Louisiana was awarded a grant of $48 million in 2016 to build our envisioned resettlement.[60] We envision our Tribal resettlement as a living and active bridge to our ancestral Island. Our relationships, ways of life, and identity will be supported by a community center, a museum, and gatherings on acreage inland—all toward the entire Tribe moving back together.[61]

But that hope to breathe Spirit into our Tribe has dwindled due to the state of Louisiana's slow response and improper execution of the HUD National Disaster Resilience Grant. In the last significant amendment,[62] the state made it clear that the IDJC Tribe was no longer a beneficiary of nor involved in the grant process.[63]

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[58] For more on the history of Isle de Jean Charles, see Andrew Yawn, "Why is Isle de Jean Charles disappearing? A timeline of land loss," The American South, *Daily Advertiser*, updated March 1, 2020.

[59] The community the Tribe was looking to move into protested the development. See "Terrebonne officials visit Isle de Jean Charles," *Houma Today*, October 19, 2009; and Charquia Wright, "Unmasking Western Science: Challenging the Army Corps of Engineer's Rejection of the Isle de Jean Charles Tribal Environmental Knowledge under APA Arbitrary and Capricious Review," *UCLA Law Review*, March 26, 2020.

[60] Coral Davenport and Campbell Robertson, "Resettling the First American 'Climate Refugees,'" New York Times, May 2, 2016.

[61] See "Tribal Resettlement," accessed August 21, 2020.

[62] Louisiana Office of Community Development—Disaster Recovery Unit, *State of Louisiana Substantial Amendment No. 5: Introduction of New Activities and Project Narrative Clarifications for the Utilization of Community Development Block Grant Funds Under the National Disaster Resilience Competition (NDRC) Resettlement of Isle de Jean Charles*, Disaster Recovery Initiative, U.S. Department of Housing and Urban Development, submitted to HUD: April 23, 2019.

[63] "[T]he planned resettlement of Louisiana's Isle de Jean Charles Biloxi-Chitimacha-Choctaw Tribe, whose ancestral island has nearly disappeared, has been mired in a conflict over tribal sovereignty. The tribe's leaders say they're not being treated as co-collaborators—in fact, they learned about the state's purchase of land for resettlement by reading a press release. State officials say they have tried to work with those leaders but are 'not in a legal position' to acknowledge the sovereignty of a tribe that is not federally recognized" (Barry Yeoman, "As Sea Level Rise Threatens Their Ancestral Village, a Louisiana Tribe Fights to Stay Put," Natural Resources Defense

Isle de Jean Charles 2018. Photo: Isle de Jean Charles Biloxi Chitimacha Choctaw Tribe

The grant did not turn out to be the catalyst for recreating the self-sustaining society we once loved, but we remain committed to our vision. The Tribe has invested in "Preserving Our Place," a movement to preserve the Island and the IDJC Tribe's long legacy of traditions, culture, and history.[64] In November 2019, the IDJC Tribal Council approved the first Tribal Museum Policy. The establishment of our own Tribal Museum and Culture Center, the first step to realizing our goals, has many moving parts. Community gardens, storytelling activities, craft demonstrations, and historical exhibits are just the tip of the iceberg.

The effort to ensure that the Island does not erode and the IDJC Tribe does not erode along with it is the most important piece of this puzzle. For a displaced, impoverished, and marginalized community, the means to undertake such a task are minimal.

In order to fully accomplish our goal, we, the people of the Tribe, the community, and the country, must ensure that the communities facing climate migration and resettlement are fully resourced. Communities dealing with these grave climate conditions need everyone to rally behind their vision to ensure the preservation of their place and come alongside them in solidarity. The solidarity should include everyone, from the federal government to philanthropy. The Government Accountability Office issued a report in July 2020, stating, "We recommended Congress consider establishing a federally-led pilot program to help communities interested in relocation."[65] The report clearly states that there are many complex problems with the current resettlement plan.

For more information on the Isle de Jean Charles Tribe and other communities, follow our story on www.isledejeancharles.com and on our Facebook page.

Resilience in Kotlik, Alaska

Written by: Philomena Keyes, Tribal Resilience Coordinator – Village of Kotlik

Adapting to climate change along with intensive development pressures on our coasts will be an ongoing challenge into the future. The intensifying impacts of climate change are already leading to changes in our coastal environments. People within our coastal communities will need to become more aware of climate change effects and either accept the changes and live with them or start adapting their

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Council [NRDC], April 13, 2020). And see Julie Dermansky, "Isle de Jean Charles Tribe Turns Down Funds to Relocate First U.S. 'Climate Refugees' as Louisiana Buys Land Anyway," *DeSmog* (blog), January 11, 2019; and Julie Dermansky, "Critics Say Louisiana 'Highjacked' Climate Resettlement Plan for Isle de Jean Charles Tribe," DeSmog (blog), April 20, 2019.

[64] "Preserving Our Place" (project and website page in process), accessed August 21, 2020.

[65] "CLIMATE CHANGE: A Climate Migration Pilot Program Could Enhance the Nation's Resilience and Reduce Federal Fiscal Exposure," U.S. Government Accountability Office, July 6, 2020, gao.gov/products/GAO-20-488.

communities so that they become more resilient to the impacts of climate change that we are already experiencing.

2013 fall storm flooding.

There are clearly benefits from increasing people's awareness of climate change impacts and acting now to adapt and provide for a more resilient community in the future.

Climate change already affects the lives and culture of our Yup'ik people who depend on traditional ways of acquiring and storing their food. It is the most pressing environmental issue of our time, affecting all regions, nations, Tribes, and both current and future generations. Without cold, the ice on rivers and coastlines is thinner and travel becomes dangerous, making hunting, fishing, and other activities more challenging, and this can lead to loss of life and infrastructure. Much of the landscape of southwestern coastal Alaska is tundra, which is becoming unstable. There are no large trees that can be used as a lumber source for new homes or buildings, and there is limited or no gravel for foundations and roads. Most building materials must be shipped in seasonally.

The lack of sea ice worries community members during the winter storm and flood season because that is what protects us from chunks of ice flowing into the Kotlik River. The river is open longer, and the ice is thinner and less stable. Structures and homes are now a few feet from the riverbank. Outbuildings and sheds, food storage areas, drying racks, smokehouses, the AC Retail Store, utility poles, personal homes, and public buildings are all threatened.

In 2013, a particularly strong storm surge flooded the Kotlik slough, causing severe damage when ice chunks were shoved up the banks. The surge and ice chunks destroyed the water and sewer facilities, damaged homes and buildings, and destroyed the boardwalk through the village. The main sewage-discharge line was damaged, and for a long-time residents had to use "honey buckets," which are 5-gallon pails lined with garbage bags, for toilets. These are difficult to manage and dump. The broken sewage line spilled raw sewage on the ground, and the flood water spread the sewage throughout the community. It has now become typical to have regular coastal flood warnings, with sea levels rising more than 10 feet and storm surges pushing water upriver.

Because of the severity of erosion and the lack of land to construct homes and businesses, the option to relocate the community to a whole new site was taken into consideration by members of Kotlik.

In 2018, a survey on community relocation was conducted by the IGAP Departments from two of the three Tribes in Kotlik. 82% were willing to move to higher grounds, and 61% of the participants were willing to move without utilities. The two relocation sites suggested by the community were Reindeer Camp, located northeast of Kotlik near Coffee Point, and Hamilton, which is located upriver from Kotlik. The majority of the votes went toward Reindeer Camp.

2013 fall storm damage to the community.

The main barrier we face while dealing with the rapidly changing climate in our village is funding. The Village of Kotlik Tribe is coordinating with agencies across the federal government system to ensure that they work together effectively to receive funding and technical assistance for the village. The planning and application process takes up a lot of time. Currently the Kotlik Tribe is completing studies to assess the long-term risks to our current site and the habitability of our two desired relocation sites.

While working on the long-term relocation plan, the Kotlik Tribe decided to migrate high-risk homes to a new subdivision within the village, but the actual project will not be underway until 2022. By then, a few of the threatened homes will definitely either be destroyed or unlivable.

While waiting to move forward with our projects, significant environmental threats can occur. Once homes, sheds, and other property end up in the river, fuel, hazardous material, human waste, snowmobiles, ATVs, and boats could also be released into the river. Exposure of hazardous waste in the river could contaminate drinking water, fish, and birds. Costs from environmental cleanup, medical costs related to injuries or deaths, and costs of residents' relocation could result in much higher costs than avoiding relocation of homes at all.

Home affected by permafrost and erosion and that is a first priority to move away from the riverbank. However, it cannot be moved due to an unstable foundation.

Currently our safety, wellbeing, and future are at stake. If we do not mitigate the impact of climate change and unpredictable storms on our community, we will be forced to leave. With the high demand for assistance from concerned individuals, the Tribe was forced to seek emergency funding in 2019 to elevate and move homes away from the eroding riverbank to protect them in the event of another natural disaster. This project concluded in the fall of 2020.

Protection-in-Place & Community-Led Relocation

Key Messages

- Climate change impacts on infrastructure can be an existential threat to communities and profoundly impacts the health, wellbeing, and safety of residents as well as Tribal lands, territories, and resources.
- Many Tribal communities are pursuing adaptation actions, including protection-in-place, moving infrastructure within or adjacent to the current site, and community-led relocation.
- Lack of funding, agency coordination, local capacity, and technical assistance are the primary barriers to protecting infrastructure.
- Nationwide, at least $6.2 billion is needed over the next 50 years to protect, replace, and move existing Tribal infrastructure (ATNI, 2020; DOI, 2020). This amount includes at least $175 million needed annually nationwide over the next 10 years.
- Due to inequitable regulatory barriers and program design, small Tribal communities are generally disadvantaged or excluded from federal programs relevant to climate adaptation.
- There is an immediate, urgent need for action to support Tribal nations and Indigenous communities on the frontlines of the climate crisis.

Recommendations

- Provide at least $175 million annually for proactive adaptation projects that empower and honor community decision-making, sovereignty, and self-determination, consistent with the federal government's trust and treaty responsibilities. This can be accomplished by dedicating funding to a lead agency and reducing barriers that Tribal communities face in accessing existing programs and resources.
- Create an all-of-government coordination structure to support Tribes in addressing environmental threats.

Flooding in Buckland, Alaska, May 2021. Photo credit: John Jones.

Background

Identification of the Problem

Widespread loss of Tribal infrastructure due to climate change is occurring now. The physical and cultural infrastructure includes, for example, Tribal gathering points and accessways to essential lands, waters, and all living relatives for practicing traditions, cultural practices, hunting, fishing, and other harvesting activities (DLGSC, 2018). Maintenance of these types of infrastructure is critical to public health, livelihoods and economies, community wellbeing, culture, and heritage (ATNI, 2020), especially considering many Indigenous peoples' profound relationship with their homelands. Even if global greenhouse gas emissions are reduced to zero today, impacts will increase in severity due to inertia in the climate system. Current federal programs and policies are ineffective at supporting Tribes with adaptation actions, including protection-in-place, moving a portion of the infrastructure within or adjacent to the current site, and community-led relocation (GAO, 2020; UUSC & Rising Voices-Working Group, 2021). Tribes across the country are leading climate adaptation actions and challenging legal and policy issues (Burkett et al., 2017). There is an immediate, urgent need for action to support Tribal nations and Indigenous communities on the frontlines of the climate crisis and uplift the actions of which they have long been at the forefront.

Tribal nations and Indigenous communities across the U.S. are being forced to involuntarily respond to the impacts of climate change on community infrastructure, livelihoods, and culture (Bennett et al., 2014; GAO, 2020; Jantarasami et al., 2018; Steen-Adams et al., 2020). Impacts such as flooding, erosion, wildfire, permafrost degradation, and decreased access to and abundance of food are compounding long-standing and existing threats, social disparities, and historical traumas and injustices. These impacts, combined with the legacy of settler colonialism and worldview of ecological domination (Whyte, 2018), are harming the interrelated conditions of Indigenous health, food security (Inuit Circumpolar Council Alaska, 2020: 47), language, economies, cultural practices, social networks, and more (ATNI, 2020; Brown et al., 2012). The current laws, regulations, management structures, and bureaucratic systems derived from historical processes of structural violence (IDJC, 2019), the lack of culturally appropriate institutional mechanisms to support adaptation responses, and inequitable adaptation policies magnify Tribal disenfranchisement by disrupting traditional lifeways, livelihoods, communities, cultures, and spiritual connections to place (Lowlander Center, 2015; Maldonado & Peterson, 2018; Marino, 2015, 2018).

The impacts of climate change on Tribal infrastructure are widespread across the U.S. For instance, at least 144 Alaska Native communities face some amount of infrastructure damage from erosion, flooding, and permafrost thaw (UAF et al., 2019). In the Pacific Northwest, due to threats from tsunamis, storm surge, and riverine flooding, the Hoh Tribe, Quileute Tribe, and the Quinault Indian Nation, for example, have been working to move villages and critical community facilities to higher ground for over a decade (Burkett et al., 2017; Papiez, 2009; Quileute Tribe, 2011, 2017; Quinault Indian Nation, 2017, 2019; Sharp, 2019; Smith, 2020; Walker, 2012). In coastal Louisiana, the Isle de Jean Charles—home of the Isle de Jean Charles Biloxi-Chitimacha-Choctaw Indians of Louisiana—has lost 98% of its landmass since 1955 due to rising sea level and erosion, including caused by oil and gas companies dredging canals through marshland (Comardelle, 2020; Lowlander Center, 2015; see narrative titled *Preserving Our Place: Isle de Jean Charles*).

Responses to climate impacts to infrastructure include protection-in-place (e.g., building a seawall, hardening shorelines to reduce erosion, and using sand bags), moving a portion of community infrastructure to an adjacent, safer area that is less vulnerable to climate change impacts, and community-wide relocation to a new site, which is the option of last resort when protection-in-place is no longer feasible (see Figure 15). Tribes continue to face vast unmet infrastructure needs across response strategies, particularly for implementation (there is more support for planning) (ATNI, 2020; GAO, 2009, 2020; House Select Committee, 2020; Steen-Adams et al., 2020).

Figure 15. Common types of solutions to climate impacts to infrastructure in Alaska Native communities. Source: DeLue, M.; Alaska Climate Adaptation Science Center. ANTHC, DCRA, et al., draft report.

As the Intergovernmental Panel on Climate Change (IPCC) and other scientists have affirmed, the Arctic is experiencing rates of warming at least two times as fast as other regions of the globe (Anisimov et al., 2007). With approximately 40% of the total number of Tribes in the political subdivision that makes the U.S. an Arctic state, this should be a substantive cause for concern. In Alaska, over the next 50 years, $4.35 billion will be necessary to protect existing infrastructure in 144 threatened communities (ANTHC, DCRA, et al., draft report). $90–110 million annually is required over the next 10 years. The vast majority of this unmet need is required to implement solutions, such as building sea walls, moving houses, creating new subdivisions, and replacing infrastructure that cannot be moved (ANTHC, DCRA, et al., draft report).

None of the 144 environmentally threatened Alaska Native communities have completed site-specific risk assessments that include climate change. Funding risk assessments for these communities is estimated to cost $32 million and is the highest near-term priority to support adaptation actions from protection-in-place to community-led relocation. These risk assessments should be completed by 2025. Completing risk assessments can effectively address the remaining gaps in our understanding of the threat to Tribal communities.

For Tribes in the contiguous U.S., the total estimated funding needed for infrastructure project implementation and needs assessment is at least $1.9 billion over the next 25 years (ATNI, 2020). This value consists of $462 million for planning and $1.4 billion for implementation. If this value was spread out over 25 years, it would equate to about $75 million per year for the implementation of projects that have already been identified. However, these numbers are significantly underestimated, as infrastructure planning has not been conducted or completed for most Tribes in the lower 48 states. The cost estimates that were documented only included those identified during a limited period of time and only include the physical, tangible impacts (ATNI, 2020).

To date, there has been limited progress to support protection-in-place or community-led relocation actions in the 144 Alaska Native Tribes and communities that the 2019 Denali Commission Statewide Threat Assessment found to be facing some amount of infrastructure damage from erosion, flooding, and permafrost thaw (UAF et al., 2019; see also GAO, 2009). For example, the Traditional Council of Newtok in Alaska has monitored local erosion for decades, leading to initiating a relocation planning process in 1994 (Newtok Planning Group, n.d.; Swan, Naquin, & Tom, 2015). However, it took nearly two decades before the first Newtok residents moved to their new site at Mertarvik (Newtok Planning Group, n.d.). The relocation is still incomplete due, in part, to the challenges of securing funding for infrastructure at the new site (Ristroph, 2017).

Barriers

There are several distinct challenges and barriers faced by environmentally threatened Indigenous peoples and communities across the U.S. regarding unmet human needs and funding access. Presently, there are limited funds and institutional support for community-wide responses, including relocation (GAO, 2020; Maldonado et al., 2013), and no lead entity or overarching structure, resulting in entire relocation processes held up when problems unfold with one agency (GAO, 2009). Comprehensive and coordinated responses are needed to facilitate a clear and organized management plan (UUSC & Rising Voices-Working Group, 2021). Unclear federal leadership, such as no federal agency having the authority to lead federal assistance for climate-driven relocation, inhibits the ability of federal agencies to provide effective assistance to communities (ANTHC, DCRA, et al., draft report ; Bronen & Chapin, 2013; GAO, 2009; GAO, 2020; Herrmann, 2017; Maldonado et al., 2013; Meeker & Kettle, 2019; Newtok Planning Group, 2007; Ristroph, 2019).

> "The three primary challenges and barriers faced by environmentally threatened communities are: (1) Insufficient funding to support all stages needed to address environmental threats; (2) Difficulty navigating the objectives and limitations of the programs and processes to address environmental threats; (3) Coordinating piecemeal funding into a cogent response is slow, exhausting, and ultimately increases the cost of the solution." (ANTHC, DCRA, et al., draft report)

Regulations, requirements, and the design of most federal programs relevant to climate adaptation disadvantage or exclude small Tribal communities (ANTHC, DCRA, et al., draft report). Furthermore, federal programs that can address environmental threats often do so without providing adequate technical support (ANTHC, DCRA, et al., draft report; Steen-Adams et al., 2020).

Recommendations

Alaska Native Tribes

The immediate urgency of the climate crisis and the problems and barriers articulated above calls for urgent solutions. The following recommendations specific to the needs of Alaska Native Tribes were made to the DOI Bureau of Indian Affairs Office of Trust Services Tribal Resilience Program (2020) and are currently being expanded by the State of Alaska and Alaska Tribal Organizations to Alaska Native Tribes with proposed review by representatives of Alaska Native Tribal Government Consortia.

1. **Provide a clear, explicit policy directive to federal agencies to adjust existing programs to better meet the needs of Tribal communities' climate change adaptation efforts**. This includes identifying and eliminating challenges faced by Tribes in accessing agency resources and services.

2. **Provide a single, committed source of funding for environmentally threatened Alaska Native communities.** Piecemealing funding is expensive, slow, and increases the cost of the solution. A lead funding agency that provides adequate technical support would significantly increase the efficiency of federal support for Alaska's threatened communities.

3. **Increase funding to federal programs with a demonstrated track record of success.** In addition to creating a lead funding agency with dedicated funding to address gaps, funding should be continued or increased to federal programs that have proven effective for addressing environmental threats. Examples include the Denali Commission Village Infrastructure Protection Program and the Bureau of Indian Affairs Tribal Climate Resilience Program.

4. **Design programs to be equitable.** Resources should be allocated to communities based on risk, funding should be set aside for small communities, and agencies should identify alternatives to cost-match requirements, including providing 100% federal cost share for Alaska Native communities. The Denali Commission Statewide Threat Assessment Combined Rank can be used as a criterion for risk-based decision-making.

5. **Create an all-of-government coordination framework designed to support Alaska Native Tribes and communities with climate change adaptation.** An all-of-government coordination structure within Alaska is needed to facilitate interagency collaboration, leverage resources, and coordinate expertise across all levels of government, nongovernmental organizations, and the private sector. Such actions should be guided by and done in collaboration with Alaska Native Tribal governments.

American Indian, Alaska Native Tribes, and Indigenous Communities, Including Native Hawaiians and Pacific, Caribbean, and Other Islanders

We also recommend the following that apply more broadly to American Indian, Alaska Native Tribes, and Indigenous communities, including Native Hawaiians and Pacific, Caribbean, and other islanders. Given the global conditions of climate change, these recommendations need to be urgently acted upon:

1. **Uphold the right to proactively adapt, within a sustainable, just, holistic, and transformative human-rights framework.** Indigenous peoples across the U.S. have proactively adapted to their respective environments and ecosystems. They are also experts at sustainable development, and for centuries and millenia they have maintained a holistic worldview, understanding their interrelated place in the natural world. Therefore, proactive planning should be done consistent with the *United Nations Declaration on the Rights of Indigenous Peoples* (United Nations, 2007), which the United States government announced its support of in 2010 (White House, 2010). Such a human-rights framework directly contributes to transformative and just actions in response to the impacts of climate change.

2. **Uphold the federal trust responsibility to Tribes facing protection-in-place and relocation**. The U.S. government has both a trust responsibility and fiduciary obligations to provide support. Ensure that the federal government upholds its trust responsibility to Tribes facing issues related to protection-in-place and relocation through government-to-government relationships and direct consultation. Rather than demanding Tribes conform to agency requirements, these efforts must honor the right of self-determination and sovereignty and be guided by Indigenous

peoples' knowledge and wisdom. Provide resource support for options for Tribes whose rights on existing reservations are threatened by climate change. "The loss of land does not mean the loss of rights. Treaties also include water and hunting rights, not just the land" (RV, 2019; see also House Select Committee, 2020). The process of securing land for community relocation is extremely challenging. Land-exchange programs that can facilitate access to more viable lands could better support communities facing these challenges and uphold the federal trust responsibility (Steen-Adams et al., 2020).

3. **Support community-led and community-wide adaptation that empowers and honors community decision-making, sovereignty, and self-determination** (IDJC, 2019; Lowlander Center, 2015; Maldonado & Peterson, 2018; Steen-Adams et al., 2020). Current barriers to community-wide adaptation strategies such as relocation create a denial of the distinct rights of Indigenous peoples displaced by climate change, especially rights to life, self-determination, sovereignty, food security, physical and mental health, housing, and physical and cultural integrity and heritage (Bronen, 2011; House Select Committee, 2020; Maldonado et al., 2013; UUSC, 2017). The right to self-determination is the prerequisite for adaptation strategies, including the relocation process (Bronen et al., 2018; see also Jantarasami et al., 2018; NRC & AIJ, 2017). Self-determination means that Indigenous peoples have the right to identify their priorities and to make decisions regarding adaptation and mitigation strategies, which includes the right to make fundamental decisions about when and how to address environmental threats and where their community is located (Bronen, 2011, 2014), as well as the right to free, prior, and informed consent, which is sourced in the right of self-determination (Article 10, United Nations, 2007).

   The Indigenous peoples who are adapting should be the ones framing the adaptation response strategies and priorities, not the supporting institutions. Adaptation support must occur not only at the individual and property-owner level, but also at the community and collective level, established through relationships and practices, as opposed to geographical boundaries (Marino et al., 2019). Climate change adaptation and resilience responses are most effective when they are community-led, from the visioning through implementation and beyond, to meet community priorities and ensure success after the physical resettlement (Clement, 2021; Lowlander, 2015; Marino et al., 2019; Steen-Adams et al., 2020). Most federal policies and programs are written and designed based on individual—not collective—rights. For many Tribes, nations, and Indigenous communities, being recognized as a community, and not just individuals, requires flexibility of policies to provide and gain community-wide support. Providing support only at the individual level for processes such as relocation further disrupts community cohesion and perpetuates harms such as loss of culture and identity incurred through forced assimilation policies (Maldonado, Marino, & Iaukea, 2020). Such objectives should be realized at both the national and international level within the context of the UN Framework Convention on Climate Change and all related documents and bodies.

   The framing and language around adaptation responses should also uphold community or collective rights, actions, and self-determination. There is danger in the current public discourse framing adaptation movements as "managed retreat," calling to question managed retreat by and for whom (Philippe et al., 2020).

4. **Maintain continued access to land, waterways, traditional foods, and cultural resources that Indigenous peoples use as traditional ways of life.** Even in relocation, although the land is no longer permanently habitable, Indigenous peoples have a right to maintain access and stewardship of place, including exercising cultural practices (Lowlander Center, 2015; Steen-Adams et al., 2020). Such matters should be undertaken in collaboration and cooperation with Tribal governments and consistent with federal trust responsibilities and the *UN Declaration on the Rights of Indigenous Peoples*.

5. **Appoint a lead federal funding agency for the implementation of protection-in-place and community-led relocation in Tribal communities.** This also includes increasing funding to effective federal, state, and local programs and making programmatic and policy changes to existing programs.

6. **Prioritize implementation funding and the full costs of adaptation actions from protection-in-place to community-led relocation.** The full costs of protection-in-place and relocation—from visioning to implementation and continued support—must be properly accounted and budgeted for; otherwise, those relocating will unjustly bear the externalized costs (Steen-Adams et al., 2020). Substantial commitment to protect existing infrastructure as well as closing infrastructure gaps should be recognized in every protection-in-place and relocation response (ANTHC, 2019; ANTHC, DCRA, et al., draft report; Clement, 2021; Comardelle, 2020; GAO 2020; House Select Committee, 2020; Kawerak, 2019; Keyes, 2020). Expand beyond benefit-cost analysis, which does not account for the distribution of costs and benefits or important social and cultural factors for survival and sovereign rights. Include nonmaterial components like histories, practices, and ways of life, critical social services, as well as hunting, fishing, harvesting, and other cultural practices that are essential to thriving, healthy communities (Maldonado, Marino, & Iaukea, 2020). Tribes and Indigenous peoples should not be strapped with cost sharing or funding match requirements (Steen-Adams et al., 2020; UUSC & Rising Voices-Working Group, 2021), including alleviating the onerous burden to respond to risk assessments. All threatened Tribal communities should receive technical assistance and funding to complete site-specific risk assessments to develop informed solutions. Data collection and risk assessments are estimated to cost at least $32 million for Alaska communities alone and should be completed by 2025 (ANTHC, DCRA, et al., draft report). In collaboration with the communities' identification of the metrics to use, an independent monitoring group could help evaluate whether community plans and priorities are being met and include a mechanism to accommodate the community's right to redress.

> "Risk assessments are necessary to help communities answer, 'Can we continue to live here?' and, 'If yes, how can we continue to live here?' Completing community-specific risk assessments should be done as soon as possible," (ANTHC, DCRA, et al., draft report).

7. **Innovate creatively.** Workforce development and innovative creation of infrastructure and a strong economy are key elements for rebuilding vibrant communities adversely impacted by conditions triggered by others and beyond their control. In the context of protection-in-place and community-led relocation, Tribes must have access to programs that employ innovative technology in regard to durable infrastructure, which may also contribute to strong local

economies and workforce development and overall cultural integrity. In order to be comprehensive, such objectives should be integrated into federal responses to the climate crisis as well as the unmet needs of Tribes and their communities.

Conclusion

Proactive planning for adaptation strategies must support community-led adaptation that empowers and honors community decision-making, sovereignty, and self-determination, consistent with the federal government's trust and treaty responsibilities and the *United Nations Declaration on the Rights of Indigenous Peoples*. The right to self-determination is the prerequisite for adaptation strategies, including protection-in-place and the relocation process. Climate change adaptation and resilience responses are most effective when community-led, from visioning through implementation and beyond.

Tribal leaders and organizers are taking actions, choosing dignity over victimization (RV, 2016). For example, in their community's vision statement, the Alaska Native Village of Shishmaref does not focus on relocation, but rather on being a "safe and resilient community. We want to be a viable community that respects and honors our Inupiat culture and traditional values" (HDR with Rim First People, Cox, & Eningowuk, 2016). Shishmaref leaders started using "site expansion" instead of "relocation" to enable more projects for the community in place, such as a new fuel tank farm, a new health clinic, an expansion to their public school, work on getting paved roads, a new washeteria, and repairing and upgrading the airport; tens of millions of dollars are still needed for shoreline protection, and there's a need for potable water (HDR with Rim First People, Cox, & Eningowuk, 2016; Maldonado et al., 2021).

The Isle de Jean Charles Biloxi-Chitimacha-Choctaw Indians of Louisiana, despite the "state of Louisiana's slow response and improper execution" of the U.S. Housing and Urban Development National Disaster Resilience Grant for the Tribe's resettlement, is continuing to pursue community resettlement, committed to keeping their community intact and preserving their place (Comardelle, 2020). The Isle de Jean Charles Biloxi-Chitimacha-Choctaw Indians of Louisiana, Pointe-au-Chien Indian Tribe, Grand Caillou/Dulac Band of Biloxi-Chitimacha-Choctaw, Atakapa-Ishak-Chawasha Tribe of the Grand Bayou Indian Village, and the Native Village of Kivalina, faced with climate-forced displacement, came together with partners to file an official complaint to the United Nations for their experiences of "ongoing human-rights violations caused by the United States government" (Alaska Institute for Justice, 2020).

Several Washington coastal Tribes are developing their own proactive plans for relocation actions to safeguard the health and safety of their citizens (for example, see Hoh Indian Tribe, 2009; Quileute Tribe, 2017; Quinault Indian Nation, 2017). The Shinnecock Indian Nation in New York has implemented innovative solutions to "restore their shoreline and protect their land" from sea-level rise through their Coastal Habitat Restoration Project (Varanasi, 2019).

These efforts must be supported by programs and policies that respect, recognize, empower, and honor community decision-making, sovereignty, and Indigenous peoples' right of self-determination.

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Chapter 11: Solid Waste

Tribes are experiencing impacts from climate change to their solid waste systems and management, and the following narratives describe some of the challenges they are facing and solutions they are implementing. The Grand Portage Indian Reservation of Minnesota opened an industrial composter at Grand Portage transfer station to protect their waterways. Due to increased Arctic temperatures, the Inupiaq village of Little Diomede in Nome, Alaska, has lost valuable ice for landing planes to backhaul waste and recyclables and to burn waste from a distance. The Prairie Band Potawatomi Nation of Kansas details their climate related issues of an evolving waste management program. The Pueblo Tribes of New Mexico implement vast education programs to prevent illegal dumping. A researched overview of Solid Waste as it relates to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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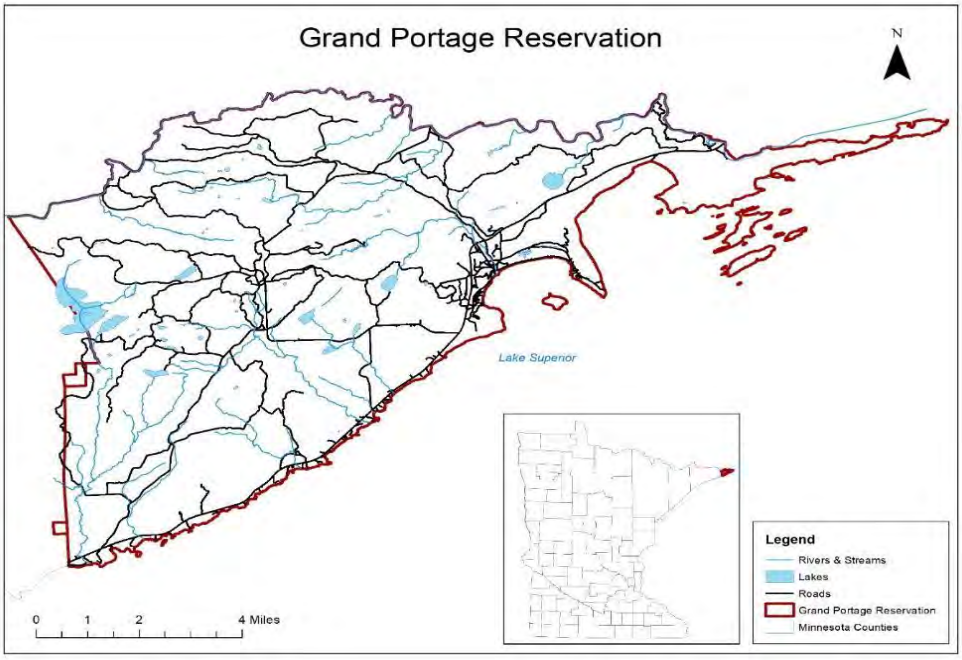
Grand Portage Band of Lake Superior Chippewa Transfer Station

Written by: Krishna Woerheide, Environmental Specialist – Grand Portage Band of Lake Superior Chippewa

Location:

The Grand Portage Indian Reservation is located in the extreme northeastern corner of Minnesota and consists of 56,000 contiguous acres of rugged and remote terrain, devoid of rail service, airport, or incorporated towns. The Reservation has a total enrollment of 1,098 members and a population living on the Reservation (Indian and non-Indian) of about 565. Approximately 42 miles of perennial and 55 miles of intermittent streams flow through the Reservation. These streams and their tributaries drain into Lake Superior and generally flow along steeply graded channels incised in bedrock. The Pigeon and Reservation Rivers flow along the northern and western boundaries, respectively. The Pigeon River watershed has a total drainage area of about 600 square miles (most of this area, about 95%, is in Canada) and encompasses the northern one-third of the Reservation. There are 17 inland lakes that collectively comprise about 816 acres, and there are about 7,204 acres of wetlands within the Reservation boundaries. Our Water Quality, Wetlands, and Non-Point Source departments work diligently to ensure the safety and quality of Reservation surface and ground waters. To date, there is no contamination of any of the waters from Reservation solid waste. Our transfer station was relocated in 2016 due to its proximity to a cold water trout stream and the projection that flooding in that area could potentially contaminate both the stream and Lake Superior.



Grand Portage Reservation

Community Served:

The Tribal enterprise consists of the Grand Portage Lodge and Casino, Trading Post, Car Wash, and Marina. The Reservation Tribal Council (RTC) provides services for the community and its members, including the following programs and departments:

- Emergency Management
- Grand Portage Health Services
- Human Resources
- Human Services
- Community Center
- Elderly Nutrition Program
- Emergency Medical Services
- Structural Fire Protection
- Construction
- Water and Sewer
- Trash service
- Maintenance
- Tribal Historic Preservation and Museum
- Veterans Affairs
- Headstart and Daycare

Aerial view of the Grand Portage transfer station.

The RTC has established the Grand Portage Trust Lands and Natural Resources Agency (Trust Lands) as the governing body for natural resource management. Trust Lands departments include:

- Land Use/Realty
- Conservation
- Biology
- Forestry and Wildland Fire
- Environmental

Industrial composter at Grand Portage transfer station

Description of Service:
In 1986, the Grand Portage Tribal Council opened a transfer station. Waste haulers are contracted to take solid waste from the Grand Portage transfer station 150 miles away to Western Lake Superior Sanitation District in Duluth, Minnesota, where it is later deposited in a certified landfill in Sarona, Wisconsin. There is no curbside pickup, so all residents bring their waste to the transfer station, and the closest waste hauler is in Grand Marais, 40 miles away.

Amount of Trash Disposed:
In 2017, the community generated approximately 7,000 yds^3 of household garbage and 900 yds^3 of larger household waste, plus cardboard and other recyclable materials, a large number of appliances, tires, scrap metal, and various household hazardous waste items.

Solid Waste Equipment at the Transfer Station:
There are ten 8-yard dumpsters for household garbage, a 30-yard roll-off for larger waste, a trailer for cardboard, and most recently an industrial composter for food waste.

Challenges:
- Financing the high cost of transporting garbage from our remote location
- Teaching people what should go in the dumpsters and what should not
- Ensuring that people do not bring trash from off the reservation

Opportunities:
- Funding from the Minnesota Pollution Control Agency to purchase composter
- Funding from Indian Health Services to assist with recycling containers and signage for casino
- Mentorships and courses through ITEP

Areas for Potential Assistance:
- Better storage location and method for household hazardous waste
- Suggestions for better layout of transfer station
- Options for baling and selling certain recyclables (aluminum, plastic, tin, cardboard)

Climate Change in U.S. Arctic: Little Diomede's Solid Waste Challenges

Written by: Opik Ahkinga from the Native Village of Diomede and Anahma Shannon, Kawerak, Inc.

Recyclable household hazardous waste getting loaded onto the plane out on the ice runway, the village of Little Diomede in the background. Photo by Opik Ahkinga, April 2010

About 15 years ago, the ocean surrounding the island of Little Diomede, the United States' farthest northwest location and home to the Inupiaq village of Little Diomede, Alaska, would freeze, creating ice more than four feet thick. In the depths of winter, once the ice froze, the locals would clear a 2,000-foot ice runway in front of the village so that small passenger planes could land. Those passenger planes would bring people and goods in from the hub community of Nome, and they would backhaul people and sometimes recyclable waste out. The ice runway would only last about five months each year, January–May, but it was enough to count on and made the recycling of aluminum cans, plastic bottles, electronics, and even lead-acid batteries efficient.

2013 was the last year of the ice runway in Diomede. Since then, warm Arctic temperatures and tumultuous ocean currents have made the ice surrounding the island weak, ever-moving, and unstable for landing planes. In the winter of 2018, the ice almost didn't form at all, finally firming up in late February for about a month.

In the past, the ice provided not only a means for getting waste out of the village, it also provided a place to burn trash far away from the community. Trash collectors would take the community's trash far out on the ice and light it afire to reduce the mass of waste. Little Diomede is an island of granite rock, and no landfill is possible anywhere on the island. The only waste management solution for the community is to burn trash, and now with the lack of sea ice, they are forced to burn trash right in the community in an enclosed burn unit with a stack. While this is better than open burning, the unit is not an incinerator, and the smoke from the burning waste still affects the air quality of the nearby houses.

First-ever tidal storm waves on February 20, 2018. Winter ocean is usually frozen around Little Diomede this time of year. Photo credit: Sistuq Ozenna, February 2018.

With the onset of COVID-19 in the year 2020, the waste stream has been negatively impacted by the amount of plastic waste the community has had to burn. The City of Diomede sanitation workers have seen an uptick in plastic hand-sanitizer bottles, store-bought masks, and plastic gloves, all of which must be burned in the burn unit every few days.

In addition to the impact to solid waste management, the absence of the ice in recent years has affected the villagers' ability to conduct subsistence activities, such as crabbing through the ice and hunting seal and walrus, which they get by hunting on the ice. The diminished ice also leaves the community vulnerable to extreme weather-event impacts, such as raging winter storms. When the ice was thick, the waves could not reach the village. Now that there is no ice, the winter water crashes into the community, damaging vital infrastructure like the power plant and water sanitation system.

Diomede elder Orville Ahkinga looks out the helicopter window at the open water surrounding the island in winter. Photo by Opik Ahkinga, February 2018

Orville Ahkinga, an 82-year-old elder leader of Diomede, said that in his entire life he had never seen open water during this time of year until 2018. He leaves us with these words: "Climate change is real…just like the elders predicted when I was a young boy."

Operator Safety and Resilience in Our Changing World

Written by: Virginia LeClere from the Priarie Band of Potawatomi Nation

The Prairie Band Potawatomi Nation (PBPN) Division of Planning and Environmental Protection manages an evolving waste management program that includes waste disposal and recycling services, composting, household hazardous waste collections, and outreach/education. Our Department employs a nine member staff responsible for implementing environmental planning and utility programs for the Nation. This includes three full-time Waste Disposal Operators and two back-up operators. Our operators log over 500 miles throughout the week, traveling on the highway, paved rural roads, dusty gravel roads, and low-maintenance dirt roads. They complete residential, commercial, and institutional waste and recycling routes in all seasons and weather conditions. In between route schedules, they sort and bale recyclables that are collected

Flash flooding washed out a drain tube on the PBPN Reservation main arterial road. Photo taken on June 4, 2015, by PBPN Road and Bridge staff.

through our single-stream program; maintain our facilities, vehicles, and equipment; and address illegal dumping violations. Safety awareness and accident prevention eclipses all other aspects of the job. We've discussed the statistics ranking their occupation in the top 10 or top 5 most dangerous occupations in the U.S. in our weekly "huddles," where our operators hash out transportation, equipment, and route observations.

In addition to the expected traffic and mechanical hazards of the job, climate change creates yet another safety variable. With increasingly frequent and extreme weather events, it isn't unusual to encounter flooding and damage to transportation infrastructure. The damages range from moderate inconveniences such as impassable, muddy driveways forcing operators to reroute residential waste service delivery to the more severe damages from Kansas tornadoes and flash floods that create life-threatening road hazards. In 2015, the PBPN experienced an exceptionally stormy, volatile spring. One storm in late May rendered several Reservation roads impassable for a short period of time, but the main arterial road of the Reservation was extensively damaged when a drain tube washed out and a large sinkhole suddenly swallowed up over 20 feet of road.

Heat-related climate stressors such as drought and overall warmer temperatures also affect the safety aspect of our operation. Extreme summer heat can cause fatigue and illness. Our operators reported low morale, exhaustion, and concerns/fears about working alone during prolonged extreme heat events. Also, winters in Kansas seem to be increasingly warmer and dryer. Mosquitos thrive after warm winters. Drought draws mice, raccoons, and other rodents in search of water into our sorting and compost facilities and even to the inside of our trucks.

Our cultural beliefs foretold this climate impact on our health. Potawatomi people have always prayed for cold winters and abundant snow. We're told the cold winters kill sickness and disease. We also wash our faces in the first snow of the season to keep us healthy and strong throughout the winter. The gradual but imminent warming and diminishing cold winter season increases exposure to disease-carrying vectors and heat-related illness, just as our cultural telling predicted.

The constant safety vigilance, daily operational challenges, and additional climate variables can be wearing on our operators, but they plan, communicate, and adapt by necessity. The waste utility program is critical to Tribal infrastructure, and the PBPN waste operators' daily performance directly impacts the health and safety of our community.

Rodents, like the raccoon pictured, regularly visit PBPN waste facilities and equipment in search of food and water.

Managing Solid Waste in the Face of a Changing Climate

Written by: Cynthia Naha

As the effects of climate change are felt with each passing season, precipitation that should fall in the form of snow, sleet, and rain, which feeds our ecosystems, our watersheds, and most importantly, our rich cultures and traditions as Tribal people, diminishes. When we think about solid waste management, we often do not correlate a connection to climate change. But as we continue to develop sustainable programs to manage our waste, perhaps the effects of a changing climate should be considered, especially as we continue to face challenges with illegal dumping, transportation to and from the landfill, and community support and buy-in.

Here in the arid Southwest, and more specifically, New Mexico, where drought is eminent and wildfires have wreaked havoc on our forests, we have seen the lack of care by many at places of recreation throughout the state, as well as within our Tribal homelands. When we experience a high volume of illegal dumping, mixed with a drier climate, there is the potential for fires to start at these dumpsites. This can lead to a more catastrophic event, especially when we do not know what materials are contained within them. Despite efforts to maintain outreach and education on why illegal dumping is not beneficial to our lands, waters, and air, challenges are still present, even when options of proper waste disposal exist. As we look across our environment and see the impacts of overgrazing, we can begin to understand that our lands lack good soil quality. During severe monsoonal events, trash in illegal dumpsites gets washed down the land with sediment and eventually ends up in our surface water, causing potential contamination. This juxtaposition of droughts and wildfire that are followed by floods combine with the problem of waste that has been illegally dumped, compounding the impacts to an ecosystem that is already stressed from climate change.

As the effects of climate change continue to be felt, developing Indigenuitive programs is necessary for the overall management of our waste and how we can ensure we are not creating more harm to our Mother Earth. I am fortunate to work with land managers in various capacities to collaboratively define shared stewardship and co-management of our rangelands, our forests, and our waterways. It is important to remember that the work we are doing is not just for our survival, but for the survival of the next seven generations. I believe in reciprocity. Through the regenerative work we are learning more about, and through the identification of innovative strategies based on our local/traditional knowledge, we can manage our lands to ensure resilience in the face of drought, wildfire, and other extreme weather events that we have witnessed becoming more intense and disastrous.

Solid Waste

Key Messages

- The component of Tribal solid waste systems that is most affected by climate change and has the furthest reaching implications is that of infrastructure. An infrastructure system that continues to be stressed has lasting impacts on the amount of illegal dumping on Tribal lands, the transportation of waste in and out of Tribal communities, and the supply and demand of local recycling markets.
- The data gaps that exist in the world of Tribal solid waste management are extensive and cause a delay in responding to the demands of new conditions created by climate change.

Recommendation

Allocate funding through a streamlined federal funding process (perhaps an interagency clearing house or memorandums of understandings) to ensure Tribal infrastructure is prepared to withstand changes in climate and extreme weather events, and collaborate with Tribes to develop an inventory and evaluation of infrastructure related to solid waste in Tribal communities. This should include roads, facilities, and equipment. Focus on regional coordination to allow for idea sharing around climate change impacts, adaptations, and resources already available to help eliminate data gaps.

Tribal Solid Waste

In most traditional Native American communities, recycling and waste recovery were at the core of the community culture. For example, at Acoma Pueblo, Pueblo Indian women crafted clay pots that were meant to last for years. When those pots broke, the broken pieces were ground into powder, soaked, and turned back into clay to craft new pots (USEPA, 2016). This example of a historical practice of waste recovery and recycling can be found throughout Turtle Island.

The broken windows theory explains that visible signs of disorder in an environment promote further disorder and misbehavior. This principle was developed to explain the decay of neighborhoods in an atmosphere of urban blight, but can be applied to many reservations and Tribal communities that are impacted by solid waste issues. Traditionally, Tribes dealt with these issues in various ways. In the Hidatsa, Mandan, and Arikara villages, the Black Mouth Society encouraged or punished citizens whose habits became untidy (National Park Service, 2019). In Cheyenne societies this was the work of the Dog Faces (PBS, 2001).

The juxtaposition of traditional knowledge with that of modern technology has negatively impacted solid waste programs across Indian Country. As these communities try to shift back to resource recovery, waste diversion, and recycling as core values, traditional methods of telling people when and how to dispose of waste have largely been replaced by codes and regulations enforced by Tribal police.

The effects of climate change, including an increase in temperatures, a change in precipitation trends (both droughts and floods), an increase in the number and severity of storms, and more extreme weather events, are causing a drain on Tribal environmental, in particular solid waste management,

programs that lack both the staff and the financial resources to adapt to these new conditions. More recently, Tribes have adopted strategies to educate community members about waste problems by sponsoring community cleanup days, during which numerous Tribal departments work with community members to clean up roadways, illegal dumps, and other problem areas. They may waive fees at pick-up locations and offer helping hands with heavy objects. Many Tribal communities promote recycling and composting while teaching the principles of sustainable material management. Additionally, Tribes participate in household hazardous waste disposal events and are working to promote industry buybacks of hard to dispose of items.

The management of solid waste occurs through a variety of methods, including landfilling, incineration, recycling, composting, waste reduction (through sustainable materials management), reuse, and debris management, to name a few. All of these options come with a host of environmental implications that must be considered. The future of Tribal solid waste planning must account for factors involving climate change in order to be successful. Many of the management strategies mentioned above have components that are declining in quality due to the changing climate, and others have the potential to reduce the rate at which the climate is changing if handled properly. Many Tribes are already aware of this and are working toward solutions, while others are trying to understand all the potential effects as they determine how to best move forward. A current lack of data in the area of solid waste management (including the number, location, and size of illegal dumpsites; information on Tribal solid waste codes; and a comprehensive list of the number, size, and status of Tribal landfills and transfer stations, among others) further complicates an already challenging situation. Although resilience and resource stewardship have always been fundamental components of Indigenous communities, these traditional lifeways are key factors in developing flexible solid waste programs in Indian Country that are protective of human health, the environment, and the culture of the people who live there.

Solid Waste and the Health of a Community

The management of solid waste can be linked to both the human health and the cultural health of a community. There are a number of proven linkages between poor solid waste management and adverse health outcomes (Figure 16). These health issues can be associated with every step of the waste management process both directly and indirectly. The specific waste management activity, listed in Table 4, can have a number of environmental impacts, including contamination of water, air, soil, landscape, and climate.

As is evident in the Prairie Band Potawatomi Nation's narrative in the beginning of this chapter, solid waste landfills and illegal dumps are the most common sources of land pollution on Tribal lands. Although illegal dumping is not uniquely a Tribal issue, it becomes an exceptionally malignant problem for historically underserved communities that struggle with environmental self-determination, and it is a glaring concern for Native populations tied so closely and inextricably to the land entrusted to them. In many Native cultures, land is considered to be much more than just property and natural resources, but as identity and as a residence for ancestors and nonhuman relatives (Figure 17). According to Dr. Robin Wall Kimmerer, in Native culture, one's identity is inseparable from the land (Kimmerer, 2020).

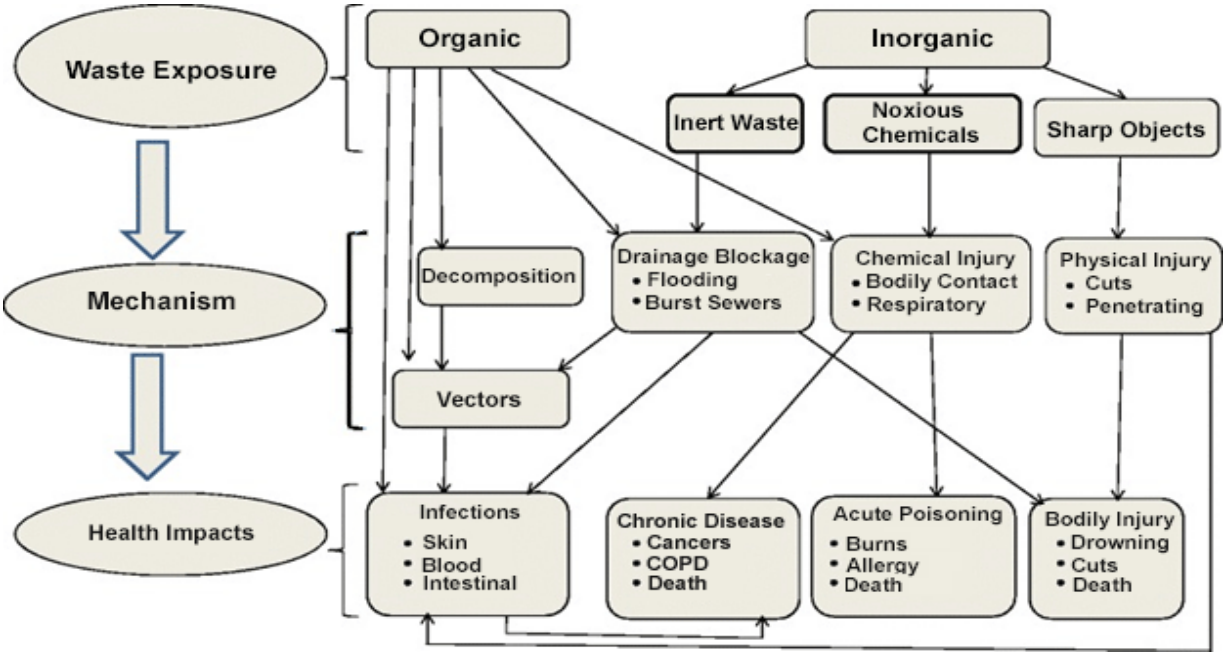


Figure 16. A framework for understanding the linkages between poor solid waste management and adverse health outcomes (Ziraba et al., 2016)

Climate Change Effects and their Impacts on Tribal Solid Waste Management

Many components of Tribal solid waste management are being made worse due to climate change. In many Native cultures, climate changes were foretold by ancestors (Christo, 2020; Daley, 2019; Wang, 2020). Rising temperature is an indicator of climate change, and extended periods of increased heat impact landfill and transfer-station operations. These changes now create conditions that promote an increase in the number of pests (Ziska et al., 2018), harmful dust, pollutants, particulate matter (USEPA, 2002), and extreme working conditions (Centers for Disease Control and Prevention, 2020), requiring Tribes to allocate additional resources from already strained budgets for equipment and staffing.

Changes in precipitation trends also influence solid waste issues in Indigenous communities. Determining a location for a landfill or a transfer station already takes into consideration factors such as accessibility, operating hours, road conditions and on-site irrigation requirements. With more unpredictable precipitation trends that range from catastrophic flash flooding to historically unprecedented drought, siting these facilities becomes even more challenging. Remote disposal facilities have the added complication of pervasive illegal dumping. This can be seen in many of the Pueblos in New Mexico (see narrative titled Managing Solid Waste in the Face of a Changing Climate). Erosion is one of the contributing factors to this. Flash flooding events create new ditches, ravines, and gullies that attract illegal dumping,

Table 4. Main environmental impact of municipal solid waste management. (Giusti, 2009)

Activity	Water	Air	Soil	Landscape	Climate
Landfilling	Leachate (heavy metals, synthetic organic compounds)	CO_2, CH_4, odor, noise, VOC's	Heavy metals, synthetic organic compounds	Visual effect, vermin	Worst option for greenhouse gas emission [a]
Incineration	Fall-out of atmospheric pollutants	SO_2, NO_x, N_2O, HCl, HF, CO, CO_2, dioxins, furans, PAHs, VOC's, odor, noise	Fly ash, slags	Visual effect	Greenhouse gases [a]
Composting	Leachate	CO_2, CH_4, VOC's, dust, odor, bioaerosols	Minor impact	Some visual effects	Small emissions of greenhouse gases [a]
Land-spreading	Bacteria, viruses, heavy metals	Bioaerosols, dust, odor	Bacteria, viruses, heavy metals, PAHs, PCBs	Vermin, insects	Small emissions of greenhouse gases
Recycling	Wastewater	Dust, noise	Landfilling of residues		Minor emissions
Waste Transport	Spills	CO_2, SO_2, NO_x, dust, odor, noise, spills	Spills		Significant contribution of CO_2

CO2 – carbon dioxide; CH4 = methane, VOC's = volatile organic compounds; SO_2 = sulfur dioxide; NOx = nitrous oxides; N_2O = nitrous oxide; HCl = hydrochloric acid, HF = hydrofluoric acid; CO = carbon monoxide and PAH's = polyaromatic hydrocarbons

[a] Assuming no energy recovery.

Figure 17. Based on "What does land mean in Native cultures?" (Kimmerer, 2020)

and as more instances of flash flooding occur, there will be more locations that become sites for this nuisance. There are currently over 1,000 open dumpsites in the Sanitation Deficiency System (SDS) managed by Indian Health Services that meet the requirements outlined for size, location on Tribal lands, and evidence in a GIS system (Shuman, 2020). A lack of consistent reporting and verification of these dumpsites and their severity make it challenging to create a benchmark for future comparison.

Floods will impact landfill design (Brand, 2020), and problems associated with drought will cause issues with vegetative caps that keep the soil in place and prevent the waste from being either blown away or washed into the community's water supply. In drier climates, periods of drought coupled with illegal dumping can even lead to an increase in wildland fire. At Superfund, brownfield, and underground storage tank sites, climate change can impact the water table and determine the success or failure of cleanup strategies. This can be particularly evident in cleanups where vapor intrusion is an issue. Moreover, erosion at these sites requires more carefully designed caps that can withstand the forces of flash floods and tidal surges.

The increase in the number and severity of damaging weather events that will impact Tribal lands requires creating comprehensive debris management plans. Whether these weather events are coastal storms, tornadoes, wildfires, or winter icing, many Tribes currently lack the necessary staff or current plans to handle debris management on a large scale. Waste collection can increase by a factor of two or

three following a flood event. The types of solid waste will also change markedly as people remove and discard ruined carpet, insulation, drywall, and other porous materials contaminated by flood waters.

The increase in extreme weather events is detrimental to roads, the vehicles that use them, and operators who must drive and maintain them. Many Tribal communities are located on rural land without easy access to a landfill, transfer station, or recycling center to properly dispose of waste. According to the U.S. Department of Transportation, the fatality rate on rural roads is two times higher than on urban roads (U.S. Department of Transportation, 2020). On the Navajo Nation, residents of 56 Navajo Chapters (approximately 80,000 residents) do not have any sort of trash pickup service and have to take their solid waste to either a transfer station or a convenience collection point. If a resident of the Navajo Nation is hoping to take their waste directly to a landfill, the distances range from as little as six miles to over 50 miles. The average distance from a Chapter House to a solid waste landfill is 40 miles, and many of these miles require traveling on rural or unmaintained roads (Navajo Nation, 2002). Reservations that do have well-managed landfills, transfer stations, or recycling centers or are located near urban areas often have a network of rural roads that rely on consistent maintenance even in the best weather situations. As this already-challenged infrastructure becomes increasingly degraded, the likelihood that residents will travel these roads to properly dispose of trash diminishes, and the number of illegal dumps is projected to rise.

Beyond the increase in illegal dumping, the damaged and degraded roads also continue to complicate the transportation of waste and recycling to and from these communities. In Grand Portage, waste travels almost 250 miles from its starting point at a reservation transfer station to its final resting point in Wisconsin (see map of route below). (See narrative titled *Grand Portage Band of Lake Superior Chippewa Transfer Station*.) These long distances from a Tribal transfer station, across the reservation, to a larger (often non-Tribal) landfill often require many miles on rural roads.

Climate change is also impacting how solid waste handlers in Indian Country must deal with recycling. According to the Census of Fatal Occupational Injuries Summary from the Bureau of Labor Statistics (BLS), “recycling material collectors” is already the fifth most dangerous job in the U.S. (Rosengren, 2017). Working alone in very hot and very cold environments represents an added hazard to an already dangerous job. In addition to the impacted quality of roads being a strain on the Tribal recycling programs, once-viable markets for recyclables have all but disappeared, leaving more and more materials heading for the landfill. For this reason, the importance of waste reduction through

sustainable materials management (SMM) is an even more vital component to Tribal solid waste programs as well as to the general health of the environment. Moving forward, the focus on SMM needs to be a national effort and should emphasize a reduction in packaging, more national takeback programs, and creating market demand for the recycling and reuse of as many products as possible. (See *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets*.)

Route from Grand Portage Band of Lake Superior Chippewa Tribal transfer station (Minnesota) to landfill (Wisconsin).

In addition to the solid waste infrastructure issues plaguing Tribal communities, there are a number of other factors and systems in Native communities that will be increasingly challenged as the climate continues to warm. Far beyond the reaches of the road system, many Alaska Native villages rely on sea ice as an integral part of how waste is transported out of their communities. Given that sea ice is now present in much smaller quantities and for much less of the year than ever before (Ramsayer, 2020), the amount of time available to remove this waste has become limited. Backhauling waste out of Alaska is a necessity, and the inability to reliably predict when periods of ice will occur is a detriment to how Native villages are able to plan for the removal of waste. As planes and barges are unable to make the same trips as in past years, these villages must create new solutions to deal with their solid waste issues. On Little Diomede Island, halfway between Alaska and the west coast of Siberia (see location map below), the solid waste that is unable to be transported out of the community is burned. An increasing number of plastics (in the form of masks, bottles, and gloves) are being brought to the island and are negatively impacting a community that once relied on an environment filled with sea ice to isolate the burning activity from the island's population (see narrative titled *Climate Change in U.S. Arctic: Little Diomede's Solid Waste Challenges*).

Location of Little Diomede Island (Stevens, 2017)

Many Tribes are actively engaged in seeking solutions to the ongoing challenges mentioned in this chapter and are heavily involved in remediation and stewardship of their land. The Yurok Tribe has great solid waste codes and enforcement mechanisms that allow them to be excellent stewards of the land. Tribes continue to focus on growing their resilience during these changing climate conditions. The following is a list of opportunities that could aid these communities in the face of climate change:

- Encourage the creation of regional recycling processing facilities. This would decrease emissions from transportation and wear on Tribal vehicles and rural Tribal roads, thus decreasing the illegal dumping that would occur there.
- Encourage the development of regional businesses that are in need of recycled feedstock. Prioritizing these local and regional markets is key to ensuring the success of Tribal recycling programs.
- Support the enhancement of composting programs and the removal of food waste from landfills. Many Tribes are faced with food scarcity issues among their Tribal members. There is a strong desire on the part of Tribes to create food security and food sovereignty programs through the creation of compost to bring these systems full circle.
- Create and support programs that require a reduction in packaging material or require a takeback component at the product's end of life. These programs help lessen the burden on Tribal solid waste programs.
- Support a Tribe's data sovereignty, while ensuring they have resources that allow them to utilize this data to create solutions to their solid waste issues. This could include assisting Tribes in better recording their open dumpsites or cataloging baseline information.

- Continue to support infrastructure upgrades to ensure Tribes have the ability to access and create successful solid waste sites. The modern road system has given the U.S. access to all types of luxuries that many reservations have not previously had access to. Climate change adds additional burdens and challenges to an already taxed system.

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Chapter 12: Emerging Topics

While emerging topics related to Tribes and climate change span a vast array of topics, workforce development and collaborative, cross-jurisdictional planning are of particular importance for addressing the cultural cascades experienced by Tribes. The narratives in this section provide examples of several organizations that are working with Tribal communities to develop future leaders and partnerships using nontraditional forms, including camps, working groups, and music. The Native Youth Community Adaptation and Leadership Congress (Congress) builds future Indigenous leaders in conservation and climate change. Since 2015, the Congress has trained approximately 450 high school students, representing more than 85 Tribes and more than 30 states and territories, including Alaska, Hawaii, and American Samoa. Then, in the video narrative that is linked and transcribed, Katherine Paul of the Indigenous indie-rock band Black Belt Eagle Scout and the PTM Foundation share the way they communicate indigeneity and climate action through their music. Lastly, the Climate Science Alliance is assisting Tribes in developing partnerships for Tribal cultural and community resilience through their Tribal Work Group (TWG), which focuses on Tribal priorities, evaluating complementary Western and traditional restoration and management practices that can complement and advance unique and innovative approaches to address climate impacts. The TWG integrates collaborative approaches to bring cultural values and traditional knowledge to the forefront. A researched overview of Emerging Topics as they relate to Tribes and climate change follows these narratives, beginning with the Key Messages and Recommendation that the authors have identified.

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The Native Youth Community Adaptation and Leadership Congress

Written by: Jennifer Hill, U.S. Fish & Wildlife Service

Since the 1990s, the United States Department of the Interior (DOI) and the U.S. Fish and Wildlife Service (FWS) have made it their priority to work with American Indian Tribes for the purpose of natural resource management. DOI's Bureau of Indian Affairs (BIA) and FWS created the Native Youth Community Adaptation and Leadership Congress (NYCALC) in 2015 to strengthen the relationship between federal agencies and Tribal communities. NYCALC's

mission is “to develop future conservation leaders with the skills, knowledge, and tools to address environmental change and conservation challenges to better serve their schools and home communities.” Annually, FWS’ National Conservation Training Center in Shepherdstown, West Virginia, hosts the weeklong Congress, except in 2020 due to the COVID-19 pandemic.

Student canoes on outdoor trip. Courtesy USFWS/Alejandro Morales.

The Congress is a highly collaborative effort involving a wide range of partners beyond the initial coordination between FWS, Bureau of Indian Affairs, and New Mexico Wildlife Federation. Today, more than a dozen federal and nongovernmental agencies comprise the NYCALC Steering Committee, with support from another dozen organizations.

NYCALC empowers the next generation of Native youth to return home with the ability to address conservation issues and enact social change. How? NYCALC provides training in leadership principles, foundational community concepts, and conservation and outdoor skills. The schedule offers a series of STEM (science, technology, engineering, and mathematics)-related workshops, presentations, activities, and more. Central to the curriculum is how we use Open Space Technology. This approach empowers the students to set their own agenda. The students identify their topics of interest, from how climate change is affecting traditional foodways to networking to climate resiliency to the importance of learning from elders. They work in teams to research their topics, then present their action plans in front of a panel of judges.

Student demonstrates traditional corn dance. Courtesy USFWS/Alejandro Morales.

Through the Congress, we have engaged emerging Native leaders in this program. Since the Congress began, approximately 450 high school students have participated, representing more than 85 Tribes from all of FWS’s geographic regions with students from more than 30 states and territories, including Alaska, Hawaii, and American Samoa. Annually, the Congress recruits approximately 30 college-age students through a nomination process conducted by participating federal agencies and organizations to act as Junior Faculty (mentors for high school students).

Congress funders extend learning to the next generation of Native leaders through mini-grants. Organizers make these resources available to empower the students to apply lessons learned once they return home to address social change and conservation priorities. To date, several students have used mini-grants to address climate-related issues that impact their communities. Project examples include planning and installing community gardens, learning traditional growing and harvesting, addressing climate resiliency within communities,

growing aquaponics, starting a recycling project, and attending climate-related workshops and conferences, to name a few.

For more information and to see NYCALC students in action, please visit nycalc.org.

Music, Indigeneity, and Climate Change: A Short Film[66]

Produced by: Coral Avery, BIA Pathways Intern – Affiliated Tribes of Northwest Indians and Belén Rodriguez, Verité – Doris Duke Conservation

[Text on screen: Katherine Paul of the Indigenous indie-rock band Black Belt Eagle Scout and the PTM Foundation—a nonprofit started by the pop-rock band Portugal, the Man—joined this project to share the way they communicate indigeneity and climate action through their music.]

Katherine Paul (00:20):
I am from a really beautiful area of the Swinomish Indian Tribal community. It's in Northwest Washington state in the Pacific Northwest. It is incredibly beautiful. There's so much beauty in the water, in the land, in the people and the animals of this area. And so I have that foundation and I guess foundational view of, of how I, of how I look at life. At the shows I would start acknowledging, you know, the, the ancestors of the land. And it was a lot of time like a learning tool, but then also when there are people who did know that information and are those Indigenous ancestors and relatives from that area, that was a really, a valuable way to, to honor, honor those people and honor the land.

[Singing]

[Text on screen: Land Acknowledgements are a step to bring awareness to the issues faced by local Native communities.]

[Text on screen: Grammy Award winning band, Portugal, The Man, has always cared deeply about the communities surrounding them. In 2017, they realized that they could help make a real difference. PTM Foundation is now the primary vehicle for Portugal, The Man to engage, advocate for, and reinvest in the communities they grew up around, currently belong to, and believe in.]

Speaker 2 (02:27):
While our advocacy, philanthropy, and community engagement work is primarily centered around universal issues related to human rights, mental health, and the environment, our organization puts a specific focus on highlighting the stories of Native peoples.

Katherine Paul (03:04):
I started this project to be able to express who I am and try and figure out my life and try and figure out my identity. And when I started it, I was, you know, having a lot of emotions and using music as a, as a therapeutic way. I think it's, it's really helpful to be able to, you know, hear sound and to get things out of yourself through sound. That love of the land, that love of the people, that love for the animals. It really stems like the importance of being able to take care of that and being able to nurture and being

[66] Music, Indigeneity, and Climate Change: A Short Film: https://www.youtube.com/watch?v=sVo0u95lWbw&feature=youtu.be

able to fight for justice for our climate and for Mother Earth. I think for words of encouragement and inspiration, I think it's important to just try and contribute to the community that you're, that you're from, or if you don't have one, try, try and find that community and be a part of it.

Katherine Paul (04:06):
For the longest time I wasn't sure who I was when I was growing up and I wasn't sure what my identity would be and how I'd choose to express that. That's how I got involved in music is through going to shows and being involved in, in that music community. One of my songs is called "Loss & Relax," and it's about that journey home. And it's about like, kind of big feelings about the land. And I think now also the fact that I've moved back home, I've moved home to Swinomish, I think in the future there are definitely going to be songs about that and about how I feel returning home.

Katherine Paul (04:50):
[Singing]

[Text on screen: With our ancestors beside us, indigenous peoples are creating a better future for the next 7 generations. Our art, music, activism and cultural revitalization further the fight for social and climate justice around the globe. Thank you to Katherine Paul and the PTM Foundation for your time on this project and your continued dedication to indigenous rights and activism everywhere.]

Paradigm Shift: Climate Science Alliance Catalyzing Partnerships for Tribal Cultural and Community Resilience

Written by: The Climate Science Alliance

Photo credit: Condor Visual Media

Incorporating Indigenous values and perspectives can help us connect climate adaptation planning to other aspects of our society like community health, cultural diversity, and human wellbeing. While this holistic approach is something that Indigenous communities have practiced since time immemorial, it is not the dominant approach for non-Tribal land managers and planners. We view this approach as a paradigm shift in Western conservation planning and management, and this new paradigm is central to the Climate Science Alliance's (CSA's) commitment to amplify Indigenous voices and integrate traditional

practices, values, and knowledge into conservation planning to support and protect people and places. Throughout Tribally-led efforts, we are working to decolonize the conservation planning process with Tribes as leaders in the paradigm shift, reclaiming the process as well as their role in stewardship of their ancestral lands that lie beyond reservation boundaries. Our collaborative work brings Tribal science and approaches to the forefront of landscape planning, integrating Tribal priorities, concerns, and cultural considerations as well as ongoing Tribal climate adaptation planning efforts into a large-scale intertribal vision. Specifically, this effort relies on a unique intertribal collaboration among 20 different Tribal nations coupled with a robust network of collaborators, including land managers, conservation planners, local researchers, youth, and community members.

Members of the Tribal Working Group participate in climate adaptation roundtable discussions and seed-banking site visits. Photo credits: Climate Science Alliance.

Convened in 2017 by the CSA at the request of Tribal partners, the Tribal Working Group (TWG) is made up of over 30+ members representing 20 Tribes and Tribal organizations across southern California. The TWG's focus is on building, supporting, and accelerating Tribal resilience under climate change through Tribal–science partnerships that integrate Western and traditional values and practices. Tribal communities are often both under-resourced and among those most susceptible to the impacts of climate change (e.g., increased wildfire risk and reduced water security), yet Tribes are often not included in the planning process. To address this discrepancy, we are partaking in a collaborative effort that will leverage existing research and catalyze actions that advance Tribal resilience by promoting the integration of cultural values into the planning process. Our team includes climate adaptation and outreach specialists from the CSA and researchers across the region with expertise in cultural and natural resource planning and actionable science and, most importantly, is led by TWG members. As a community of practitioners, we are building on the leadership and vision of the TWG coupled with a foundation of regional climate research and a strong stakeholder community to advance approaches to climate adaptation strategies and solutions through the equal valuations of traditional and Western science.

With a focus on Tribal priorities, we are evaluating complementary Western and traditional restoration and management practices that can complement and advance unique and innovative approaches to address climate impacts. Our approach is unique in that it not only focuses on Tribal engagement and priorities, but on a collaborative approach to bring cultural values and traditional knowledge to the forefront. Building on our climate research and collaborative efforts, we are developing strategies that are customized to have an immediate and direct impact both within and outside Tribal communities. Our projects reflect long-term development of collaborative conservation and climate adaptation work—both research and application—that catalyzes activities and builds bridges between Western and Indigenous perspectives of connectivity and conservation to break away the boundaries and lines drawn on maps that separate us. We are addressing the needs of multiple Tribes and laying a foundation to support Tribal climate adaptation efforts that benefit conservation and connectivity goals in tandem with culture, community, health, and wellness.

To learn more about the TWG and our Tribally-led projects to advance transformational climate adaptation, please visit https://www.climatesciencealliance.org.

Photo credit: Climate Science Alliance

Emerging Topics

Key Messages

- Integrating Tribal workforce development and supporting Tribal Colleges and Universities can lead to greater climate resiliency and Tribal sovereignty and can create opportunities to educate and train future Indigenous generations in climate-related fields if administered additional funding and resources.
- There are many climate-related cultural cascades, including economic and social, Indigenous relationships with the natural world, and pandemics.
- Tribal nations are sovereign, and the U.S. federal government, in meeting its intent to address climate, environmental justice, and racial justice, should work collaboratively to support Tribes to engage in internal diplomatic relations. Other collaborations across jurisdictions and Tribal governments should be considered to enhance climate-planning efforts.

Recommendation

Recognizing that climate-related cultural cascades, including economic and social, affect Indigenous relationships with the natural world, Tribes and Tribal partners should support collaborative climate-planning efforts across jurisdictions and Tribal governments, including Tribal Colleges and Universities and other workforce development opportunities such as prioritizing Indigenous knowledge and labor. These practices will lead to stronger climate resiliency and sovereignty efforts.

Introduction

Climate change is a complex, interdisciplinary, and transdisciplinary topic. While the preceding chapters of this report focus on specific topics, this chapter highlights the emerging issues Tribes face in relation to climate change and includes subsections on workforce development, mainstreaming climate change considerations into planning, climate change planning and implementation occurring simultaneously, funding issues related to climate change adaptation planning and implementation, social implications, climate-related cultural cascades, policy issues, and Tribal leadership and engagement.

Integrating Workforce Development

Indigenous peoples are emphasizing the importance of youth involvement in climate change initiatives to prepare the next generation for leadership and employment. One example of this is the work of the Native Youth Community Adaptation and Leadership Congress (NYCALC) (see narrative titled *The Native Youth Community Adaptation and Leadership Congress*). Students face challenges and barriers to their capacity to continue in educational programs, which has an effect on the transition of students into the workforce. For example, Tribes have less access to broadband services, which is a disadvantage for Native American students who often live in remote, rural reservations (Center for Native American Youth, 2020). This is especially problematic during the current pandemic, given most education has switched to online and virtual platforms.

There are promising programs with strong federal support. Tribal Colleges and Universities (TCUs), for example, are important institutions for students to transition from education to their careers as professionals. “TCUs are unique institutions that combine personal attention with cultural relevance, in

such a way as to encourage American Indians—especially those living on reservations—to overcome the barriers in higher education" (AIHEC, 1999). There are 32 accredited TCUs, and a major advocacy organization focused on their advancement, the American Indian Higher Education Consortium in Washington, DC. While the science programs at TCUs represent one key avenue for students to take, further support would open additional mentorship and training opportunities that would guide students with an initial interest in climate change work. Another program is the BIA Pathways Program, which includes educational programs and internships that foster the greater involvement of young persons in careers stewarding trust lands. Given the impacts of climate change on trust lands, BIA Pathways is a critical vehicle for young persons to launch meaningful careers in environmental stewardship and climate change planning.

For professionals seeking employment or upgrades in their training, there continue to be challenges that affect Tribal peoples' capacity to prepare for climate change. For example, there may be training programs available within particular sectors related to climate change skills, but no sufficient jobs available within Tribal departments. There is an important opportunity to develop jobs that are in line with Tribal values and stewardship of the Earth, which is evident within the just transitions and green-jobs movement (*see Chapter 7: Energy & a Just Transition*). Black Mesa is a prime just transition example because the closure of the Mohave Generating Station allowed for the restoration of Hopi and Navajo water sources, as well as allowed for economically stimulant opportunities to emerge, such as the Green Economy Fund and Commission, the Native American Business Incubator Network, the Black Mesa Solar Project, the Navajo Wool Market Improvement Project, and the Food Sovereignty Project (Cha, 2020; Gearon & Johns, 2016). It is also important to understand that Indigenous persons living in urban centers can have greater potential to work in climate change related fields. While many Indigenous persons live in large urban centers, their interests and values are often left out of discussions about workforce training. For recommendations of how to include Indigenous voices and support Native workforce development, refer to the National Congress of American Indian's report *Empowering Tribal Workforce Development.*[67]

Addressing Workforce and Local Hire through Protect-in-Place, Mitigation, & Relocation
As Tribes increasingly face the impacts of accelerated climate change, there is an opportunity to justly and creatively address Indigenous career and workforce development issues. These workforce issues can transcend long-standing inequity issues. Mitigation and adaptation that includes protect-in-place, managed retreat, relocation, Indigenous food security, and energy transition all require innovation and infrastructure (see *Chapter 10: Protection-in-Place & Community-Led Relocation*).

In Alaska, Tribes and regional Tribal consortiums are increasingly including workforce and employment goals in adaptation plans. In the southwest area of the state, the Association of Village Council Presidents, a federally recognized Tribal government consortium of 56 Yup'ik villages in the Yukon-Kuskokwim Delta, identified increasing employment in science, engineering, and fish and game management as a priority. On-the-job training programs to apply emerging technologies in energy generation are identified as actions they plan to implement in their regional 2019 climate adaptation strategy (Beck et al., 2019). The Village of Newtok has workforce development and local hire as priorities that guide the Newtok Planning Team and were included in their first relocation plan, the

[67] NCAI's Empowering Tribal Workforce Development:
https://www.ncai.org/ptg/NCAI_WORKFORCE_DEVELOPMENT_BRIEF_v2.0_2020.pdf

Mertarvik Strategic Management Plan. Also included is a series of guiding principles that Newtok Traditional Council developed and adopted by resolution. One of these principles is about local hire, which states, "Development should: ... Hire community members first." Workforce development was also identified as a strategic focus area in the plan: "Develop a skilled workforce that can pursue, construct, and maintain infrastructure at Mertarvik and help close and restore Newtok." A priority action of the plan is, "Assess existing local workforce skills and identify skills needed to complete upcoming projects; create a training plan to address labor needs and fill strategic skill sets" (Alaska Department of Commerce, Community, and Economic Development, Division of Community and Regional Affairs, 2012).

The Mertarvik Strategic Management Plan serves as the "umbrella document" to other parts of the relocation effort. For example, local hire was a key element of the Mertarvik Housing Master Plan,[68] which describes how community residents were involved in the construction of the demonstration home designed by the Cold Climate Housing Research Center (CCHRC). Aside from the CCHRC instructors, all construction labor was locally hired by the Tribe. As the housing master plan notes, "the local crew who built the home will be able to put their skills to use in future projects. Besides providing well-paying jobs to local residents, this design drastically reduces the cost of construction. The resident family was required to provide at least one household member to take the construction course and work with the crew on the project. The resident was given thorough instruction in all aspects of their home's components, operation, and maintenance requirements" (Alaska Department of Commerce, Community, and Economic Development, Division of Community and Regional Affairs, 2012).

Although Tribal communities are making strides to address workforce development and local hire issues, there is not only a need for Tribes to build workforce capacity, but to retain this capacity. The *Assessment of Indian Forests and Forest Management in the United States*, prepared by the Indian Forest Management Assessment Team (IFMAT), is currently a three-series report, with its most recent addition published in 2013. In the IFMAT III report, workforce education, recruitment, and retention of Tribal professionals in natural resource management were specifically included. Prominent recruitment and retention barriers highlighted within the IFMAT III report include compensation, remote locations, small organizations, and increasing populations of eligible retirees, all of which make it difficult to establish a long-term career within Tribal forest management and natural resources (IFMAT, 2013). The linkage between Tribal colleges and Tribal natural resource and forestry professionals is also suffering from lack of funding for training and continuing education opportunities as well as inconsistent staffing. To bring Tribal forestry up to the level of other forest ownerships, the IFMAT recommends a minimum investment of $100 million and an additional $12.7 million for staff recruitment, retention, and development (IFMAT, 2013).

An additional emerging topic that would be beneficial to Tribes is defining what they believe is workforce development in their climate adaptation and mitigation plans. There are different levels of building capacity. For example, in addition to the "blue collar" workforce, additional capacity will be needed to train Indigenous peoples to work on the actual planning and all other related jobs that require higher education or high-level technical skills and training. These jobs include training

[68] Mertarvik Housing Master Plan: https://www.commerce.alaska.gov/web/Portals/4/pub/mertarvik_housing_master_plan.pdf

Indigenous engineers, planners, project managers, and IT experts to implement and support climate adaptation work.

Rising Role of Tribes in Observing Networks

Indigenous peoples have firsthand knowledge and intimate relationships with the land, air, and sea and, through existing and evolving observation networks, are contributing to the knowledge of the impacts of climate change. Local observers are involved in community-based monitoring or work hand-in-hand with scientists, researchers, and data collectors to provide a clear image of current changes. Observations and a keen awareness of the relationships within the natural world are seen holistically within a worldview that includes people as part of the land or ecosystem. With the onset of the abrupt disruption that came with the global COVID-19 pandemic, there is increased awareness of the significant role local Indigenous observers have in contributing to sustainable observation networks regionally and globally. This observation can align and be defined through an Indigenous framework. In the spring of 2020, the Arctic Observing Summit (AOS), Call to Action, recognized the leadership role of Indigenous peoples in the region in maintaining "critical long-term scientific observations and research infrastructure" (AOS, 2020).

Mainstreaming Climate Change Considerations into Planning

There are opportunities to transform how adaptation planning is approached and mainstreamed into existing Tribal planning efforts and documents. Certain environmental areas, such as "natural resources" and "wildlife" that are represented in Tribal agencies and programs, have opportunities to incorporate adaptation planning in their existing work and to address common areas across Tribal programs to harness shared resources and capacities. Adaptation planning can be included in all planning processes and planning documents in Tribal governments. Given current and future projected climate disruptions, adaptation planning is an active process and occurs simultaneously with implementation.

Tribes are often understaffed and overworked with a limited amount of time and resources to focus solely on climate change. Integrating climate change into already ongoing planning and implementation efforts can be more efficient, less time-consuming, and more cost-effective and can lead to actions that are more sustainable in the long term. Examples of plans in which climate change can be considered include FEMA Tribal Hazard Mitigation Plans and EPA Tribal Environmental, Community Comprehensive, and Land/Resource Management Plans (Dalton et al., 2018; Pletnikoff et al., 2017).

The Bureau of Indian Affairs also produces a variety of plans that could include climate change considerations. Such plans include forest management, wildland fire management, irrigation projects, fish and wildlife, agricultural resources, and integrated resource management, which is a comprehensive management planning program for Tribes that incorporates aspects of planning with various federal agencies. This planning process allows Tribes to do one plan that crosscuts many agencies/issues and reduces the number of plans required instead of working on a separate plan for each issue. The inclusion of climate change could take place as part of regularly occurring plan updates.

Climate Change Planning and Implementation Can Occur Simultaneously

In a typical planning and implementation paradigm, planning occurs first while implementation follows once the planning has been completed. There may be a variety of reasons behind such a paradigm, including optimizing the allocation of adaptation resources and avoiding maladaptation. For many

Tribes, though, climate change impacts are happening now, time and resources to develop plans and shepherd them through Tribal Council approval may be limited, and there is an urgency to take action. Thus, some Tribes are conducting the two processes simultaneously. In addition, some Tribes have found that taking actions in conjunction with the planning process can help build momentum. Tribal communities throughout Alaska, such as Newtok, Napakiak, Point Lay, and Point Hope, have been responding to climate change for decades. In these cases, Tribal communities are taking action before long-term planning occurs. Examples include elevating and relocating buildings and adapting to the change in distribution and abundance of fish and wildlife by traveling farther and using different tools (Nelson and Andrew, 2020).

Funding Issues Related to Climate Change Adaptation Planning and Implementation

Inadequate funding remains one of the greatest barriers for Tribes to create and implement climate adaptation plans (Wotkyns & Gonzalez-Maddux, 2014). Lack of federal funding in turn slows Tribal adaptation planning, extenuating the adverse impacts Tribes face from climate change. A recent publication about the Climate-Ready Tribes Initiative (2020) recommends that specific funding be allocated to Tribes to avoid competition from non-Tribal applicants, as well as simplification of funding applications and technical assistance throughout application processes. Furthermore, TCUs, as the gateway for Tribal workforce development, have an opportunity to advance climate adaptation initiatives, yet also lack the financial resources to adequately support research, education, and outreach related to climate adaptation (Fillmore, Singletary, & Phillips, 2018).

Cross-Boundary Collaborative Implementation

The impacts of climate change are often interconnected and complex, sometimes crossing artificial jurisdictional lines. Collaborative responses at larger geographic scales have the potential to be more cost efficient, inclusive with respect to decision-making, and effectual and sustainable in terms of their benefits for people, nonhuman relatives, and places (Reuling et al., 2015). Tribes are participating in a variety of cross-boundary, collaborative projects. One example is the Rio Grande Water Fund. The Fund was established in 2014 by The Nature Conservancy (TNC) in the aftermath of the 2011 Las Conchas Fire in New Mexico, which grew to more than 150,000 acres. The fund covers a geographic area extending from Belen, New Mexico, north to the Colorado border and includes a number of Native American Pueblos as well as the cities of Albuquerque and Santa Fe, New Mexico (TNC, 2014). The goal of the fund is to "generate sustainable funding for a 20-year program of large-scale forest restoration treatments" to ensure a continuous supply of clean water for the region's people and wildlife (TNC, 2020a; TNC, 2020b). Fund investors include federal, state, county, and city sources as well as private individuals and foundations. Santa Clara Pueblo and others are participating in the planting of "tree-islands" in burned areas of the Jemez Mountains to serve as seed sources for the future. The project engages youth and contributes to workforce development (TNC, 2020). The Pueblo of Jemez is involved in a project to restore the eroded channel of San Antonio Creek. Other examples of cross-boundary, collaborative management and restoration in which Tribes are participating include the U.S. Forest Service's Collaborative Forest Landscape Restoration Program (CFLRP) and the Roundtable on the Crown of the Continent, which includes entities from Montana, Alberta, and British Columbia and Tribes and First Nations residing therein (CFLRP, 2020; Kelly and Kusel, 2015; Reuling et al., 2015).

Additional Collaborative Responses

Collaborative responses to climate change should also "incorporate indigenous values and perspectives to broaden climate adaptation planning to other aspects of society such as, community health, cultural

diversity, and human wellbeing" (see narrative titled *Paradigm Shift: Climate Science Alliance Catalyzing Partnerships for Tribal Cultural and Community Resilience).* The Climate Science Alliance[69] engages in this paradigm shift, as the organization is "committed to amplifying Indigenous voices and integrating traditional practices, values, and knowledge into conservation planning to support and protect people and places," (see narrative *Id*.). Beyond climate adaptation planning efforts, collaborative and interdisciplinary approaches to climate mitigation and action extend to climate justice efforts. One such project is a recently produced video, Music, Indigeneity, and Climate Change,[70] which captures the story of musicians communicating Indigeneity and climate action through song (see narrative titled *Music, Indigeneity, and Climate Change*).

Social Implications

There is a growing body of literature that explores the relationship between climate change and gender violence within Indigenous communities (Acosta et al., 2020; Chase, 2018; Dankelman, 2010; Deer & Nagle, 2017; Vinyeta et al., 2015; Whyte, 2014). Women and two-spirit people are affected in greater ways by certain types of climate change impacts, given their responsibilities and work within their communities. There are also connections to how masculinity is affected by climate change (Vinyeta et al., 2016). These gendered effects can create stresses on mental health, community cohesion, and cultural integrity. Energy and fossil fuel extraction are connected to gender violence and the trafficking of Indigenous persons (Deer & Nagle, 2017; Sweet, 2014). While each Tribe is different, there are nonetheless concerns that in some cases Tribal leadership positions favor heterosexual men (Green, 2007).

Climate change is also closely connected with the maintenance of Indigenous languages. Indigenous persons have understood Indigenous languages as encoding knowledge about climate change and representing temporal, spatial, and spiritual dimensions of relationships with environmental and climatic systems. Changes in climate can also change habitats that are the referents of Indigenous languages and their uses. In response, some Tribes have developed educational initiatives aimed at restoring and maintaining traditional knowledge and languages. For example, many Alaska Native villages hold culture camps that allow elders to share knowledge about traditional language and patterns of ecosystem use (Noodin, 2019; Norton-Smith et al., 2016; Kofinas et al., 2010). There is an urgency associated with education and maintenance of Indigenous languages, which includes both the issue of knowledge of climate change and how climate change can threaten opportunities to communicate through Indigenous language.

Oral history, which is shared through storytelling, must also be included in the process of data collection as it relates to climate change. Some Indigenous stories are over 10,000 years old and provide a solid foundation and baseline for climate change data marking. Utilizing the elders for Indigenous knowledge and storytelling for timeline changes is vital to the survival of this cultural element and the gathering of information that predates modern science monitoring.

[69] Climate Science Alliance: https://www.climatesciencealliance.org/
[70] Music, Indigeneity, and Climate Change: https://www.youtube.com/watch?v=sVo0u95lWbw&feature=youtu.be

Climate-Related Cultural Cascades

Climate cascades are an emerging issue, with a growing number of studies demonstrating tipping points. A climate cascade occurs when climate change triggers high levels of sequential reorganization of ecosystem, biogeochemical, and Earth system processes that are interlinked, coupled, or connected (Lenton et al., 2019).

Kelp forests, for example, are a foundation species and provide multiple benefits to ecological communities and people (Eger et al., 2020; Naar, 2020). They provide habitat and nurseries for a multitude of species, including fish, shellfish, and crustaceans. The canopy they provide alters the surrounding environment and stabilizes it. They remove and store carbon and other pollutants from the water. They dampen wave energy, reducing shoreline damage and erosion. Bull kelp in northern California has been reduced by over 90% by a variety of factors. Kelp is sensitive to temperature and is globally threatened by marine warming and heat waves induced by climate change (Smale, 2020). Outer coastal southern giant kelp and bull kelp populations are more affected than Pacific Northwest populations that are currently maintained by cold upwelling, although there is concern about future warming and climate impacts on shallow areas of inland marine waters such as the Puget Sound (Calloway et al., 2020; Smale, 2020). Combined climate and nonclimate stressor-induced loss of these kelp forests leads to multiple and cascading failures in ecosystem services and functions, changes in species interactions and composition, ecological simplification, and associated economic and cultural values (Eger et al., 2020; Naar, 2020).

There is still considerable uncertainty and disputes over the occurrence, extent, attribution, and predictability of cascades, but they have been demonstrated in some systems and in the geological record (Harley et al., 2006; Steffen et al., 2018). Cascades and tipping points are not ubiquitous, as systems may exhibit resilience in response to climate change (Ford et al., 2020). The ability to understand and predict climate cascades is improving but complex.

A growing body of research documents cascading climate impacts on economic and social, trade-related, financial, market, aid, and other socioeconomic factors associated with abiotic and biotic changes (CASCADES, 2020; Lawrence et al., 2020). These cascades arise from the complex connections, relations, and interactions among multiple systems, climate and nonclimate drivers, and direct and indirect impact pathways.

Recent research also supports the existence of cultural cascades that reflect strong human–environment relationships of Indigenous peoples with the natural world (Yletyinen et al., 2019; Yletyinen et al., 2020). These strong relationships can be both a source of vulnerability and a source of resilience, influenced by factors related to place, agency, institutions, collective action, Indigenous knowledge, and learning (Ford et al., 2020). Tribes are experiencing climate impacts in the context of multiple nonclimate factors such as historical and ongoing traumas, urbanization, territorial encroachment, habitat, and landscape fragmentation (Ford et al., 2020). Tribes are also experiencing considerable pressures from other emerging climate change impacts such as wildfires and pandemics.

Climate change impacts on the severity and extent of wildfires have multiple effects on Tribes. Tribes have historically used traditional knowledges of fires in cultural burning practices to manage the environment for culturally desired species (Steen Adams et al., 2019). Patch-scale and low-intensity wildfires are being replaced by landscape-scale and high-intensity wildfires that have many long-lasting

consequences. Some of the cascading consequences include significantly increased erosion, escalating costs of firefighting and diminished funds available for other Tribal needs, loss of forest-related economies, loss of the ability to continue traditional, spiritual, and cultural practices on the land, and the erosion of traditional knowledge (Norgaard, 2014). These impacts can be exacerbated by the denial of Tribal access to use cultural burnings. Reciprocally, the use of cultural burning can help prevent and increase Tribal resilience to potential climate cascades (Long & Lake, 2018).

Pandemics can also lead to cultural cascades. Pandemics have multiple origins, such as through higher human population numbers and densities and wildlife-borne zoonotics. There is growing evidence that climate change can directly influence the origin and spread of pandemics or indirectly affect them through human responses to climate change, as well as influence the spread of pandemics through culturally important wildlife populations (Azevedo et al., 2020; Sanderson & Alexander, 2020). Pandemics have impacts on the cultural and economic activities of Tribes through lockdowns and restrictions of markets and nonmarket consumption of wild game (Lane, 2020). The current COVID-19 pandemic is disproportionately affecting both Tribes and Tribal elders and restricting the practice and transmission of Indigenous knowledges. The death of knowledge holders may have long-lasting and potentially transformational impacts on Tribes (Chinn, 2021; Smith-Morris, 2020). Detailed studies are lacking, but there are some signs that Tribes have solutions to prevent or mitigate these impacts, such as through forest protection and restoration and the use of traditional knowledges (Sen, 2020; Smith Morris, 2020).

Much more work needs to be done on understanding and characterizing cultural cascades in the context of climate change. Outstanding questions include: what determines whether a given impact or set of impacts results in increased resilience or vulnerability to a cascade? If a cascade occurs, what determines the depth or extent of a cascade and whether impacts are reversible or irreversible? Are there indicators for an approaching cultural tipping point?

Tribal Leadership & Engagement

The energy transition away from fossil fuels is a critical mitigation step for climate change. Yet there are questions about whether there will be genuine Tribal leadership in the energy transition or whether Tribes will be passive actors while others make decisions. Currently, Tribes are in situations of dependency regarding where their energy comes from. Tribes have long histories of having to adapt to the fossil fuel industry, including their efforts to stop the U.S. from leasing Tribal lands to private companies at lower rates of profitability and concerns about safety and environmental risks. Given this history, it is important that the energy transition not repeat the problems of the past. A growing literature is showing that the U.S. energy sector has still not created programs in which Tribes can emerge as leaders. (See *Chapter 7: Energy & a Just Transition*.)

Although Tribes are not the largest consumers or producers of fossil fuels in the U.S., there is tremendous potential for Tribal governments to reduce greenhouse gas emissions. Since the *Energy & a Just Transition* chapter highlighted the renewable energy development potential for Tribes, this chapter will showcase another means of carbon reduction, the sale of carbon credit markets. Recently, The National Indian Carbon Coalition (NICC)[71] has supported three projects: the Lower Brule, the Fond du Lac

[71] National Indian Carbon Coalition (NICC): https://www.indiancarbon.org/about-us/

Band of Lake Superior Chippewa, and the Keweenaw Bay Indian Community[72] with carbon credit projects. In July 2020, The Fond du Lac Band of Lake Superior Chippewa "approved a forest-based carbon sequestration project...which will quantify greenhouse gas emission reductions that exceed current forest management practices...sequestering more than 77 metric tons of carbon dioxide...and earning the Tribe approximately $4 million over a 40-year timeframe" (NICC, 2020). These types of projects exemplify the potential Tribes have to mitigate climate change through greenhouse gas reduction efforts as well as provide financial prosperity and stability for the Tribes. (See also *Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets*.)

Conclusion

While there are an extensive number of emerging issues pertaining to Tribes and climate change, the authors of the STACC Report highlighted the issues most pertinent at this time. The examples featured in this chapter intend to support and uplift Tribal climate change mitigation and adaptation efforts and to provide pathways forward for success.

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CONCLUSIONS, KEY MESSAGES, & RECOMMENDATIONS

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The 2021 *Status of Tribes and Climate Change Report* demonstrates the unique impacts from climate change experienced by Tribes and the many ways in which Tribal communities are responding and leading the way. Gaining an understanding of Tribal worldviews, Indigenous knowledges, and the increased vulnerabilities that many Tribal communities face may lead to improved responses to climate change in the U.S. and greater environmental and social justice for the original peoples of this land. When we recognize we are not separate from our natural environment and value justice, equity, and respect for all of our relations, we may collectively achieve a society in which all can thrive.

The close relationship that Tribes have with their lands, waters, resources, and heritage includes a responsibility to one another, to all relations, and to the past and future generations of human and nonhuman relatives alike. One way of understanding the holistic systems of Indigenous peoples is that they are generally tightly interwoven with many compounding dimensions such that impact on one dimension can lead to cascading impacts on other dimensions. Close Tribal reliance on and interconnectedness with the natural world make them particularly vulnerable to cascading effects, but also particularly well-positioned to recognize, adapt to, and mitigate both current and future climatic changes. Many climate accounts do not address the intangible dimensions of climate change or characterize the dimensions as psychological, social, or spiritual categories, which are important considerations and are often a focal point of Tribal experiences and responses.

The challenges facing Tribes in relation to climate change are complex and involve many aspects that are either unique to them or amplified by cultural, environmental, historical, economic, livelihood, political, legal, and other contexts. The historical context of settler colonialism and failures to adequately uphold Tribal treaties as the supreme law of the land must be taken into account in understanding climate impacts on Tribes. The health and broader cultural impacts of the initial wave of settlement are now being repeated under COVID-19 failures to protect Tribes, such as water and food insecurity, job losses, access to healthcare, and the digital disconnect.

Tribes must be closely involved at all stages of climate action cycles, from conceptualization, proposals, development, and design to implementation, management, monitoring, review, and revision. There are actions Tribes can—and do—take for their own territories and homelands. Tribes must be involved in characterizing and developing indicators of these impacts on their own terms. Treaty, Tribal trust, human rights, and obligations arising from constructive arrangements between Tribes and the United

States must be fully implemented in order for Tribes to exert their sovereignty to address climate impacts and advance their resiliency.

The authors of the STACC Report have indicated the following Key Messages and Recommendations:

Chapter 1: History of Indigenous Peoples in NCAs

Key Message

Indigenous peoples have been substantively involved in national and international climate assessments for decades, and this involvement has grown, including more Indigenous engagement and authorship on the third and fourth National Climate Assessments. There is still much work to be done to engage and include Indigenous perspectives, knowledge, and expertise in climate assessments.

Recommendation

Future reforms to make NCAs more inclusive should acknowledge, learn from, and build on Indigenous peoples' involvement throughout the history of the U.S. Global Change Research Program.

Chapter 2: Worldviews, Knowledges, & Social Impacts

Key Messages

- Indigenous peoples have their own systems of governance that have norms of behavior for land use and land care.
- A growing dialogue among some Indigenous peoples articulates Indigenous knowledge systems through an understanding that all things are interconnected.
- Legacies left by colonialism in economic, social, environmental, and educational systems have altered lifeways, traditions, practices, customs, and values of Indigenous peoples, influencing their understanding of how climate change affects their daily lives and opportunities for adaptation.

Recommendation

Climate change policy and climate science fields should respect Indigenous self-determination in governance and knowledge exchange. Indigenous peoples should be consulted meaningfully from the earliest stages of policy and research development. Legal, policy, ethical, and cultural best practices and requirements should be followed to make consultation meaningful.

Chapter 3: Actionable Science & Collaborative Climate Planning

Key Messages

- Tribes are investing efforts in adaptation planning and projects to keep their communities, ecosystems, and people healthy. In doing so, they are implementing the most cutting-edge work on climate. Tribal nations are actively creating climate-vulnerability assessments, adaptation plans, and hazard-mitigation plans. Protecting traditional knowledges is an important part of these processes.
- Locally relevant and regionally specific information is needed to understand local climate impacts and develop solutions that incorporate local, traditional, and Western knowledge for holistic solutions.
- Actionable science co-produced in partnership with Indigenous peoples can support Tribal resource management decision-making.

Recommendation

Support Tribal sovereignty and self-determination through Tribally-led climate adaptation planning to allow Tribes to prepare for climate uncertainty and associated risks. Management decision-making should involve consultation with Tribes early and often, co-production of actionable science, and the incorporation of local knowledge.

Chapter 4: Ecosystems & Biodiversity

Key Message

Indigenous peoples' worldviews are often explicit in their centering of relationality, responsibility, and reciprocity as critical concepts. These concepts may inform Indigenous responses to climate change impacts. Examples of these impacts include increases in destructive wildfires and invasive species and decreases in ice cover due to warming temperatures. Indigenous actions to address climate change are vast, but some specifics include cultural burning, protection of keystone species, and observation and evaluation of invasive species before deciding how to respond.

Recommendation

Indigenous peoples' self-determination as practitioners of biodiversity conservation and ecological protection should be respected and reinforced. This can be accomplished through collaboration across jurisdictions; consultation and consent in the first stages of land and water planning, research, and management processes; increasing support mechanisms for the exercise of Tribal sovereignty; and the removal of barriers to Indigenous peoples' rights to implementing land management practices. Special measures need to be taken to provide access to and management of off-reservation areas to promote the retention of culturally valued species to the maximum extent possible. This helps to ensure the promotion and maintenance of Indigenous economies, traditional knowledge systems, livelihoods, meanings, and identities. Where retention is not feasible, measures are needed to support Tribes in making new relationships with newly arriving living beings.

Chapter 4.1: Air

Key Messages

- The federal government must uphold Tribal sovereignty, authority, and co-management rights for air quality management. Impediments to exercising sovereignty could be removed. For example, Tribes should be allowed to perform traditional fire-prevention activities on their lands, such as cultural burning of the landscape to prevent wildland fires.
- Tribes experience disproportionate impacts from poor air quality, including smoke/fine particulates, heat, and humidity, all of which can be connected to climate change. These factors are believed to impact rates of mortality and morbidity from COVID-19.

Recommendation

Fully engage Tribes as co-regulators in the very first stages of air quality regulatory planning, development, implementation, and enforcement. Adequate funding of air quality programs for staffing, monitoring, and emergency response to air quality issues supports Tribal sovereignty, as does addressing underlying causes of environmental, social, and health inequalities and injustices with the full participation of Tribal peoples.

Chapter 4.2: Water

Key Messages

- Climate change is negatively impacting water quality, increasing ocean acidification, leading to an increase in the frequency and duration of harmful algae and biotoxin events, increasing drought, negatively impacting water and food security, causing coastal inundation, and, in places, increasing riverine flooding. Even water storage reservoirs and flood management infrastructure operations and management are impacted. Each of these impacts can threaten local economies, human and non-human health and wellbeing, and Indigenous lifeways.
- Tribes and Alaska Natives are responding to these threats by drawing on traditional knowledge; observing and monitoring water sources and the linked hydrological, climatological, and ecological systems and connections; utilizing new tools; forming partnerships; creating adaptation and contingency plans; and through adaptation itself.

Recommendation

Emphasis should be on early, meaningful, and sustained engagement and consultation by federal and state regulatory and other agencies on both water quality and availability and on the associated food and water security impacts of contamination, ocean acidification, hazardous algal and biotoxin events, and risks associated with both drought and flooding. Tribes and Alaska Natives should be supported in implementing Tribally-led planning and solutions, partnerships, and cooperative efforts.

Chapter 4.2.1: Drinking Water Infrastructure

Key Messages

- Tens of thousands of Native Americans do not have access to safe drinking water. Climate change has the potential to exacerbate this lack of access.
- Operation and maintenance (O&M) of water systems is key to sustainability, cost effectiveness, and, most importantly, the ability to supply safe and reliable drinking water. Proper O&M require adequate funding, staffing, and technical, managerial, and financial training. Proper O&M may become even more critical with climate change as systems respond to increasingly extreme climate events and greater uncertainty with respect to water quantity and quality conditions.
- Water infrastructure deficiencies provide opportunities to install climate-resilient infrastructure.

Recommendation

Climate change is making it more urgent to increase resources for Tribal drinking water infrastructure and for operation and maintenance to eliminate disparities in safe drinking water access and increase infrastructure resilience to climate-related disasters and impacts.

Chapter 5: Health & Wellbeing

Key Messages

- Indigenous peoples' health and wellbeing (HWB) is founded on mutually beneficial relationships among humans, nonhuman relatives, and the environment; therefore, HWB is highly impacted by climate change

- Social-emotional health, water security, and first foods security (includes foods, medicines, and technologies) are key aspects of Indigenous peoples' health and wellbeing that merit increased attention and rapid adaptation at local scales due to Indigenous peoples' unique cultures and worldviews
- Indigenous peoples' resilience is strong; supporting community-defined climate strategies and capacity building within Indigenous communities will augment resilience

Recommendation

Accelerate incorporating Tribal HWB evaluations, priorities, and action plans into government policy, laws, and decision-making.

Chapter 6: Economic Development: Renewables, Sustainable Economies, & Carbon Offsets

Key Message

Indigenous science, knowledges, philosophies, and heritages guide Tribal self-determination in rediscovering economic sovereignty through pursuing, among other sustainable enterprises, renewable energy development, carbon sequestration via carbon markets, water and food security, and subsistence-based enterprises.

Recommendations

- Address complex land tenure, fractionation, and checkerboard jurisdictional boundary issues that persist on reservation lands and may constrain Tribal economic sovereignty.
- Invest in capacity building that increases in-house legal, technical, vocational, and varied fields of research expertise to strengthen Tribal economic self-determination while mitigating the effects of and adapting to a changing climate.

Chapter 7: Energy & a Just Transition

Key Messages

- An Indigenous just transition is an Indigenous-led transition to an Indigenous-based, nonextractive, regenerative economy that transforms community planning and ecosystem restoration.
- Indigenous peoples have been deeply affected by extractive industries such as the fossil fuel and uranium mining industries.
- Tribal lands have tremendous renewable energy development potential, which could help Tribes achieve energy and economic independence, sovereignty, and stability.

Recommendation

Remove barriers to renewable energy development, while supporting Indigenous people in a just transition, to reduce reliance on and negative impacts from fossil fuels and nuclear energy. The most significant barriers to the development of renewable energy on Tribal lands are a lack of financing, infrastructure, training in renewable energy careers, resources to access that training, and inadequately supported Tribal leadership and staff.

Chapter 8: Cultural Resources

Key Messages

- Tribal cultural resources include intangible cultural beliefs, practices, and traditions as well as tangible physical sites, landscapes, plants, and animals.

- Tribal climate change mitigation strategies should include considerations of both tangible and intangible cultural resources.

Recommendation

Integrate the tangible and intangible cultural, spiritual, and traditional significance of plants, animals, ecosystems, and landscapes into analyses of the consequences of climate change.

Chapter 9: Emergency Management

Key Messages

- It is estimated that currently less than 25% of all Tribal nations have an Office of Emergency Management, and less than 10% of those have full-time emergency managers. Without a Tribal emergency management program, it is deeply challenging to implement and adhere to a number of federal mandates and policies.
- Native Americans have a long and varied history of storytelling and culturally unique ways of communicating with one another and with other communities. When seeking to communicate with Tribes, this rich tradition of storytelling and oral histories should be incorporated.
- Barriers such as a lack of effective leadership at state and federal levels of government have prevented Tribal emergency management programs from making greater progress on responding to and mitigating climate-driven hazards.

Recommendation

Increase resources and support at the state and federal levels to develop Tribal emergency management programs across Tribal nations. Increase coordination with Tribal nations to respond to and prepare for climate-driven hazards.

Chapter 10: Protection-in-Place & Community-Led Relocation

Key Messages

- Climate change impacts on infrastructure can be an existential threat to communities and profoundly impacts the health, wellbeing, and safety of residents as well as Tribal lands, territories, and resources.
- Many Tribal communities are pursuing adaptation actions, including protection-in-place, moving infrastructure within or adjacent to the current site, and community-led relocation.
- Lack of funding, agency coordination, local capacity, and technical assistance are the primary barriers to protecting infrastructure.
- Nationwide, at least $6.2 billion is needed over the next 50 years to protect, replace, and move existing Tribal infrastructure (ATNI, 2020; DOI, 2020). This amount includes at least $175 million needed annually nationwide over the next 10 years.
- Due to inequitable regulatory barriers and program design, small Tribal communities are generally disadvantaged or excluded from federal programs relevant to climate adaptation.
- There is an immediate, urgent need for action to support Tribal nations and Indigenous communities on the frontlines of the climate crisis.

Recommendations

- Provide at least $175 million annually for proactive adaptation projects that empower and honor community decision-making, sovereignty, and self-determination, consistent with the federal government's trust and treaty responsibilities. This can be accomplished by dedicating funding to a lead agency and reducing barriers that Tribal communities face in accessing existing programs and resources.
- Create an all-of-government coordination structure to support Tribes in addressing environmental threats.

Chapter 11: Solid Waste

Key Messages

- The component of Tribal solid waste systems that is most affected by climate change and has the furthest reaching implications is that of infrastructure. An infrastructure system that continues to be stressed has lasting impacts on the amount of illegal dumping on Tribal lands, the transportation of waste in and out of Tribal communities, and the supply and demand of local recycling markets.
- The data gaps that exist in the world of Tribal solid waste management are extensive and cause a delay in responding to the demands of new conditions created by climate change.

Recommendation

Allocate funding through a streamlined federal funding process (perhaps an interagency clearing house or memorandums of understandings) to ensure Tribal infrastructure is prepared to withstand changes in climate and extreme weather events, and collaborate with Tribes to develop an inventory and evaluation of infrastructure related to solid waste in Tribal communities. This should include roads, facilities, and equipment. Focus on regional coordination to allow for idea sharing around climate change impacts, adaptations, and resources already available to help eliminate data gaps.

Chapter 12: Emerging Topics

Key Messages

- Integrating Tribal workforce development and supporting Tribal Colleges and Universities can lead to greater climate resiliency and Tribal sovereignty and can create opportunities to educate and train future Indigenous generations in climate-related fields if administered additional funding and resources.
- There are many climate-related cultural cascades, including economic and social, Indigenous relationships with the natural world, and pandemics.
- Tribal nations are sovereign, and the U.S. federal government, in meeting its intent to address climate, environmental justice, and racial justice, should work collaboratively to support Tribes to engage in internal diplomatic relations. Other collaborations across jurisdictions and Tribal governments should be considered to enhance climate-planning efforts.

Recommendation

Recognizing that climate-related cultural cascades, including economic and social, affect Indigenous relationships with the natural world, Tribes and Tribal partners should support collaborative climate-planning efforts across jurisdictions and Tribal governments, including Tribal Colleges and Universities

and other workforce development opportunities such as prioritizing Indigenous knowledge and labor. These practices will lead to stronger climate resiliency and sovereignty efforts.

Appendix A: Funding

Recommendation

Increase funding mechanisms that are reflective of the unique needs of Tribal nations, including resources for workforce development, overall capacity building, implementation of climate adaptation projects, and zero cost-share grants.

APPENDIX A: FUNDING

Funding Recommendation

Increase funding mechanisms that are reflective of the unique needs of Tribal nations, including resources for workforce development, overall capacity building, implementation of climate adaptation projects, and zero cost-share grants.

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Introduction

Tribal climate change initiatives depend on accessible and sustained support. When funding is not available within Tribal governments, external sources of funding are critical. Federal grants, support from foundations, and even private sources of funding can ensure that Tribes have the resources necessary to see projects through from planning to implementation. While grants specific to climate change can be extraordinarily beneficial, other types of grants and funding sources can help Tribes to accomplish climate-related goals through a wide range of initiatives that pertain to other Tribal departments, including natural resources, public health, education, economy, and more.

This funding appendix seeks to highlight key resources to assist Tribes in developing funding strategies for Tribal climate change projects. The appendix uses the overall structure of the report to highlight examples of grants by sector and then identifies several recommendations related to increasing funding and improving support for Tribes working to address climate change.

Analysis of Funding Climate Change at Tribal Nations

Throughout the *Status of Tribes and Climate Change Report*, the authors highlighted major themes in funding climate change at Tribal nations. Some of these major themes include:

- Importance of the federal trust responsibility
- Capacity issues and lack of in-house technical expertise
- The lack of baseline funding combined with project-by-project funding cycles, making building broader resilience a challenge
- Grant requirements can create a heavier burden on smaller Tribal administrations
- Employee retention issues connected to funding, which lead to a loss in productivity
- Time delays and bureaucratic processes as roadblocks in a time-sensitive field
- The need for increased implementation funding to turn planning into action
- The need for funding to scope the potential for a project or build relationships to create or sustain projects
- The lack of flexible gap-seed funding to get something started or help sustain until permanent funding can be found (especially in a time of COVID, funds were reallocated to address critical needs while leaving projects and planning without the resources to pick up again once it is safe to do so)

General Recommendations

Throughout this Report, the authors discussed ways to improve funding efforts in their respective sectors or areas of focus. Each of these sectors or areas of focus may have specific recommendations that are unique. In this section, a general overview is provided that more broadly reiterates recommendations for funding that might assist climate adaptation and mitigation for Tribal nations.

1. Invest in Tribal administration to improve staff retention and build capacity for addressing climate change. Staff turnover and lack of capacity are challenges with any organization, and even more so for Tribal nations trying to address climate change. Finding and retaining talented, capable staff is a significant barrier to addressing climate change and is often constrained by insufficient funding. Ways to improve this might be funding a full-time climate change coordinator position at each federally recognized Tribal nation or allocating funding for multiple part-time positions. This could be funded through various entities such as the EPA's General Assistance Program or through BIA's Tribal Resilience Program.

2. Remove cost share from climate change related grants for Tribal nations that meet needs-based requirements. Currently, there are federal grants that still require some type of cost-share requirement that is out of reach for a large number of Tribal nations. For example, FEMA's Hazard Mitigation Assistance Programs require 10% cost share, which makes them inaccessible for most Alaska Native communities (ANTHC, 2020).

3. Provide incentives for collaboration across departments within Tribal administrations. Much like any bureaucracy, there is rarely cross-departmental coordination within Tribal governments. For an existential threat like climate change, all resources and efforts could be brought to bear within the Tribal government. While it should not be mandatory, funders could encourage and incentivize this type of coordination through their proposal-scoring process by explicitly valuing this coordination in the criteria.

4. Utilize resources at the state level when they exist. For example, the California state government has programming and funding in place for climate change related planning and projects. Many of these funding sources also have dedicated funding calls for federally and state-recognized Tribes. Specifically, the California Strategic Growth Council Tribal Government Challenge Planning Grant Program provides funding for California Tribes to conduct planning to identify solutions to reduce greenhouse gas emissions, improve clean energy access, and advance climate adaptation and resiliency on Tribal lands and in Tribal communities. Similar funding opportunities are available across North America.

Funding Resources

Federal grants provide a direct source of support for Tribes to address a wide range of climate change related issues. Grants.gov is a key source of information on available grants, deadlines, Tribal eligibility, and other information. Several federal agencies have websites with information dedicated to showcasing sources of funding to address climate change. The Environmental Protection Agency, for example, lists current and recent grants related to climate change that may be of interest to Tribes here: https://www.epa.gov/research-grants/climate-change-research-grants.

There are numerous sources of information on Tribal climate change grants, including several organizations that provide regular listings of grants that may pertain to Tribal climate change efforts. These funding clearinghouses and databases include:

- Institute for Tribal Environmental Professionals Climate Change Funding Resources. This page includes a list of relevant grants and resources to assist Tribes seeking funds for climate change

efforts. ITEP also includes funding notices in their monthly newsletter. https://www7.nau.edu/itep/main/tcc/Resources/funding

- Tribal Climate Change Guide. This online database is part of the Pacific Northwest Tribal Climate Change Project at the University of Oregon. The searchable database is updated weekly and includes a search mechanism to assist users in identifying funding sources by geography, sector, or other key search terms. https://tribalclimateguide.uoregon.edu/
- Climate Adaptation Science Centers funding resources
- Bureau of Indian Affairs Climate Adaptation Science Center Tribal Liaisons
- American Indian Higher Education Consortium

Grants by Sector

The following section includes examples of grant sources that could assist Tribes in addressing issues aligned within the STACC Report. This is not a comprehensive list but could be expanded over time.

Ecosystems & Biodiversity, Air, and Water

- **National Coastal Resilience Fund.** The National Coastal Resilience Fund restores, increases, and strengthens natural infrastructure to protect coastal communities while also enhancing habitats for fish and wildlife. Established in 2018, the National Coastal Resilience Fund invests in conservation projects that restore or expand natural features such as coastal marshes and wetlands, dune and beach systems, oyster and coral reefs, forests, coastal rivers and floodplains, and barrier islands that minimize the impacts of storms and other naturally occurring events on nearby communities.

- **Bureau of Reclamation WaterSMART Grants:** Water and Energy Efficiency Grants. The objective of this funding announcement is to invite states, Tribes, irrigation districts, water districts, and other organizations with water- or power-delivery authority to leverage their money and resources by cost sharing with Reclamation on projects that seek to conserve and use water more efficiently; increase the production of hydropower; mitigate conflict risk in areas at a high risk of future water conflict; enable farmers to make additional on-farm improvements in the future, including improvements that may be eligible for Natural Resources Conservation Service (NRCS) funding; and accomplish other benefits that contribute to water supply reliability in the western United States. https://www.grants.gov/web/grants/view-opportunity.html?oppId=319158

- **Wildlife Conservation Society Climate Adaptation Fund**: The WCS Climate Adaptation Fund provides a total of $2.5 million in grant awards between $50,000 and $250,000 to conservation nonprofit organizations each year. Eligible applicants must be U.S.-based nonprofit conservation organizations with approved IRS 501(c)(3) status, but the funding organization encourages collaborative projects. https://www.wcsclimateadaptationfund.org/program-information

- **Indian Land Tenure Foundation** makes grants to Indian nations and nonprofit organizations for land-related initiatives in education, cultural awareness, economic opportunity, and legal reform. https://iltf.org/grants/

- **NOAA Sea Grant**. State Sea Grant Programs provide funding opportunities for a variety of topics within Sea Grant's strategic priorities. The NOAA Sea Grant website provides a table with opportunities available within each state program. Sea Grant supports students on their path to marine and coastal careers. NOAA Sea Grant also supports undergraduate and graduate

students in finding career development opportunities through scholarships, internships, and fellowships. For more information on NOAA Sea Grant funding opportunities, visit https://seagrant.noaa.gov/Funding.

- **NOAA Climate Program Office.** The NOAA Climate Adaptation and Mitigation Program (CAMP) supports research, programs, projects, and other activities related to NOAA's mission, primarily through collaborations among scientists and professionals in areas of mutual interest across the full spectrum of NOAA climate sciences. https://www.climate.noaa.gov/Funding-Opportunities/A-Cooperative-Agreement-for-Climate-Adaptation-and-Mitigation-2021-Funding-Opportunity

Drinking Water Infrastructure

- **Tribal Resource Directory Matrix of Federal Assistance for Water and Wastewater Treatment Services.** The Environmental Protection Agency has shared a Tribal Resource Directory Matrix of Federal Assistance for Water and Wastewater Treatment Services. The Tribal Infrastructure Task Force Federal partner agencies have developed a matrix summarizing the various federal assistance vehicles for water and wastewater treatment services in Indian country and Alaska Native villages. This matrix was developed in 2018 and includes links to information on grant programs, loans, and other funding sources to address water and wastewater infrastructure. The matrix can be found here: https://www.epa.gov/sites/production/files/2019-03/documents/itf_funding_eligibility_matrix_pdf_dec_2018_508c.pdf

Health & Wellbeing

- **National Indian Health Board Climate Ready Tribes Grants**. https://www.nihb.org/public_health/climate_resources.php#funding

- First Nations Development Initiative. Native Agriculture and Food Systems Scholarships (NAFSI). Applications are now being accepted for the NAFSI Scholarship Program, which aims to advance Native food sovereignty and improve overall health. First Nations will award 20 to 25 scholarships of $1,000 to $1,500 each for the 2020–2021 academic school year to Native college students majoring in agriculture and agriculture-related fields. https://www.firstnations.org/grantmaking-scholarship/

- **The Christensen Fund**. Includes a focus area related to agrobiodiversity and food sovereignty. Their grants support Indigenous peoples' efforts to secure and exercise their rights to their land, territories, resources, and sovereign systems of governance. They currently do not have any open application windows for funding in 2020 and will be unable to respond to any unsolicited proposals. Please check back for information regarding funding opportunities for 2021. https://www.christensenfund.org/funding/

Economic Development

- **Native American Business Development Institute Grant**. The U.S. BIA is soliciting proposals from Tribes for technical assistance funding to hire consultants to perform feasibility studies of economic development opportunities located in designated Opportunity Zones. These grants are also intended to fund applicants to obtain qualified guidance on how the development projects, businesses, or technologies they propose can attract investments from an Opportunity Fund. https://www.federalregister.gov/documents/2020/06/17/2020-13063/native-american-business-development-institute-nabdi-grant-solicitation-of-proposals

Energy & a Just Transition

- **U.S. Department of Energy. Energy Deployment on Tribal Lands**. The Office of Indian Energy Policy and Programs includes current funding opportunities here: https://www.energy.gov/indianenergy/funding. The Office of Indian Energy Policy and Programs also maintains a database of Tribal Energy Projects. https://www.energy.gov/indianenergy/tribal-energy-projects-database

- **The Tribal Solar Accelerator Fund** aims to catalyze the growth of solar energy and expand solar job opportunities in Tribal communities across the United States. https://tribalsolaraccelerator.org/

- **U.S. DOI's Tribal Energy Program** provides financial and technical assistance that enables Tribes to evaluate and develop their renewable energy resources and reduce their energy consumption through efficiency and weatherization. The program also offers education and training opportunities designed to foster clean energy–technology adoption, promote green jobs and growth, and strengthen native communities. https://www.energy.gov/indianenergy/office-indian-energy-policy-and-programs

Cultural Resources

- **The National Park Service (NPS) Cultural Resources, Partnerships, and Science directorate** administers a variety of federal grant programs that help protect our nation's significant historic and cultural sites and preserve our diverse cultural heritage. The State, Tribal and Local Plans & Grants division (formerly the Historic Preservation Grants division) works in partnership with other Cultural Resource programs to administer grant programs. https://www.nps.gov/history/tribes/financial_assistance.htm
- **BIA Tribal Climate Resilience Fund** has been used for climate planning for cultural resources in Southern California. https://www.bia.gov/bia/ots/tribal-resilience-program

Emergency Management

- **Federal Emergency Management Agency Hazard Mitigation Grants**. FEMA's hazard mitigation assistance provides funding for eligible mitigation measures that reduce disaster losses. More information is available here: https://www.fema.gov/grants/mitigation. Specific programs include:
  - Hazard Mitigation Grant Program (HMGP). Assists in implementing long-term hazard mitigation planning and projects following a presidential major disaster declaration.
  - HMGP Post Fire Grant. Assistance available to help communities implement hazard mitigation measures after wildfire disasters.
  - Flood Mitigation Assistance (FMA) Program. Provides funds for planning and projects to reduce or eliminate risk of flood damage to buildings that are insured annually under the National Flood Insurance Program.
  - Building Resilient Infrastructure & Communities (BRIC). Supports states, local communities, Tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards.
  - Pre-Disaster Mitigation (PDM) Program. Provides funds annually for hazard mitigation planning and projects.

Protection-in-Place & Community-Led Relocation

- **BIA Tribal Climate Resilience Program**. Provides direct support for adaptation planning and capacity building (including planning, training and workshops and travel support), ocean and coastal management planning, and relocation, managed retreat, or protect-in-place planning. Funded annually since 2011. More information on guidelines and awards available here: https://www.bia.gov/bia/ots/tribal-resilience-program

- **Climate Justice Resilience Fund (CJRF)**. The Arctic is warming twice as fast as the rest of the world. Its residents face risky travel across melting ice and tundra, rapid change in important wild food sources, and severe coastal erosion that is forcing whole communities to relocate. CJRF gives grants to help Indigenous communities in Alaska, Canada, and Greenland strengthen their resilience to these climate change issues. https://www.cjrfund.org/arctic-grants

- **U.S. Department of Housing and Urban Development (HUD) Healthy Homes Technical Studies Grant Program** assists academic institutions, nonprofit and for-profit organizations (provided no fees are charged for services), states, Native American Tribes, and local governments to develop the most promising, cost-effective methods for identifying and controlling housing-related hazards and build local capacity to operate sustainable programs to prevent, minimize, and control housing-related hazards in eligible residences. https://www.hud.gov/program_offices/healthy_homes/hhi/hhts

Solid Waste

- **EPA Hazardous Waste Management Grant Program for Tribes**. Provides financial assistance to Tribal governments and Tribal consortia for the development and implementation of hazardous waste programs; for building capacity to improve and maintain regulatory compliance; and for developing solutions to address improper management of hazardous waste on Tribal lands. https://www.epa.gov/tribal-lands/hazardous-waste-management-grant-program-tribes

Education and Outreach

- **NOAA's Environmental Literacy Program** provides funding to communities across the country to help them build the environmental literacy necessary for resilience to extreme weather events and other environmental hazards. https://www.noaa.gov/office-education/elp/grants

- **EPA Environmental Education Grants**. Under the Environmental Education Grants Program, EPA seeks grant applications from eligible applicants to support environmental education projects that promote environmental awareness and stewardship and help provide people with the skills to take responsible actions to protect the environment. https://www.epa.gov/education/grants

Funding References

[ANTHC] Alaska Native Tribal Health Consortium. Center for Environmentally Threatened Communities. 2020. Appendix C. Summary of Relevant Findings.

APPENDIX B: RESOURCES FOR TRIBES

Background

With the increasing number of projects addressing climate change, there are a growing number of resources. Many of these resources are based on the needs of a wide range of nonprofit, for-profit, academic, federal, and state agencies and Tribal and Indigenous communities.

Chapter Lead
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Adaptation Clearinghouse

An online database and networking site that serves policymakers and others who are working to help communities adapt to climate change. Powered by Georgetown Climate Center and users like you.

AirNow and AirNow Tribal Partners

The AirNow system, developed in 1998 by the EPA, NOAA, NPS, and several state, local, and Tribal partners, provides the public with easy access to real-time national air quality information. The AirNow Air Quality Index informs the public about the existing air quality and the associated health effects of concern and, through a system of numbers and colors, helps people understand what actions they can take in order to protect their health. Twenty-nine Tribal partners in 13 states are actively engaged in AirNow.

Alaska Native Tribal Health Consortium (ANTHC)

A nonprofit Tribal health organization designed to meet the unique health needs of Alaska Native and American Indian people living in Alaska.

- Alaska Rural Utility Collaborative Building Self-Supporting Communities

American Indian Higher Education Consortium (AIHEC)

Provides leadership and influences public policy on American Indian and Alaska Native higher education issues through advocacy, research, and programmatic initiatives; promotes and strengthens Indigenous languages, cultures, communities, lands, and Tribal nations; and, through its unique position, serves member institutions and emerging TCUs.

ASPIRE Study

Studying the impacts of wildfire smoke on indoor air quality and mitigating exposure to community members; Hoopa Valley Tribe is a partner in this study.

ATNI: Affiliated Tribes of Northwest Indians: Climate Change Project

Provides guidance in developing and implementing administrative and legislative actions related to Indigenous peoples and climate change.

***Chemṣhúun Pe'ícháachuqeli* (When our Hearts are Happy), a Tribal Psychosocial Resilience Framework**
Designed to help Pala and other communities consider how to safeguard mental and emotional wellbeing when preparing for the impacts of climate change, this report is part of Pala's National Indian Health Board funded Climate Change Adaptation Plan, which incorporates health and wellbeing strategies.

Climate Adaptation Knowledge Exchange (CAKE)
Launched in July 2010 and managed by EcoAdapt, CAKE is a knowledge-sharing platform featuring high-quality climate change adaptation case studies, tools, and resources spanning all phases of the adaptation process (assessment, planning, implementation, evaluation, and monitoring).

Climate Impacts Group: University of Washington
The Group develops and delivers scientific information that is both useful to and used by the decision-making community by fully integrating research with stakeholder engagement.

Climate Ready Tribes Program
This program is a part of National Indian Health Board's nationally focused public health program and is funded by the Centers for Disease Control and Prevention (CDC).

Climate Science Alliance (CSA) safeguards natural and human communities in the face of a changing climate through leading activities and creating partnerships that increase awareness of climate change impacts, promote solutions, and facilitate action.

- La Jolla Band of Luiseño Indians Climate Adaptation Plan The 2019 Climate Adaptation Plan for the La Jolla Band of Luiseño Indians is a living document that provides a foundation for the Tribe to address climate change impacts to a variety of sectors, including natural resources, infrastructure and economy, health and wellness, and community and culture.
- Manzanita Band of Kumeyaay Indians Tribal Resilience Strategy (2020) Phase II of the Tribe's vision for the Manzanita Tribal Resilience Project *(in progress, more updates TBA)*
- "San Diego Wildlife, Climate Change, and You!" A public campaign was created with a web page and pocket guide targeted specifically for the public to learn more about the findings of the assessment and the 10 things they could do to help

Confederated Tribes of the Colville Reservation

- Smoke Ready Community Resources
  Creating a Smoke Ready Community was an online meeting held to gain information about how to effectively engage with the community on what to do when there is a smoke event and how to minimize exposure. All interested partners were welcomed, including decision and policy makers, government representatives, business owners, and citizens. The effects of wildfire smoke on human health and the impact it has on the communities within the Colville Reservation and Okanogan River Airshed were discussed.
- DIY Box Fan Filters, Colville Tribes Air Quality program
  DIY user's guide developed to assist Tribal members in protecting themselves from wildfire smoke using low-cost materials.

Congressional Research Service (CRS)
The CRS serves as shared staff to Congressional committees and members of Congress, and services come in many forms: reports on major policy issues, tailored confidential memoranda, briefings and consultations, seminars and workshops, expert Congressional testimony, and responses to individual inquiries.

- Wildfire Statistics

Creating Resilient Water Utilities (CRWU) (EPA)
This initiative provides drinking water, wastewater, and stormwater utilities with practical tools, training, and technical assistance needed to increase resilience to climate change. Through a comprehensive planning process, CRWU assists water utilities by promoting a clear understanding of potential long-term adaptation options for decision-making related to water utility infrastructure financing.

Cultural Resources Climate Change Strategy (National Park Service (NPS)
The purpose of this Strategy is to set out the broad scope of cultural resources in relation to climate change and identify major directions of action in cultural resources and climate change for the NPS.

Federal Emergency Management Agency (FEMA) Tribal Funding, Mitigation, and Planning Resources
This site provides resources for Tribes to prepare for emergencies, including trainings, funding opportunities, and preparedness tips. Includes the Tribal Mitigation Planning Handbook, which is a tool for Tribal governments to use in developing a mitigation plan that meets the requirements of Title 44 of the Code of Federal Regulations, Section 201.7 (44 CFR 201.7).

Guidelines for Considering Traditional Knowledges in Climate Change Initiatives is a publication intended to be an informational resource for Tribes, agencies, and organizations across the United States interested in understanding traditional knowledges in the context of climate change.

Indian Environmental General Assistance Program (GAP) Act
Commonly referred to as IGAP. Authorized by the EPA to provide GAP grants to federally recognized Tribes and Tribal consortia for planning, developing, and establishing environmental protection programs in Indian country and for developing and implementing solid and hazardous waste programs on Tribal lands.

Indigenous Environmental Network (IEN) Indigenous Just Transition Assembly
The IEN and Haskell Indian Nations University gathered frontline Indigenous leaders from across Turtle Island and Haskell students at the first-ever Indigenous Just Transition Assembly in 2019. The website provides information about the Indigenous Principles of Just Transition.

Institute for Tribal Environmental Professionals (ITEP)
Created to act as a catalyst among Tribal governments, research, and technical resources at Northern Arizona University (NAU), various federal, state, and local governments, and the private sector in support of environmental protection of Native American natural resources. Established at NAU in 1992 in cooperation with USEPA. ITEP accomplishes its mission through several programs, including Air Quality, Environmental Education Outreach Program (EEOP), National Tribal Air Association (NTAA),

Tribes and Climate Change Program (TCCP), Tribal Pesticides Council Program, Volkswagen (VW) Technical Assistance Program, National Tribal Water Council (NTWC), and several other partnership and committee groups.

ITEP's Tribes and Climate Change Assessments and Adaptation Plans
This spreadsheet contains a comprehensive list of Tribal vulnerability assessments and adaptation plans that are publicly available. The list is part of ITEP's Tribal Climate Change Adaptation Planning Toolkit and #9 on the list of toolkit resources, which can be downloaded as a zip file or as individual documents.

Legal Justice Coalition and the Rising Voices Community Relocation & Site Expansion Working Group
This coalition developed a set of policy recommendations to guide policy makers' response to the climate crisis and to address the shortfalls of the current response. At the heart of these policy recommendations is the need to center the agency, leadership, and self-determination of frontline communities in addressing climate-forced displacement.

National Climate Assessment (NCA)
These proceeding reports assess the science of climate change and variability and its impacts across the United States, now and throughout this century. Each report serves as the official U.S. Government's "State of the Union" about climate change impacts.

- NCA3 (2014) The full report provides an in-depth look at climate change impacts on the U.S. It details the multitude of ways climate change is already affecting and will increasingly affect the lives of Americans.
- NCA4 (2018) Volume II: Impacts, Risks, and Adaptation in the United States

National Indian Carbon Coalition (NICC)
An Indian-led nonprofit program that helps Tribal nations and individual Indian landowners take advantage of carbon credit and enter environmental commodities markets through the development of carbon sequestration or offset projects.

National Register of Historic Places
Guidelines for Evaluating and Documenting Traditional Cultural Properties (U.S. Department of the Interior, National Park Service, Interagency Resources Division). Technical information on comprehensive planning, survey of cultural resources, and registration in the National Register of Historic Places.

National Renewable Energy Lab's (NREL) Tribal Energy Atlas
This application shows the data generated and collected as part of the NREL study "Techno-Economic Renewable Energy Potential on Tribal Lands."

National Weather Service Watch, Warning, Advisory Display

- NOAA's National Weather Service and Storm Prediction Center
- Fire Weather Outlooks
- Severe Weather Outlooks

National Wildlife Federation—The New Energy Future in Indian Country: Confronting Climate Change, Creating Jobs, and Conserving Nature
Produced by the National Wildlife Federation Tribal Lands Program in collaboration with the University of Colorado Law School, Institute for Tribal Environmental Professionals, National Congress of American Indians, Native American Fish and Wildlife Society, and Native American Rights Fund. (2010)

Native Youth Community Adaptation and Leadership Congress (NYCALC)
The mission is to develop future conservation leaders with the skills, knowledge, and tools to address environmental change and conservation challenges to better serve their schools and home communities. This program is created in partnership with U.S. Fish and Wildlife Service, National Park Service, Bureau of Indian Affairs, U.S. Forest Service, and New Mexico Wildlife Federation.

New Mexico Tribal Resilience Action Network (NM TRAN)
This working group is a collaboration of ad-hoc Tribal staff and leaders, former war chiefs, Tribal council members, and others interested in improving adaptation and resilience to the effects of climate change on their communities and surrounding landscapes.

NOAA and National Weather Service's Weather Prediction Center
- Provides U.S. 3-7 Hazards Outlook. These products are only created Monday through Friday. Please exercise caution using this outlook during the weekend.
- Excessive Rainfall Forecasts

NOAA Climate Prediction Center (CPC) Seasons Outlooks
The CPC issues maps showing the probability of exceeding thresholds of above and below normal conditions for temperature and precipitation.
- Drought Monitor and Outlooks

Okanogan River Airshed Partnership
Seeks nonregulatory projects, programs, and partnerships in the Okanogan River airshed to increase understanding of and help reduce $PM_{2.5}$ air pollution.

Pacific Northwest Seismic Network (PNSN)
The PNSN is an organization dedicated to reducing impacts of earthquakes and volcanic eruptions in the states of Washington and Oregon by providing accurate and fast information about earthquakes and ground motions to scientists, engineers, planners, and the public. To monitor earthquake and volcanic activity across the Pacific Northwest, the University of Washington and the University of Oregon cooperatively operate the PNSN, which is sponsored by the U.S. Geological Survey, the U.S. Department of Energy, the State of Washington, and the State of Oregon.

PurpleAir: Real-Time Air Quality Monitoring
Using a new generation of laser particle counters to provide real-time measurement of $PM_{1.0}$, $PM_{2.5}$, and PM_{10}, PurpleAir sensors are easy to install and require only a power outlet and WiFi. They use WiFi to report in real time to the PurpleAir map.

Safe and Affordable Funding for Equity and Resilience (SAFER)
This site provides information on a set of tools, funding sources, and regulatory authorities designed to ensure that one million Californians who currently lack safe and affordable drinking water receive it as quickly as possible. The SAFER program also aims to reach sustainable operations for all of the state's drinking water systems and is a critical element for achieving the goals of safe, accessible, and affordable water for all Californians.

San Diego County Ecosystems: Ecological Impacts of Climate Change on a Biodiversity Hotspot
The full technical report, as included in California's Fourth Climate Change Assessment. The San Diego County Ecosystems Assessment was part of California's Fourth Climate Change Assessment as a technical report. The Climate Science Alliance led the creation of multiple products to help translate science in real time to various audiences, helping individuals see themselves as part of the solution.

Smoke-Ready Toolbox for Wildfires by the EPA
Public health officials and others can use the resources in the Smoke-Ready Toolbox to help educate people about the risks of smoke exposure and actions they can take to protect their health.

Status of Tribal Air Report (STAR)
Outlines the successes, challenges, and needs of Tribal air programs, including an extensive budget analysis. Published by the NTAA and intended to provide an understanding of the importance and impact of Tribal air programs. Nationally vetted Tribal needs, priorities, and recommendations are all outlined, and the successes and challenges experienced by the environmental professionals are highlighted by way of personal narratives submitted by the Tribes. This annual report has been published since 2014.

Swinomish Indigenous Health Indicators (IHI)
The indicators are a set of community-scale, nonphysical aspects of health that are integral to Coast Salish health and wellbeing. The IHI reflect deep connections between humans, the local environment, and spirituality. IHI provide a template for resource-based communities to tailor in order to suit their own unique connections and health priorities.

The Center Pole
A Native nonprofit grassroots organization founded in 1999. Our "Living Culture" campus is located at the foot of the Little Big Horn Battlefield National Monument on the Crow Indian Reservation in Montana. The Center has expanded its work to include diverse interwoven projects and programs that meet the expressed needs of its people for a stronger Crow community. The expansion includes an alternative energy demonstration project, food sovereignty, digital archives, an art and culture facility, an Indigenous media and education center, and a radio station to give the Crow people a voice.

Tribal Biomass Demonstration Project
Project is designed to provide Indian Tribes with greater autonomy over the management and development of their energy resources. The Bureau of Indian Affairs, in partnership with the Bureau of Land Management, is implementing the Project to promote biomass energy production for federally recognized Indian Tribes and Alaska Native corporations.

Tribal Climate Adaptation Menu
Developed by a diverse group of collaborators representing Tribal, academic, intertribal, and government entities in Minnesota, Wisconsin, and Michigan, the Menu provides a framework to integrate Indigenous and traditional knowledge, culture, language, and history into the climate adaptation planning process. Developed as part of the Climate Change Response Framework, the Tribal Climate Adaptation Menu is designed to work with the Northern Institute of Applied Climate Science (NIACS) Adaptation Workbook and as a stand-alone resource.

Tribal Climate Change Network & Project by the University of Oregon
The Project is funded by diverse partners, including the Bureau of Indian Affairs, the Affiliated Tribes of Northwest Indians, the North Pacific Landscape Conservation Cooperative, and the USDA Forest Service Pacific Northwest Research Station. The project focuses on understanding needs and opportunities for Tribes in addressing climate change, examining the government-to-government relationship in a climate context, and exploring the role of traditional knowledge in climate change studies, assessments, and plans.

Tribal Climate Tool
This tool is designed to help Tribes in the Pacific Northwest and the Great Basin area understand how the climate is expected to change in places that they care about. It provides maps, graphs, tables, and descriptions of projected changes. *(Note: Works best in Google Chrome)*

U.S. Department of the Interior Indian Affairs Tribal Biomass Demonstration Project
This project provides more effective and accessible ways for Indian Tribes to develop their energy resources, generate revenue, and improve the wellbeing of their communities. It also provides the Bureau with an avenue to assist Tribes in securing reliable, long-term supplies of woody biomass materials.

United States Geological Survey and Climate Adaptation Science Centers
A partnership-driven program that teams scientific researchers with natural and cultural resource managers and local communities to help fish, wildlife, waters, and lands across the country adapt to changing conditions.

- Regional Climate Adaptation Science Centers (CASCs): NW CASC, NC CASC, SW CASC, SC CASC, NE CASC, SE CASC, AK CASC

The network is composed of the National Climate Adaptation Science Center (NCASC) and eight regional CASCs, formerly named the Climate Science Centers, covering the continental U.S., Alaska, Hawai'i, and the U.S. Affiliated Pacific Islands. Each CASC is based out of a host university in its region, and most are composed of multi-institution consortia, which include university and nonuniversity partners.

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Local News
The Seattle Times

Climate change is threat to Pacific Northwest forests, researchers say

Nov. 17, 2023 at 6:00 am

1 of 14 | Christine Buhl, a forest health specialist for the Oregon Department of Forestry, uses an increment borer to core a dead western red cedar at Magness Memorial Tree... (Amanda Loman / The Associated Press) **More**

By NATHAN GILLES and Columbia Insight

The Associated Press

SHERWOOD, Ore. (AP) — Deep inside a forest in Oregon's Willamette Valley stands a dead "Tree of Life."

Its foliage, normally soft and green, is tough and brown or missing altogether. Nonetheless, the tree's reddish bark, swooping branches and thick, conical base identify it as the Pacific Northwest's iconic western red cedar.

Christine Buhl, a forest health specialist for the Oregon Department of Forestry, plunges a tool called an increment borer into the dead tree's trunk. Twisting the handle of the corkscrew-like borer, Buhl extracts a long, thin sample of the tree's inner growth rings.

The rings become thinner over time, indicating the tree's growth slowed before it finally died. It's a sign that this red cedar, like thousands of others in Oregon and Washington, died from drought.

"That's why it's the canary," Buhl says. "Any tree that's less drought tolerant is going to be the canary in the coal mine. They're going to start bailing [out]."

For thousands of years, people have used red cedar to make everything from canoes to clothing.

Red cedar's many uses have earned the species endearing names, including the "Tree of Life." More recently, scientists have started calling this water-loving relative of redwoods by a less flattering name: the climate canary.

Last year, Buhl and colleagues reported that red cedars were dying throughout the tree's growing range not because of a fungus or insect attack but due to the region's "climate change-induced drought."

Red cedars aren't alone.

In recent years, at least 15 native Pacific Northwest tree species have experienced growth declines and die-offs, 10 of which have been linked to drought and warming temperatures, according to recent studies and reports.

Many researchers, Buhl included, are now arguing that these drought-driven die-offs are the beginning of a much larger and long-predicted shift in tree growing ranges due to

climate change.

EDITOR'S NOTE

This story is part of a collaboration between The Associated Press and Columbia Insight, exploring the impact of climate on trees in the Pacific Northwest.

Trees, and plants generally, have growing ranges that are largely determined by climate factors, namely moisture and temperature.

For decades, scientists have argued that as atmospheric warming continues, growing ranges in the Northern Hemisphere will shift upslope in elevation and farther north, leaving many trees stranded in a warmer, drier world.

As climate mismatch sets in, trees are expected to die off and not grow back, according to predictions.

Daniel DePinte, Forest Service aerial survey program manager, suspects range changes are driving "Firmageddon." A term coined by researchers, including DePinte, "Firmageddon" refers to the more than 1,875 square-mile die-off of five fir species in Oregon, Washington and Northern California.

"The forests are moving uphill," said DePinte.

DePinte and colleagues first identified and named the massive, drought-driven fir mortality event last year while surveying area forests via airplane.

According to tree-range predictions, climate-induced die-offs are expected to start at the edges of growing ranges, including at lower-elevation locations that are anticipated to become too warm and dry for many species.

DePinte's survey revealed that the largest die-offs associated with Firmageddon are occurring at lower-elevation sites.

Buhl and colleagues found a similar pattern with western red cedar. Mortality was greatest at sites less than about 650 feet in elevation west of the Cascade Range, according to their analysis.

Scientists have also observed a similar pattern for Douglas fir, the region's leading commercial timber species. Douglas fir is currently experiencing a 720-square-mile die-off, the majority in the Klamath Mountains near the southern Oregon cities of Ashland and Medford.

The die-off is limited to the lower elevations but is likely to move uphill as temperatures warm in the coming decades, according to a study in the Journal of Forestry.

"Our analysis concluded that if climate change continues as predicted, we could see increased Douglas fir mortality at higher elevations," said study co-author, David Shaw, a professor and forest health specialist at Oregon State University.

Shaw called the die-off "consistent with predictions for climate change."

But whereas red cedar is believed to be dying from drought alone, the Firmageddon and Douglas fir die-offs have been linked to a combination of drought weakening trees and insect pests moving in for the kill.

"These insects are not normally tree killers," said DePinte. "This is evidence that the forests are reacting to climate change and droughts."

Douglas fir is not considered a true fir and is not officially part of Firmageddon, according to DePinte.

The combination of drought-induced stress and pests, said Patrick Tobin, associate professor of disturbance ecology at the University of Washington, is analogous to a person with a weakened immune system dying from the flu.

"Drought stress opens a window for biotic agents that might otherwise not be able to overcome a healthy, well-defended tree," said Tobin.

Tobin is a co-author of a 2021 study in the journal Forest Ecology and Management on the widespread decline of big leaf maples in Western Washington. Tobin's study was unable to determine whether drought alone or drought in combination with disease-causing fungi was killing the native maples.

As for the climate canary, Buhl believes red cedar is unlikely to disappear from the landscape entirely but probably won't grow back in areas where it's dying off.

"Unless we turn back climate change, there is no reason to hope western red cedar is going to make a comeback," said Buhl.

Nathan Gilles is a science writer and journalist based in Vancouver, Washington.

Columbia Insight is an Oregon-based nonprofit news website covering environmental issues affecting the Pacific Northwest.

NATHAN GILLES.

Columbia Insight.

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ECONOMIC ANALYSIS OF OUTDOOR RECREATION IN OREGON

EARTH ECONOMICS

EXECUTIVE SUMMARY

Across all of Oregon, there are thousands of recreation sites and opportunities where one can hike, camp, bike, picnic, hunt, kite surf, and more; and every year, billions of dollars are spent by folks enjoying Oregon's outdoors. Recognizing that outdoor recreation is a major contributor to the state's economy, Travel Oregon, the Oregon Office of Outdoor Recreation (OREC), and Oregon Department of Fish and Wildlife (ODFW) came together to commission a study on the impacts of the outdoor recreation economy.

The study found that **in 2019, outdoor recreation in Oregon supported $15.6 billion in spending**. Consumer spending on outdoor recreation supports businesses and jobs throughout the state, and then ripples throughout Oregon's economy as business income and wages are re-spent, causing economic effects in sectors not directly tied to outdoor recreation. Total consumer spending on outdoor recreation in 2019 **supported 224,000 full and part-time jobs in Oregon**, associated with $9.3 billion in wages and other compensation.

The analysis further categorized spending by locals and visitors, where local recreation is defined as Oregonians who travel fewer than 50 miles to reach their recreation destination and visitors includes both Oregonians who travel 50 or more miles and out-of-state visitors. This distinction allows us to understand how much new money is entering a regional economy. In 2019, visitors in Oregon spent $7.3 billion in trip-related spending, which supports 115,700 full and part-time jobs. Local recreation amenities also proved to be important to our economy. Local recreation, such as the spending effects associated with picnicking at a park near your home, supported $5.1 billion in spending in 2019.

The results presented here bring greater awareness to the meaningful contributions of economic impacts generated by Oregonians and visitors that are recreating in our vast and abundant outdoors. This information will assist local leaders to pursue well-informed policies that maintain the quality of life for residents and that provide sustainable access to locals and visitors alike. Results of the analysis are made available at the county, legislative, and tourism region level. Activity-specific estimates are provided at the state level.

One of the many goals of this project was to develop a reliable, scalable framework to monitor outdoor recreation participation and spending. The framework used in this analysis can be shared across land management agencies to align data sets with the goal of standardizing data collection, filling in data gaps and supporting the comparison of economic estimates across jurisdictional and agency lines.

HOW THIS COMPARES TO OTHER ANALYSES

This analysis is consistent with findings from other research conducted on Oregon's outdoor recreation economy. In 2017, the Outdoor Industry Association estimated that $16.4 billion was spent on outdoor recreation trips and gear purchases in Oregon, an estimate slightly higher than the one presented here. The U.S. Bureau of Economic Analysis (BEA) estimated that spending on outdoor recreation in Oregon in 2019 contributed $7.2 billion to Oregon's GDP and supported 88,000 jobs. While these estimates vary from the findings of this analysis, it is important to understand that the BEA analysis does not consider local recreation in their analysis, making the results more comparable to the visitor expenditure estimate presented earlier.

BENEFITS NOT INCLUDED IN THIS STUDY

While this report estimates the significant economic contribution of outdoor recreation in Oregon, it does not present the full suite of benefits that outdoor recreation and natural spaces used for outdoor recreation provide, including consumer surplus, health benefits, and environmental benefits. Over the years, Oregon has devoted funding to further the understanding to these benefits. In 2018, the Oregon Parks and Recreation Department (OPRD) estimated the consumer surplus, or total net economic value, for recreation participation in Oregon by Oregonians to be $54.2 billion annually, based on 2017 use levels. Consumer surplus (i.e., total economic value net of the costs) is a measure of the contribution to societal welfare.

Regarding health benefits, parks and natural spaces promote physical and mental health. Those who participate in outdoor recreation are shown to have lower medical and insurance costs than their non-active counterparts. Researchers from Oregon State University estimated the economic value of this physical activity to be $1.4 billion in insurance savings. These savings reduce total health care expenditures by 2-3.6% statewide.

Another omission from this study are the environmental benefits provided by parks and green spaces. Among other benefits, natural lands in Oregon provide clean, drinkable water (thus reducing filtration costs); sequester carbon (avoided economic impacts associated with increased CO2); provide scenic beauty (increasing home values); and provide habitat for plants and animals (strengthening our food webs). These benefits can be monetized to show the value of stewarding these lands for a resilient future.

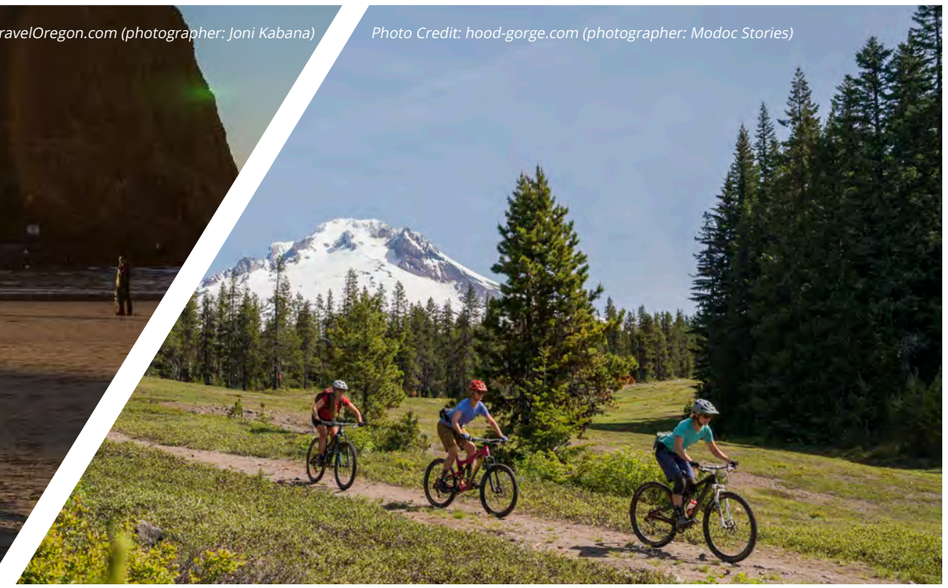
Finally, it is important to remember that this study uses data from 2019 and does not include impacts due to COVID-19 or the 2020 wildfires. The results of this study provide a strong baseline of where the recreation economy stood, which can then be used to inform how these events have altered the landscape. It is worth noting that outdoor recreation participation to date has been greater than in previous years.

OREGON
OUTDOOR RECREATION
SPENDING

TOTALLED
$15.6 BILLION

AND SUPPORTED **224,000**
FULL- AND PART-TIME JOBS

Photo Credit: TravelOregon.com (photographer: Joni Kabana)



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EARTH ECONOMICS

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INTRODUCTION

Oregon is home to scenic wonders and abundant natural resources. Many of these areas, and the activities they support carry national name recognition: windsurfing in the Columbia River Gorge, hiking in the Cascades, camping at Crater Lake, fishing the Oregon Coast, and jet boat tours in Hells Canyon. Yet there are many locations in Oregon that hold a lower degree of fame, special places that are less traveled. Oregon's impressive landscapes – well known or not – lend themselves to boundless outdoor recreation opportunities.

Outdoor recreation is an important part of Oregon's identity. An overwhelming majority of Oregonians participate in outdoor recreation (95%), while scenic beauty and outdoor recreation are primary drivers of visitation to and around the state. However, less understood are the quantifiable benefits that outdoor recreation participants have on Oregon's economy.

This report quantifies the economic benefits of outdoor recreation, including the trip length, consumer spending, and economic effects associated with engaging in outdoor recreation activities in Oregon by residents and out-of-state visitors.

As Oregon's population increases, visitation grows, and as the popularity of outdoor recreation expands, it is necessary to understand the role of outdoor recreation in the state's economy. Understanding how outdoor recreation fits within Oregon's present economy also provides us with insights into economic development opportunities for the future. Recognizing this, Travel Oregon, the Oregon Office of Outdoor Recreation (OREC), and Oregon Department of Fish and Wildlife (ODFW) came together to commission this study. Our goal is to accurately understand the impact of outdoor recreation on Oregon's economy, present the information in a digestible and usable format, and provide resources that can help inform effective decision and policymaking.

FIGURE 1. STATE OF OREGON

INDIGENOUS PEOPLES LAND ACKNOWLEDGEMENT

More than 60 tribes and bands of Indigenous peoples have lived in the northwest region since time immemorial. The people survived season to season on their sacred foods and environments, providing them with a strong sense of identity, culture and spirituality. After the treaties of 1855, only nine tribes were federally recognized in what is now Oregon, while other treaties went unratified and unrecognized. Today, these nine tribes work extensively to manage the resources throughout their original territories playing active roles in their regions, counties, states, and communities, leveraging their extensive knowledge and history of the area. In 1996, for example, Governor John Kitzhaber signed Executive Order (EO) 96-30, directing state agencies to develop working relationships with Oregon's nine federally-recognized Indian Tribes. Outdoor recreation occurs on the ancestral lands of these original peoples and caretakers.

FIGURE 2. INDIGENOUS TERRITORIES, OREGON

REPORT OVERVIEW

This report on Oregon's outdoor recreation economy is organized as follows:

- The current chapter, Chapter 1, introduces the outdoor recreation environment in Oregon and provides a brief summary of Oregon's long history of natural resource richness. This section recognizes the ancestral stewardship of Oregon's native tribes.
- Chapter 2 reviews the concepts and methods used to estimate total spending associated with outdoor recreation in Oregon.
- Chapter 3 quantifies recreation participation, trip-related spending, and equipment-related spending.
- Chapter 4 estimates the economic contribution and impact of the spending calculated in Chapter 3, offering readers estimates on jobs, wages, taxes, Gross Domestic Product (GDP) contributions, and total spending associated with outdoor recreation.
- Chapter 5 focuses on the spending and economic impacts made by visitors (Oregonians traveling 50 or more miles and out-of-state visitors.
- Chapter 6 summarizes the results of the economic analysis and the opportunities to use outdoor recreation for economic development, as well as suggestions on how to improve outdoor recreation data and industry information.
- The appendices include a list of lands included in this study; breakout data by jurisdictional boundaries, agencies, and activity type; input-output sector mapping; and references.

OUTDOOR RECREATION IN THE CONTEXT OF COVID-19 AND THE 2020 WILDFIRES

The COVID-19 pandemic has wrought major impacts on economies around the world, and Oregon's economy is no exception. In the late summer of 2020, historic wildfires wreaked havoc on a portion of Oregon's landscape. As this report is written, we are still experiencing and learning about the specific local economic effects of COVID-19 in Oregon and elsewhere, and the wildfires have impacted many of the areas commonly used for outdoor recreation. The authors would like to offer the following considerations:

1. This report gathers and interprets recreation participation data from 2019 and does not reflect the impacts of COVID-19 or the 2020 wildfires. The estimates presented in this report can be used as a baseline for future analyses to better understand the impacts that these events have had on Oregon's outdoor recreation economy in 2020 and beyond.

2. In June 2019, the seasonally adjusted unemployment rate in Oregon was 4%, and by June 2020 had climbed by a staggering 7 percentage points to 11.3%. Early in the pandemic, as travel came to a virtual halt, the industries and jobs associated with the recreation economy, including leisure and hospitality, retail trade, and government, have been among the hardest hit, so the impacts on unemployment for these sectors may be even higher than the statewide average. As detailed in this report, outdoor recreation directly benefits these industries, and therefore employment estimates may not be representative of the current state of affairs.

That said, given that most outdoor recreational activities are relatively "safer" in terms of virus transmission potential, outdoor recreation may be an important tool for rebuilding local economies. While spending estimates have not been analyzed, personal communication with recreation agencies suggest that participation in recreation is near historic levels of use, a likely result of this "safe haven" (perceived or real) provided by outdoor recreation spaces. These conversations are supported by preliminary data showing increased visitation to Crater Lake National Park, increased boater and RV registrations, and increased fishing license sales. Gear and equipment sales are also booming; for instance, RV sales are up 49% year-over-year and 55% of those sales are driven by first-time buyers; bike sales saw colossal increases in comparison to 2019, upwards of 800%.

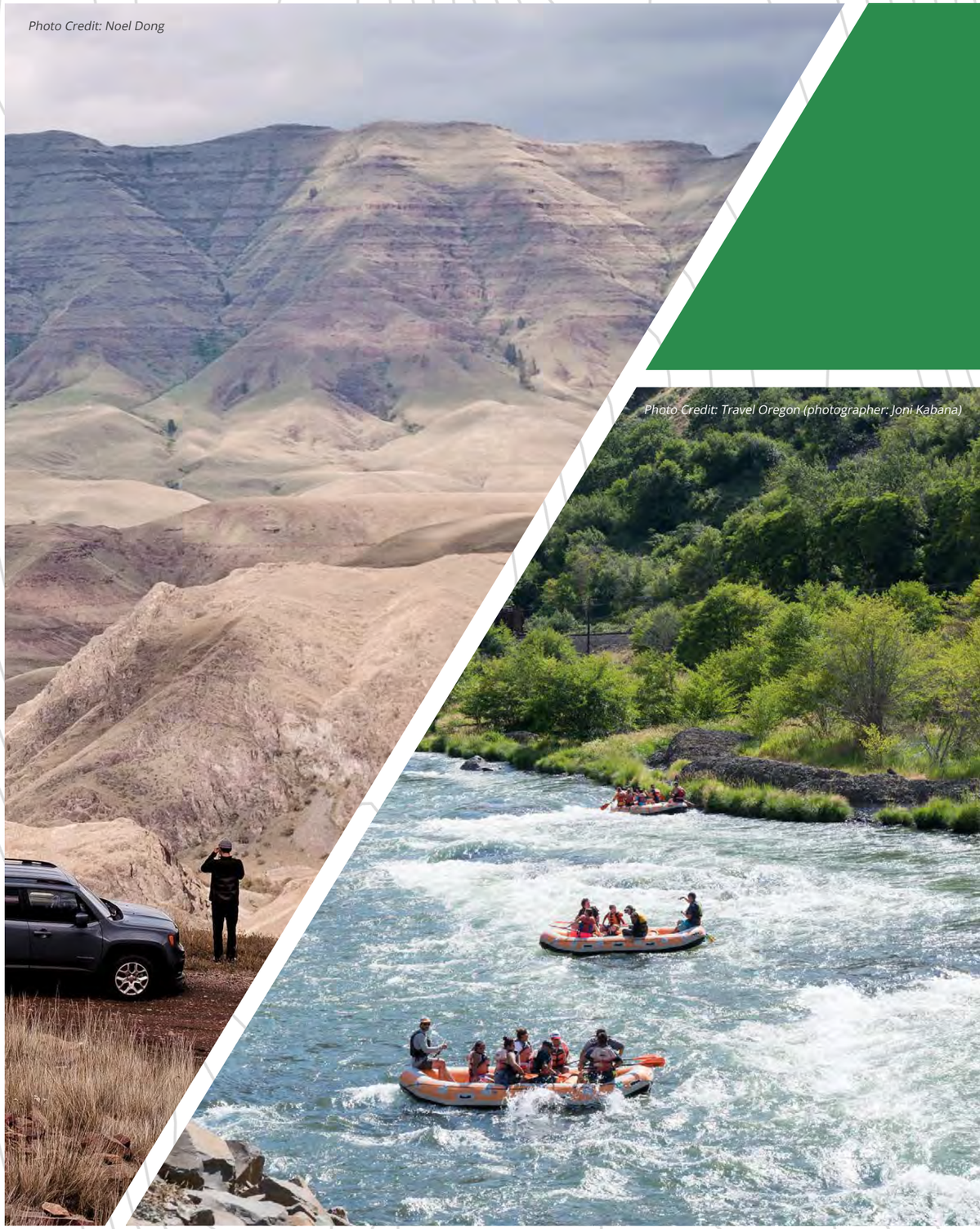

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Photo Credit: Travel Oregon (photographer: Joni Kabana)

KEY CONCEPTS AND METHODS

DEFINING OUTDOOR RECREATION

This report defines outdoor recreation as activities participated in for personal pleasure and health that occur in nature-based environments outdoors. Oregon's landscapes allow recreationists to off-road vehicle (ORV) throughout the openness of Eastern Oregon; head to the Columbia River Gorge for world-class windsurfing; take epic rafting trips down the Rogue River; hike through the Cascade Mountains and depart on one of many charter boats for ocean sport fishing.

In 2017, the Oregon Parks and Recreation Department (OPRD) identified 56 recreation activities known to occur in Oregon, which they group into eight categories:

a. non-motorized trail or related activities
b. motorized activities
c. non-motorized snow activities
d. outdoor leisure and sporting activities
e. nature study activities
f. vehicle-based camping activities
g. hunting and fishing
h. non-motorized water-based and beach activities

Because each of the 56 unique activities could not be directly tied to recreational trips where monetary transactions occurred, Appendix E of this report provides participation and spending estimates for 32 of these recreation activities.

ESTIMATING RECREATION PARTICIPATION AND SPENDING

When Oregonians and out-of-state visitors participate in outdoor recreation, they spend money – $10 here, $60 there – and it adds up to billions of dollars in spending throughout local economies in Oregon. Local residents stop in at coffee shops on their way to the park; residents from Portland take weekend trips to the Oregon Coast and spend money at boutique retailers and restaurants; and out-of-state visitors soak up all that Oregon has to offer while spending money at hotels, retail stores, and on guide services. These expenditures are referred to **trip-related spending** – spending that occurs while participating in, or traveling to participate in, an outdoor recreation activity. An outdoor recreation trip is not dependent on how far the participant travels from their home – both close to home and travel-related recreation are considered in this analysis.

A second form of spending valued in this report is **equipment-related spending** – spending on outdoor recreation gear, equipment, and apparel (e.g., bikes, fishing rods, binoculars, jackets, backpacks, and seasonal rentals). These expenditures are not directly tied to any specific outdoor recreation trip, but are purchased for their use in outdoor recreation.

Participants were classified as **local**, those travelling fewer than 50 miles to participate in recreation, and **visitors**, which includes both Oregonians who travel 50 or more miles and out-of-state visitors. This distinction is important for several reasons— in-state travelers and out-of-state visitors inject "new" money into a local community, and different visitor types contribute differing levels of spending across varying industries. For instance, an out-of-state recreationist is more likely to spend money at a hotel than a local participant, while both may be just as likely to stop at a local brewery. Spending by visitor types is collected and organized into spending profiles – or average expenditures by a unique visitor group.

In addition to classifying recreation participants by visitor type, recreation participation and expenditure data is further categorized by land manager. We categorize land managers into two groups: 1) public agencies, and 2) private landholders who allow for recreational access on their property. For example, the U.S. Forest Service, OPRD, and the Bend Park and Recreation District are examples of federal, state, and local agencies that manage recreation lands; while land trust-owned conservation lands, Weyerhaeuser-owned timberlands, private campgrounds, and private hunting lands are all managed by private landholders, representing the wide range of land owners considered in this analysis.

To estimate the total spending associated with outdoor recreation, we documented the total days of outdoor recreation participation across different recreation agencies and recreation activities. Next, we collected spending profile data for the various agencies and activities. With the addition of spending on equipment, gear and apparel, the product of these two components – recreation days and average daily spending – is used to calculate total recreation spending (i.e., **trip-related spending plus equipment-related spending equals total spending on outdoor recreation).** The data collected is visitor type and site specific, aggregated, and presented at jurisdictional geographies: counties, legislative districts, tourism districts, and state-level.

CALCULATING ECONOMIC CONTRIBUTIONS AND IMPACTS

Measuring the magnitude of outdoor recreation's contribution to the economy provides meaningful insight to those tasked with budgetary and policy decisions that may affect the access to and quality of outdoor recreational opportunities. Critical economic indicators include total spending on outdoor recreation trips and equipment, job creation, incomes, and tax revenues. Other useful indicators of economic health include economic output (or the total spending associated with outdoor recreation, including secondary effects) and the contribution outdoor recreation spending makes to the state's Gross Domestic Product (GDP).

Photo Credit: traveloregon.com

Photo Credit: TravelOregon.com (photographer: Joni Kabana)

Photo Credit: Chris Henry (unsplash.com)

Photo Credit: Aly Nicklas

Total economic effects resulting from consumer spending are called economic contributions and are described in detail in Figure 3. Each of the contribution types identified in Figure 4 can be broken out into direct, indirect, and induced effects. **Direct effects** are the immediate impacts that occur from the expenditure – impacts at hotels, campsites, restaurants, gas stations, and outdoor recreation gear retailers. The impacts of direct effects ripple out to the businesses and employees which support the operation of the directly impacted businesses, classified as secondary effects. Secondary effects are further broken out into indirect and induced effects. **Indirect effects** are the impacts that are driven by business-to-business transactions. For instance, hotels need fresh linens, restaurant owners purchase meat, dairy and vegetables, and river fishing charters buy fishing gear. This secondary spending creates additional economic contributions and impacts. **Induced effects** are the additional economic effects resulting from employees spending their earnings, such as on rent, food, and leisure in Oregon. Secondary effects continue to push money through Oregon's economy until it is either placed into savings or used to purchase goods and services from outside the state (leakage). The longer money circulates within the regional economy, the larger the economic impacts are (often called multiplier effects).

The impacts in Figure 3 can be calculated through an economic contribution analysis. An economic contribution analysis demonstrates the contribution of a given industry to the surrounding economy, at current levels of production. Contribution analyses can be useful in demonstrating the relative size of an industry – in this case recreation – within the larger economy.

To conduct the economic contribution analysis, input-output (IO) modeling is used, which characterizes the financial linkages between industries within a regional economy. Simply put, it shows how spending in one industry ripples throughout the economy. This analysis used a multi-region IO model, allowing us to measure how spending in one region not only contributes to the immediate regional economy (such as a county or legislative district), but also how these economic effects ripple throughout the rest of the state. This analysis used an industry standard IO modeling software called IMPLAN V3.1, and uses IMPLAN economic data from 2018.

FIGURE 3. ECONOMIC CONTRIBUTION TYPES

JOBS

Spending on outdoor recreation supports full and part-time employment in counties throughout Oregon. Employees of hotels, gas stations, guide services, and specialty retailers all directly benefit from recreation expenditures. These expenditures also indirectly support jobs in industries that provide necessary services to these sectors, such as greenspace maintenance, government services, real estate and medicine.

LABOR INCOME

In addition to the number of jobs supported, the IO model estimates the wages paid to workers (salaryplus benefits) who are supported by outdoor recreation spending. As employees of directly impacted businesses pay for necessities such as food and housing, the wages of workers in other industries are supported. Additionally, directly impacted businesses use recreation income to purchase the goods and services they need to function as businesses.

TAX REVENUE

While Oregon does not have a statewide sales tax, outdoor recreation spending generates local and state tax revenues through income and property taxes paid by recreation supported businesses and their employees. Other taxes and assessments on people participating in outdoor recreation may include items such as: transient lodging, rental cars, fuel, airports, alcohol, and marijuana.

ECONOMIC OUTPUT

The initial spending on outdoor recreation leads to additional spending within Oregon – classified as economic activity. The total economic activity by industries directly and indirectly supported by outdoor recreation expenditures can be understood as the total economic output of that investment. In essence, economic output is a measure of all spending that results from the initial expenditure.

VALUE ADDED

Value added, often referred to as GDP, is a subset of total economic output, calculated by removing the value of intermediate inputs (e.g., raw materials, semi-finished goods, and business-to-business services) from the total economic output to better represent the value of final goods and services added to the regional economy.

ECONOMIC CONTRIBUTIONS IN ACTION

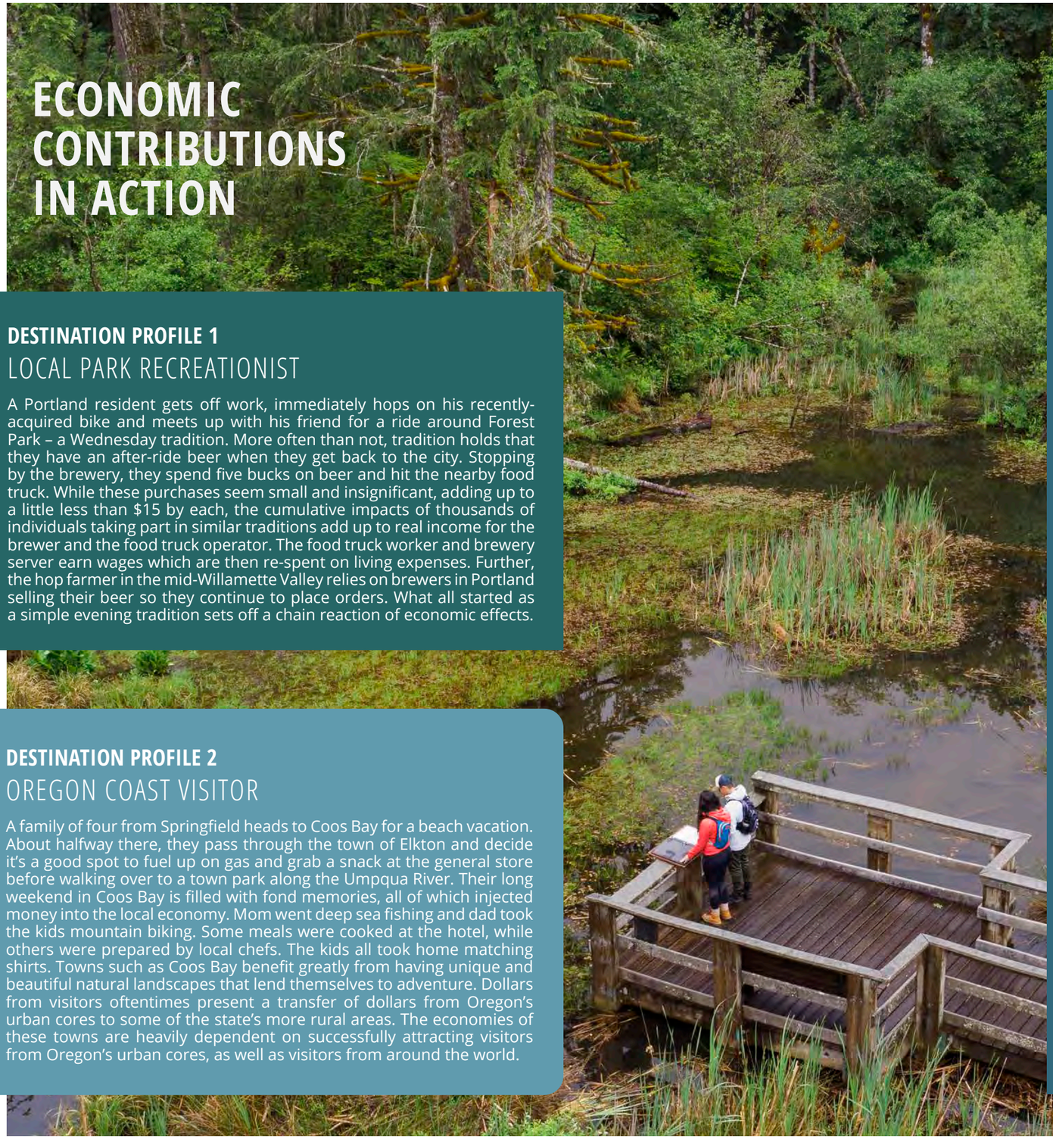


Photo Credit: hood-gorge.com (photographer: Modoc Stories)

DESTINATION PROFILE 1

LOCAL PARK RECREATIONIST

A Portland resident gets off work, immediately hops on his recently-acquired bike and meets up with his friend for a ride around Forest Park – a Wednesday tradition. More often than not, tradition holds that they have an after-ride beer when they get back to the city. Stopping by the brewery, they spend five bucks on beer and hit the nearby food truck. While these purchases seem small and insignificant, adding up to a little less than $15 by each, the cumulative impacts of thousands of individuals taking part in similar traditions add up to real income for the brewer and the food truck operator. The food truck worker and brewery server earn wages which are then re-spent on living expenses. Further, the hop farmer in the mid-Willamette Valley relies on brewers in Portland selling their beer so they continue to place orders. What all started as a simple evening tradition sets off a chain reaction of economic effects.

DESTINATION PROFILE 2

OREGON COAST VISITOR

A family of four from Springfield heads to Coos Bay for a beach vacation. About halfway there, they pass through the town of Elkton and decide it's a good spot to fuel up on gas and grab a snack at the general store before walking over to a town park along the Umpqua River. Their long weekend in Coos Bay is filled with fond memories, all of which injected money into the local economy. Mom went deep sea fishing and dad took the kids mountain biking. Some meals were cooked at the hotel, while others were prepared by local chefs. The kids all took home matching shirts. Towns such as Coos Bay benefit greatly from having unique and beautiful natural landscapes that lend themselves to adventure. Dollars from visitors oftentimes present a transfer of dollars from Oregon's urban cores to some of the state's more rural areas. The economies of these towns are heavily dependent on successfully attracting visitors from Oregon's urban cores, as well as visitors from around the world.

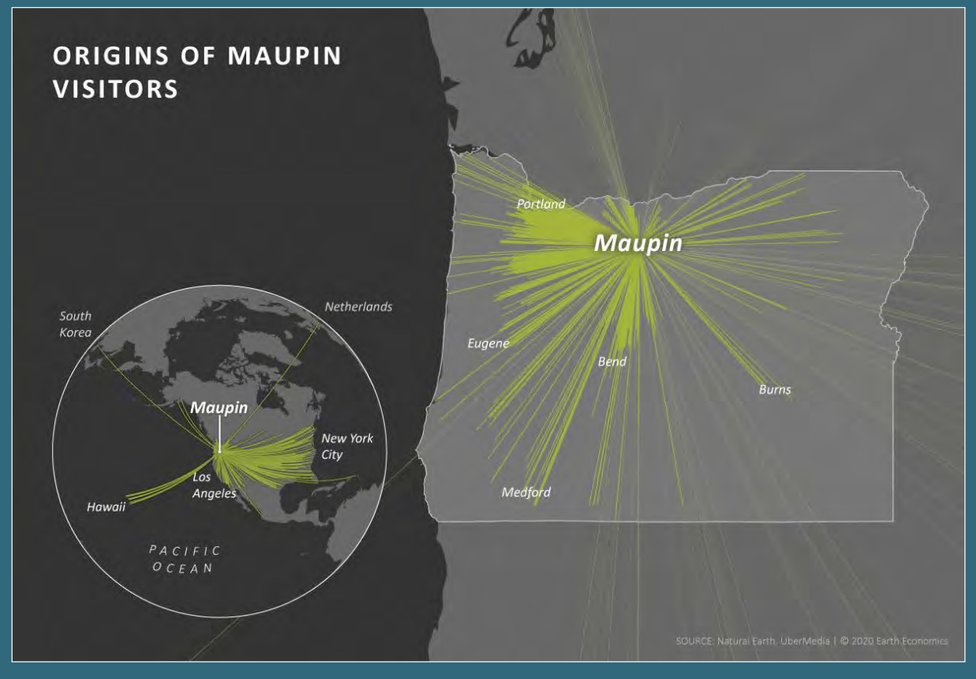
DESTINATION PROFILE 3

CITY OF MAUPIN

The city of Maupin, Oregon is located in north-central Oregon, and the Deschutes River runs straight through the middle of it. Just two hours outside of Portland, Maupin is an attractive destination for recreators – particularly fly fishers and river paddlers. A local river hotel and river guide company enjoys the business of a significant portions of their customers coming from across the county, even some internationally (Figure 5). Visitors often stay in the nearby hotel, prior to a guided river floating trip. These river visitors allow the business owners to pay their mortgage, purchase new recreation equipment, pay the utility bills, and cover personal expenses. The regular influx of these visitors allows the shop owner to employ a group of river guides that spend much of their free time in the community, whether it be participating in other recreation activities or frequenting local establishments – their actions perpetuate the flow of dollars within the community's economy. Visitors to Maupin are essential to its economic health. Visitors from out-of-state bring new money into Oregon's economy, while in-state travelers are recirculating money within Oregon's own economy. Through an analysis of visitor spending, the scale of economic contributions supported – direct, indirect, and induced – can be measured with an economic contribution analysis.

Through an analysis of recreation participant data, we can determine where participants come from (local recreationists vs. visitors), how long they stay in the area for, and how often they visit. Breaking out visitor types allows us to better understand how the different visitor segments contribute to the local economy. Figure 4 shows the home locations of recreation visitors to Maupin in 2019.

FIGURE 4. ORIGINS OF MAUPIN RECREATIONISTS



RESULTS

PARTICIPATION AND SPENDING

Throughout 2019, Oregonians and out-of-state visitors participated in 167 million days of recreation. Most of this recreation occurred on public lands, such as national forests, state parks, and local parks, but private recreation was also an important provider of recreation, specifically land conservancies and private hunting lands. Through trip-related spending and equipment-related spending, total outdoor recreation spending is estimated to be $15.6 billion in 2019.

Trip-related spending (both by local recreationists and visitors) totaled $12.4 billion in 2019. Oregon's beaches carry national prominence, attracting visitors from throughout the state and around the world. For this reason, Oregon's coastal counties, such as Coos, Lane, and Lincoln, lead the state in consumer spending by county.

Photo Credit: Aly Nicklas

Photo Credit: hood-gorge.com (photographer: Modoc Stories)

FIGURE 5. TRIP-RELATED SPENDING BY COUNTY

County	Trip-Related Spending (000s)
Baker	$124,847
Benton	$79,975
Clackamas	$628,307
Clatsop	$785,485
Columbia	$37,085
Coos	$1,267,023
Crook	$85,516
Curry	$611,819
Deschutes	$744,279
Douglas	$375,005
Gilliam	$6,645
Grant	$74,955
Harney	$172,662
Hood River	$283,142
Jackson	$310,974
Jefferson	$138,255
Josephine	$174,794
Klamath	$384,217
Lake	$109,581
Lane	$1,289,630
Lincoln	$2,077,683
Linn	$204,072
Malheur	$82,215
Marion	$316,326
Morrow	$22,405
Multnomah	$426,210
Polk	$64,793
Sherman	$6,710
Tillamook	$737,143
Umatilla	$115,689
Union	$81,331
Wallowa	$62,528
Wasco	$288,737
Washington	$163,550
Wheeler	$20,955
Yamhill	$68,677
Grand Total	$12,423,222

This analysis found that outdoor recreation at Oregon's 12 national forests supported the largest share of trip-related expenditures at $3.4 billion; Mt. Hood National Forest contributed $823 million to Oregon's economy on its own. Looking solely at state-owned lands, recreation at OPRD lands (e.g., state parks, state natural areas) was the lead driver of consumer spending, supporting $1.4 billion in annual consumer spending. The iconic Silver Falls State Park outside of Salem supported nearly $60 million in annual spending.

The purchase of gear, equipment, and apparel within Oregon by residents and nonresidents totaled $3.2 billion in 2019. A large portion of equipment-related expenditures were associated with the purchase of motor vehicles and parts, followed by sporting goods and apparel. Though these expenditures are not directly tied to Oregon's well-known history of designing and manufacturing quality outdoor equipment and accessories, and estimating this relationship is outside the scope of this analysis, some of these purchases are associated with products made in Oregon and/or by Oregon-based companies, for which the dollars remain local and lead to higher multiplier effects.

FIGURE 6. EQUIPMENT-RELATED SPENDING BY INDUSTRY

Industry	Equipment Expenditures (000s)
Retail - Motor vehicle and parts	$1,183,429
Retail - Electronics and appliances	$447,783
Personal and household goods repair and maintenance	$127,939
Retail - Sporting goods, hobby, books, and music	$767,629
Retail - Clothing and clothing accessories stores	$671,676
TOTAL	$3,198,456

ECONOMIC CONTRIBUTIONS

Expenditures on outdoor recreation trips and equipment were analyzed for their effects at the state level and in regional economies within Oregon, including the following geo-political boundaries: counties, legislative districts, and tourism regions.

Statewide, it was found that recreation trips and equipment purchases supported $15.6 billion in expenditures in 2019. These recreation expenditures supported 224,000 full and part-time jobs in Oregon. 122,000 of these jobs were a direct result of recreation expenditures, and the remaining 102,000 jobs resulted from indirect and induced effects.

These results clearly demonstrate how jobs directly supported by outdoor recreation have immense ripple effects throughout Oregon's economy. The industries with the highest employment were sit-down restaurants, the amusement and recreation industry, such as golf courses and ski facilities, and hotels (top 15 industries are provided in Figure 7). Total compensation for employees of outdoor recreation related industries was $9.1 billion. The average annual salary of employees in these industries is $41,000.

FIGURE 7. OUTDOOR RECREATION RELATED EMPLOYMENT BY INDUSTRY - TOP 15 INDUSTRIES

Sector	Employment*	Compensation	Average Compensation
Full-service restaurants	34,396	$1,022,043,543	$29,714
Other amusement and recreation industries	20,271	$525,913,454	$25,944
Hotels and motels, including casino hotels	15,573	$601,467,194	$38,623
Retail - Miscellaneous store retailers	11,538	$313,658,806	$27,185
Retail - Food and beverage stores	11,039	$409,429,369	$37,090
Transit and ground passenger transportation	7,748	$155,291,680	$20,044
Other accommodations	4,731	$215,758,177	$45,609
Retail - Sporting goods, hobby, musical instrument, and bookstores	11,356	$314,906,148	$27,730
Other federal government enterprises	4,441	$479,325,705	$107,942
Other real estate	4,925	$146,237,424	$29,691
Retail - Clothing and clothing accessories stores	4,119	$128,102,365	$31,103
Retail - Electronics and appliance stores	2,521	$124,647,358	$49,451
Personal and household goods repair and maintenance	1,979	$126,871,540	$64,112
Wholesale - Motor vehicle and motor vehicle parts and supplies	657	$45,567,200	$69,367
Management of companies and enterprises	313	$43,348,923	$138,318

**Employment data is generated based on spending activity and may not align with other datasets. Appendix F details how spending was attributed to industry sectors for analysis in IMPLAN.*

Photo Credit: Travel Oregon

Photo Credit: Daniel Sharp

Outdoor recreation also generates revenue for the state. Oftentimes, the impact that outdoor recreation has on the state's budget is viewed only as the revenue generated by entrance fees and license sales. A more comprehensive picture is gained by also looking at the tax contributions generated by consumer spending on gas, hotel/lodging/camping, car rental, and airport taxes, and from employment gains through payroll and personal income taxes. In 2019, $1.1 billion in state and local tax revenues were generated through outdoor recreation spending. Trip-related spending produced 60% of these revenues, with the remaining 40% resulting from equipment-related spending.

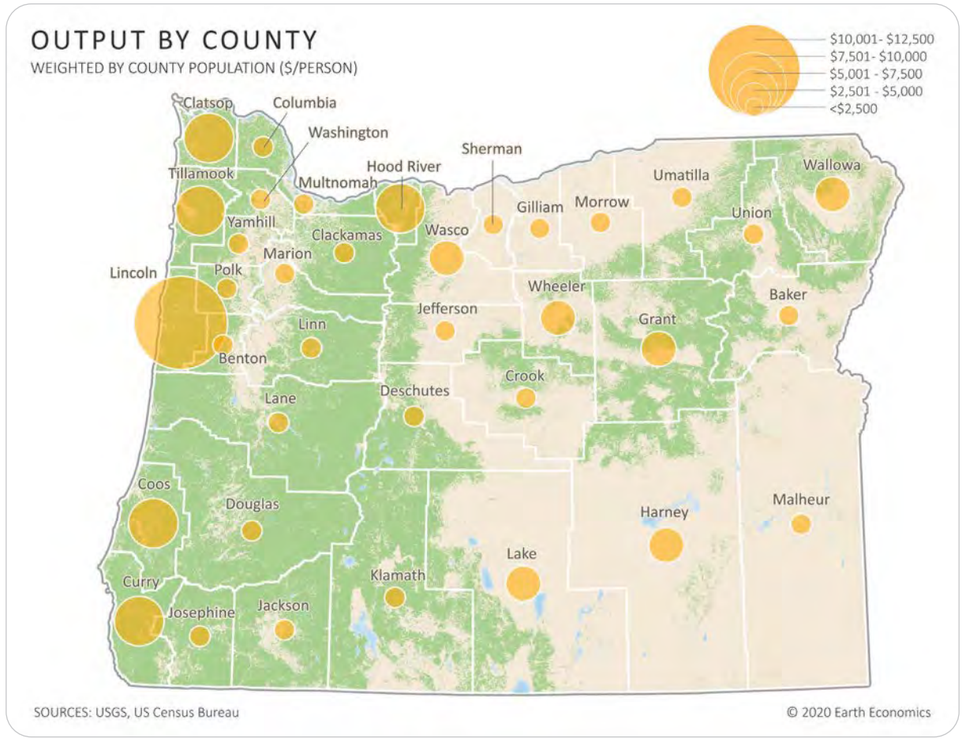
The economic output of outdoor recreation expenditures totaled $24.6 billion. Economic output represents the total spending associated with an initial expenditure plus secondary spending effects made by businesses and employees. Industries with the highest direct economic output include restaurants, hotels, grocery stores, and sporting goods and apparel retailers. Economic output of $24.6 billion can also be interpreted as every $1 spent on outdoor recreation, an additional $0.52 of revenue is generated for a total economic effect of $1.52 per $1.

Finally, a standard measure of economic productivity for an industry is its contribution to the region's GDP. Outdoor recreation contributed $13.1 billion to Oregon's GDP, equaling 6% of Oregon's $227 billion GDP. This estimate represents the monetary value of finished products. The U.S. Bureau of Economic Analysis (BEA) estimated that spending on outdoor recreation in Oregon in 2019 contributed $7.2 billion to Oregon's GDP and supported 88,000 jobs. The primary difference between the data presented here and BEA data is the inclusion of local recreation, which accounts for approximately 40% trip-related spending.

FIGURE 8. ECONOMIC CONTRIBUTION OF OUTDOOR RECREATION IN OREGON

Impact Type	Employment	Labor Income (000s)	Output (000s)	Value Added (000s)
Direct Effect	122,164	$4,040,363	$8,950,746	$4,346,014
Indirect Effect	58,419	$3,141,293	$9,245,128	$4,921,822
Induced Effect	43,527	$2,144,972	$6,391,280	$3,840,207
Total Effect	224,110	$9,326,627	$24,587,154	$13,108,043

FIGURE 9. POPULATION WEIGHTED ECONOMIC OUTPUT



ECONOMIC IMPACT OF OUTDOOR RECREATION-BASED TOURISM

Outdoor recreation-based tourism brings dollars from outside the region into the local economy. The injection of new dollars into an economy supports jobs and incomes in the regional economy and provides an additional revenue stream for government agencies through tax contributions. Recreation visitors are defined as Oregonians who travel 50 or more miles and out-of-state visitors.

Visitors bring dollars into communities from outside the region. Visitors also spend more than their local counterparts. For instance, across all state parks in Oregon, overnight visitors spend 66% more than local overnight visitors ($296.51 vs. $178.78 per party, per trip), and day visitors spend 165% more than local day visitors ($93.15 vs. $35.62 per party, per trip). When Oregonian's take trips within Oregon, it keeps the money local and reduces economic leakages.

In 2019, visitors spent an estimated $7.3 billion participating in outdoor recreation in Oregon. Visitors account for 60% of all recreation spending in Oregon. Dollars such as these provide an economic development opportunity for communities with rich recreation opportunities to capture.

The $7.3 billion spent on outdoor recreation by visitors generated substantial economic activity in Oregon. 115,700 jobs are associated with this spending, 63,200 of which are direct jobs, with the remaining 52,500 stemming from indirect and induced spending effects. Industry sectors most benefiting from visitors are accommodations, restaurants, and amusement and recreation industries, similar to the statewide observations. Economic output, or total spending associated with direct expenditures of $7.3 billion is estimated to be $12.7 billion, meaning for every $1 spent on outdoor recreation by out-of-state visitors, $0.74 is re-spent with Oregon's economy for a total spending impact of $1.74

Further breaking visitors down, the economic impact exclusively by of out-of-state visitors represents *new* money flowing into the state. This estimate allows us to understand the loss in economic benefits that would occur in the event the visitors did not come to Oregon. It is assumed that these visitors would travel elsewhere or stay at home, and the revenue flows from their visit would go with them. Out-of-state visitors brought $3.8 billion into Oregon's economy, supporting 60,800 jobs throughout the state.

FIGURE 10. ECONOMIC CONTRIBUTION OF OUTDOOR RECREATION VISITORS IN OREGON

Visitor Type	Consumer Spending (000s)	Employment	Labor Income (000s)	Output (000s)	Value Added (000s)
In-state Traveler	$3,481,544	54,947	$2,148,654	$5,802,931	$3,315,259
Out-of-state Visitor	$3,800,602	60,814	$2,537,137	$6,880,321	$3,560,540
All Visitors	$7,282,146	115,761	$4,685,790	$12,683,252	$6,875,799

Photo Credit: traveloregon.com

Photo Credit: Austin Shepard

CONCLUSION AND DISCUSSION

Outdoor recreation is an important and significant part of Oregon's overall economy. Spending on outdoor recreation in Oregon totaled $15.6 billion in 2019 and had GDP contributions equal to 6% of Oregon's economy. Outdoor recreation also supported 8.6% of all employment in Oregon at 224,000 full and part time jobs. The average wage – including benefits – was estimated to be $41,000 per year.

Spending by in-state travelers and out-of-state visitors ($7.3 billion) made up approximately 60% of trip-related spending. The continued investment in stewardship of lands, development of recreation amenities, and promotion of outdoor recreation by state and regional tourism agencies ensures these dollars continue to flow into the state.

The analysis also found that coastal Oregon counties – specifically, Lincoln, Tillamook, and Curry – had the highest percent of the labor force employed by outdoor recreation spending. This emphasizes the importance of outdoor recreation in these communities, particularly because a large share of these dollars come from outside the region (67-77% of all recreation spending within the county). Policies that strengthen and promote outdoor recreation will have important implications for these economies. In 2020 outdoor recreation stakeholders, including the agencies that commissioned this study, developed recommendations through the Governor's Task Force on the Outdoors: 2020 Framework for Action. That report details several consensus policies to support economic development in rural and urban areas, increase outdoor recreation participation among traditionally underserved communities, and balance improved outdoor recreation access with resource protection.

The estimates above provide a strong baseline of Oregon's outdoor recreation economy, providing a benchmark for future studies. The importance for agencies to collect visitation data, and in a consistent way, has also been realized, which can help reveal the value of their presence and relationship with local communities.

It also presents the challenges that agencies face when doing so. Due to the dispersed nature of outdoor recreation, accurately counting recreation visitors can be a challenging task at facilities with little or no access control. This report recognizes these challenges exist and used best available science to estimate visitation. New opportunities to monitor use are emerging, such as social media and anonymized cell phone data, and should be emphasized in future studies.

Other common concerns with the data presented are the double counting of park visitors, double counting of people who engage in multiple types of recreation on a given day, and differences in methods for estimation used by various facilities and management agencies. To adjust for double counting, nonprimary visitors (or visitors whose primary trip purpose was not recreation at the site) were treated as local day visitors, limiting their spending impacts.

While this report estimates the significant economic contribution of outdoor recreation in Oregon, it does not represent the full suite of economic benefits that outdoor recreational spaces and activities generate, for example:

- **CONSUMER SURPLUS**

  An economic concept that refers to the value people get from recreation over and above what they pay, consumer surplus is an important measure of societal welfare. In 2018, the OPRD estimated the consumer surplus, or total net economic value, for recreation participation in Oregon by Oregonians to be $54.2 billion (2018 USD) annually.

- **PUBLIC HEALTH**

  Parks and natural spaces promote physical and mental health. Those who participate in outdoor recreation are shown to have lower medical and insurance costs than their non-active counterparts. Oregon State University has estimated the economic value of this physical activity to be $1.4 billion in insurance savings per year. These savings are equivalent to 2-3.6% of total health care expenditures in the states.

- **ENVIRONMENTAL BENEFITS**

  Among other public benefits, recreational spaces in Oregon provide clean, drinkable water (thus reducing filtration costs); carbon sequestration (avoiding economic impacts associated with increased CO_2); scenic beauty (increasing home values); and habitat for plants and animals (strengthening food webs). While these benefits have not been quantified or valued across all outdoor recreation spaces in Oregon, nearby studies suggest this value can be immense. For example, Earth Economics estimated that each year, Washington state's public lands provide between $216 billion and $264 billion in environmental benefits.

The findings presented in this report provide a baseline of the outdoor recreation economy in Oregon. The analysis also provides a structure for collecting and organizing visitation and spending data. Using this approach allows for future updates to be directly comparable. As Oregon's population continues to grow, and preferences and demand for outdoor recreation evolves, this study should be updated every five years, on a parallel planning track with the Statewide Comprehensive Outdoor Recreation Plan. Important future studies should also increase our understanding of:

- **EQUITABLE ACCESS**

  The equitable access to outdoor recreation has not been studied in this analysis. The authors recognize that not all populations have equal access to and/or feel comfortable in outdoor spaces, notably, people of color are underrepresented within the outdoor space.

- **OVERCROWDING**

  This report does not discuss the impact that outdoor recreation has on our landscapes. Park agencies are tasked with weighing visitor demand with ecosystem needs. Economic contribution analysis and other benefit analyses (as highlighted above) can highlight the importance of investment in our natural spaces.

- **CLIMATE CHANGE**

  Oregon's susceptibility to natural disasters impacting recreational landscapes is heightened through climate change. Wildfires, excessive heat, and warmer winters have a noticeable impact on recreation use. Rising sea levels, invasive species, and water temperatures may result in long-term impacts to use. Of recent relevance, wildfires are not only dangerous to the immediate population, but wildfire smoke can make recreation unhealthy to engage in throughout the state. Wildfires can later cause drought by not allowing water to recharge aquifers in burned areas, further impacting water-based recreation.

Photo Credit: traveloregon.com

Photo Credit: Carter Reschke (unsplash.com)

APPENDIX A

RECREATIONAL LANDS INCLUDED IN THIS STUDY

NATIONAL PARK SERVICE

Crater Lake National Park, John Day Fossil Beds National Monument, Lewis And Clark National Historical Park, Oregon Caves National Monument and Preserve

U.S. FISH AND WILDLIFE SERVICE

Bear Valley National Wildlife Refuge, Malheur National Wildlife Refuge, Bandon Marsh National Wildlife Refuge, Lewis and Clark National Wildlife Refuge, Nestucca Bay National Wildlife Refuge, William L. Finley National Wildlife Refuge, Cold Springs National Wildlife Refuge, McKay Creek National Wildlife Refuge, Umatilla National Wildlife Refuge, Klamath Marsh National Wildlife Refuge, Upper Klamath National Wildlife Refuge, Tualatin River National Wildlife Refuge, Siletz Bay National Wildlife Refuge, Lower Klamath National Wildlife Refuge, Oregon Islands National Wildlife Refuge, Ankeny National Wildlife Refuge, Baskett Slough National Wildlife Refuge, Cape Meares National Wildlife Refuge, Three Arch Rocks National Wildlife Refuge

OREGON PARKS AND RECREATION DEPARTMENT

Arizona Beach State Recreation Site, Ellmaker State Wayside, Emigrant Springs State Heritage Area, Face Rock State Scenic Viewpoint, Farewell Bend State Recreation Area, Fogarty Creek State Recreation Area, Fort Rock State Natural Area, Fort Stevens State Park, Fort Yamhill State Heritage Site, Bald Peak State Scenic Viewpoint, Geisel Monument State Heritage Site, Gleneden Beach State Recreation Site, Golden And Silver Falls State Natural Area, Bandon State Natural Area, Governor Patterson Memorial State Recreation Site, Guy W. Talbot State Park, H.B. Van Duzer Forest State Scenic Corridor, Harris Beach State Park, Hat Rock State Park, Heceta Head Lighthouse State Scenic Viewpoint, Hilgard Junction State Park, Bates State Park, Hug Point State Recreation Site, Humbug Mountain State Park, Illinois River Forks State Park, Iwetemlaykin State Heritage Site, Battle Mountain Forest State Scenic Corridor, Jackson F. Kimball State Recreation Site, Jasper State Recreation Site, Jessie M. Honeyman Memorial State Park, Beachside State Recreation Site, Joseph H. Stewart State Recreation Area, Koberg Beach State Recreation Site, L.L. "Stub" Stewart State Park, Lake Owyhee State Park, Lapine State Park, Lewis And Clark State Recreation Site, Lost Creek State Recreation Site, Lowell State Recreation Site, Luckiamute State Natural Area, Manhattan Beach State Recreation Site, Maud Williamson State Recreation Site, Mayer State Park, Agate Beach State Recreation Site, Mcvay Rock State Recreation Site, Memaloose State Park, Milo Mciver State Park, Minam State Recreation Area, Molalla River State Park, Munson Creek State Natural Area, Benson State Recreation Area, Nehalem Bay State Park, Neptune State Scenic Viewpoint, Neskowin Beach State Recreation Site, North Santiam State Recreation Area, Oceanside Beach State Recreation Site, Ochoco State Scenic Viewpoint, Ontario State Recreation Site, Beverly Beach State Park, Oswald West State Park, Otter Crest State Scenic Viewpoint, Otter Point State Recreation Site, Paradise Point State Recreation Site, Peter Skene Ogden State Scenic Viewpoint, Pilot Butte State Scenic Viewpoint, Pistol River State Scenic Viewpoint, Port Orford Heads State Park, Portland Women's Forum State Scenic Viewpoint, Prineville Reservoir State Park, Roads End State Recreation Site, Rocky Creek State Scenic Viewpoint, Rooster Rock State Park, Saddle Mountain State Natural Area, Samuel H. Boardman State Scenic Corridor, Sarah Helmick State Recreation Site, Seal Rock State Recreation Site, Seneca Fouts Memorial State Natural Area, Seven Devils State Recreation Site, Bob Straub State Park, Shore Acres State Park, Silver Falls State Park, Siuslaw North Jetty , Boiler Bay State Scenic Viewpoint, Smelt Sands State Recreation Site, Smith Rock State Park, South Beach State Park, Starvation Creek State Park, Ainsworth State Park, Sumpter Valley Dredge State Heritage Area, Sunset Bay State Park, Sunset Beach State Recreation Site, The Cove Palisades State Park, Tolovana Beach State Recreation Site, Tou Velle State Recreation Site, Tseriadun State Recreation Area, Tumalo State Park, Ukiah-Dale Forest State Scenic Corridor, Umpqua Lighthouse State Park, Umpqua State Scenic Corridor, Unity Lake State Recreation Site, Valley Of The Rogue State Park, Viento State Park, W.B. Nelson State Recreation Site, Wallowa Lake State Park, Booth State Scenic Corridor, Warm Springs State Recreation Site, White River Falls State Park, Willamette Mission State Park, William M. Tugman State Park, Winchuck State Recreation Site, Yachats Ocean Road State Natural Site, Yachats State Recreation Area, Yaquina Bay State Recreation Site, Bradley State Scenic Viewpoint, Brian Booth State Park, Bridal Veil Falls State Scenic Viewpoint, Bullards Beach State Park, Cape Arago State Park, Cape Blanco State Park, Cape Lookout State Park, Cape Meares State Scenic Viewpoint, Cape Sebastian State Scenic Corridor, Carl G. Washburne Memorial State Park, Cascadia State Park, Catherine Creek State Park, Champoeg State Heritage Area, Alfred A. Loeb State Park, Clay Myers State Natural Area, Cline Falls State Scenic Viewpoint, Clyde Holliday State Recreation Site, Collier Memorial State Park, Cottonwood Canyon State Park, Crissey Field State Recreation Site, Crown Point State Scenic Corridor, D River State Recreation Site, Dabney State Recreation Area, Dalton Point Recreation Site, Del Rey Beach State Recreation Site, Deschutes River State Recreation Area, Detroit Lake State Recreation Area, Devil's Lake State Recreation Area, Devil's Punch Bowl State Natural Area, Arcadia Beach State Recreation Site, Dexter State Recreation Site, Driftwood Beach State Recreation Site, Ecola State Park, Elijah Bristow State Park

OREGON DEPARTEMENT OF FORESTRY

Clatsop State Forest, Santiam State Forest, Tillamook State Forest, Coos District, Klamath-Lake District

UNITED STATES ARMY CORPS OF ENGINEERS

Blue River Lake, Bonneville Lock and Dam, Cottage Grove Lake, Detroit Lake, Dexter Lake, Dorena Lake, Fall Creek Lake, Fern Ridge Lake, Foster Lake, Green Peter Lake, Hills Creek Lake, John Day Lock And Dam, Lake Umatilla, Lookout Point Lake, Lost Creek Lake, McNary Lock And Dam, Willow Creek

U.S. FOREST SERVICE

Columbia River Gorge National Scenic Area, Deschutes National Forest, Fremont-Winema National Forest, Malheur National Forest, Mt. Hood National Forest, Ochoco National Forest, Rogue River-Siskiyou National Forests, Siuslaw National Forest, Umatilla National Forest, Umpqua National Forest, Wallowa-Whitman National Forest, Willamette National Forest

GOLF COURSES

Counties with golf courses; specific courses not included to protect privacy.

Baker County Golf Course, Benton County Golf Course, Clackamas County Golf Course, Clatsop County Golf Course, Columbia County Golf Course, Coos County Golf Course, Crook County Golf Course, Curry County Golf Course, Deschutes County Golf Course, Douglas County Golf Course, Grant County Golf Course, Harney County Golf Course, Hood River County Golf Course, Jackson County Golf Course, Jefferson County Golf Course, Josephine County Golf Course, Klamath County Golf Course, Lake County Golf Course, Lane County Golf Course, Lincoln County Golf Course, Linn County Golf Course, Malheur County Golf Course, Marion County Golf Course, Morrow County Golf Course, Multnomah County Golf Course, Polk County Golf Course, Tillamook County Golf Course, Umatilla County Golf Course, Union County Golf Course, Wallowa County Golf Course, Wasco County Golf Course, Washington County Golf Course

LOCAL PARKS

Baker City, Baker County, Benton, Benton County, Benton County Fairgrounds, City Of Unity And Baker County, Clackamas, Clackamas County, Clackamas County Historical Society, Clatsop, Clatsop County, Columbia, Columbia County, Coos, Coos County, Crook County Parks And Recreation District, Curry, Curry County, Deschutes, Douglas, Douglas County, Douglas County Fairgrounds, Gilliam, Gilliam County, Grant, Grant County, Harney, Harney County, Harney County Little League , Hood River, Hood River County, Jackson, Jackson County, Jefferson, Jefferson County, Josephine, Josephine County, Klamath, Klamath County, Lake, Lake County, Lane, Lane County, Lincoln, Lincoln County, Linn, Linn County, Malheur, Malheur County, Marion, Marion County, Morrow, Morrow County, Multnomah, North County Recreation District, Northern Wasco County Parks And Recreation District, Polk, Polk County, Sherman, Sherman County, Tillamook, Tillamook County, Tillamook County - Disavowed, Tillamook County Pioneer Museum, Umatilla, Umatilla County, Union, Union County, Wallowa, Wallowa County, Wasco, Wasco County, Washington, Washington County, Wheeler, Wheeler County, Yamhill, Yamhill County

PRIVATE LAND TRUST PROPERTIES

Andrew Reasoner Wildlife Preserve, Bald Hill, Boneyard Ridge, Borax Lake, Camassia Preserve, Cascade Head, Cascade-Siskiyou, Cedar Mill Preserve, Circle Creek, Clear Lake Ridge, Cogswell Foster, Colwood Park, Creep and Crawl Lake, Deer Creek - Illinois River, Doris Davis Beaver Marsh, Drift Creek - Alsea River, Elk Meadows Nature Park, Estella Matilda Happ Preserve, Finn Rock Reach - East, Fishers Point, Fitton Green, Five Mile - Bell Creeks, Forest Dell, Fourmile Wetlands, Gilchrist, Hayden Island, Hood River - Punch Bowl Falls, Jackson-Frazier, Jacksonville Woodlands, Jacksonville Woodlands, Beekman Woods, Jacksonville Woodlands, Britt Woods, Jacksonville Woodlands, The Quarry, John Day River, Murtha Ranch, Juniper Hills, Kingston Prairie, Lewis and Clark National Historical Park, Lincoln County Conservation Easement, Lindsay Prairie, McKenzie Camp, Miami Wetlands, Mill Creek, Miller Tree Farm Community Forest, Minthorn Springs, Neal's Fen, Neawanna Point, North Umpqua, Nyberg Wetland, Old Siskiyou Sheep Trail, Reed Ranch, Sandy & Little Sandy Rivers, Slide Creek, Snake River/Cache Creek Ranch, Sutton Lake Swamp, Sycan Marsh, Table Rocks Fee, Thompson Falls, Tom McCall at Rowena, Whetstone Savanna, Willamette - Luckimute Landing, Willamette Confluence, Williamson River Delta, Williamson River Delta - Goose Bay, Wolf Bay Twilight Eagle Sanctuary, Woolfolk, Yeon Easement

APPENDIX B
COUNTY LEVEL RESULTS

County level results are estimated for trip-related spending and do not include expenditures on equipment (outdoor recreation gear, apparel, equipment, and repair), which are measured at the state-level. Trip-related spending occurs while participating in, or traveling to participate in, an outdoor recreation activity. The results below show the economic effects associated with direct spending and their secondary effects **occurring within the county**. Secondary effects measure how direct spending ripples out to the businesses and employees which support the operation of directly impacted businesses. County results do not include state-wide economic effects resulting from direct spending.

FIGURE 11. OREGON COUNTIES

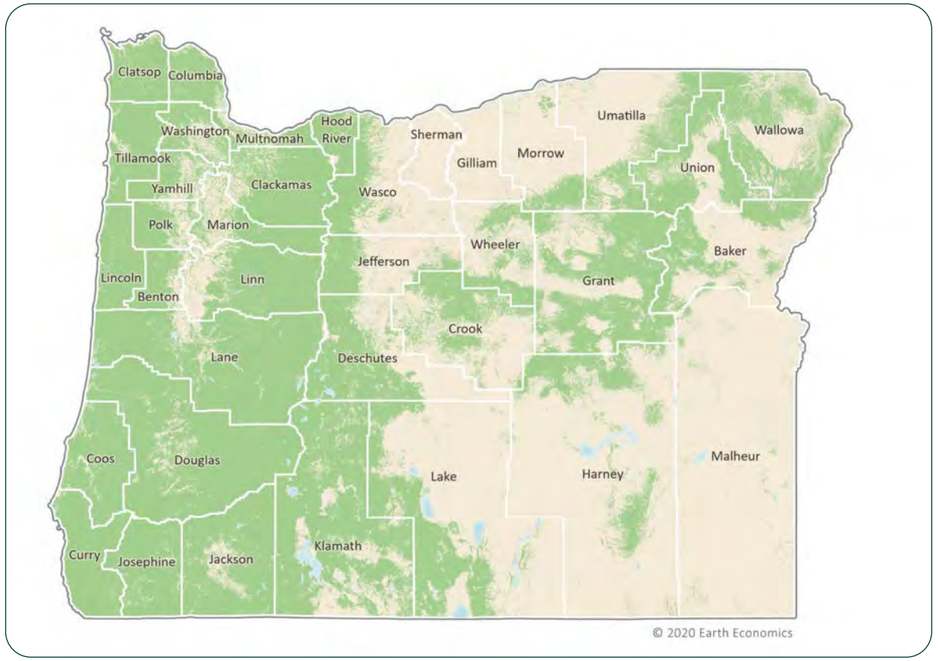


Photo Credit: Travel Oregon (photographer: Joni Kabana)

Photo Credit: Travel Oregon (photographer: Dylan VanWeelden)

FIGURE 12. ECONOMIC CONTRIBUTION OF OUTDOOR RECREATION IN OREGON – COUNTY-LEVEL RESULTS

County	Trip-Related Spending (000s)	Employment	Labor Income (000s)	Output (000s)	GDP Contributions (000s)	State and Local Tax (000s)
Baker	$124,847	1,060	$26,648	$73,834	$31,701	$3,959
Benton	$79,975	765	$24,497	$63,848	$34,694	$4,383
Clackamas	$628,307	7,455	$312,218	$683,446	$356,266	$36,835
Clatsop	$785,485	5,784	$215,710	$554,435	$325,603	$26,095
Columbia	$37,085	271	$8,785	$22,726	$10,789	$1,477
Coos	$1,267,023	13,385	$446,408	$1,058,855	$80,683	$49,207
Crook	$85,516	841	$26,058	$74,226	$35,006	$3,974
Curry	$611,819	5,137	$151,929	$418,400	$203,470	$17,017
Deschutes	$744,279	9,424	$370,650	$863,301	$432,902	$43,791
Douglas	$375,005	3,821	$124,538	$304,117	$137,531	$18,959
Gilliam	$6,645	36	$1,048	$2,539	$1,306	$139
Grant	$74,955	909	$21,311	$55,783	$16,319	$4,369
Harney	$172,662	1,065	$34,881	$82,538	$33,144	$6,833
Hood River	$283,142	3,468	$131,692	$281,252	$119,835	$15,901
Jackson	$310,974	3,225	$120,626	$307,924	$163,486	$16,156
Jefferson	$138,255	1,396	$45,791	$114,943	$47,229	$5,982
Josephine	$174,794	1,701	$65,084	$150,161	$74,463	$8,011
Klamath	$384,217	4,396	$143,566	$345,049	$150,652	$21,275
Lake	$109,581	1,412	$32,449	$82,022	$21,994	$6,259
Lane	$1,289,630	12,689	$492,165	$1,201,642	$654,169	$67,056
Lincoln	$2,077,683	16,195	$523,094	$1,444,388	$821,526	$71,230
Linn	$204,072	1,789	$67,440	$153,240	$76,134	$8,638
Malheur	$82,215	609	$18,304	$50,752	$25,408	$3,478
Marion	$316,326	2,939	$116,914	$300,358	$163,326	$15,555
Morrow	$22,405	171	$4,922	$11,953	$6,062	$988
Multnomah	$426,210	4,285	$198,537	$473,529	$287,961	$23,219
Polk	$64,793	453	$14,075	$35,502	$19,327	$2,055
Sherman	$6,710	41	$1,419	$3,849	$2,148	$143
Tillamook	$737,143	5,459	$167,967	$484,088	$260,165	$29,049
Umatilla	$115,689	968	$28,881	$75,329	$39,573	$5,263
Union	$81,331	792	$23,172	$66,841	$28,713	$3,223
Wallowa	$62,528	748	$19,837	$50,269	$16,602	$2,809
Wasco	$288,737	3,746	$133,389	$307,916	$145,060	$19,153
Washington	$163,550	1,267	$54,666	$135,914	$83,425	$6,400
Wheeler	$20,955	192	$4,360	$12,001	$3,107	$548
Yamhill	$68,677	529	$18,896	$48,224	$25,784	$2,651
Total County Effects	-	118,421	$4,191,928	$10,395,196	$4,935,564	$552,081
Secondary State Effect	-	105,689	5,134,700	14,191,958	8,172,478	-
State-Wide Total	$12,423,222	224,110	$9,326,627	$24,587,154	$13,108,043	552,081

APPENDIX C

STATE SENATE DISTRICT RESULTS

State Senate District results are estimated for trip-related spending and do not include expenditures on equipment (outdoor recreation gear, apparel, equipment, and repair), which are measured at the state-level. Trip-related spending occurs while participating in, or traveling to participate in, an outdoor recreation activity. The results below show the economic effects associated with direct spending and their secondary effects occurring in the region. Secondary effects measure how direct spending ripples out to the businesses and employees which support the operation of directly impacted businesses.

FIGURE 13. OREGON STATE SENATE DISTRICTS

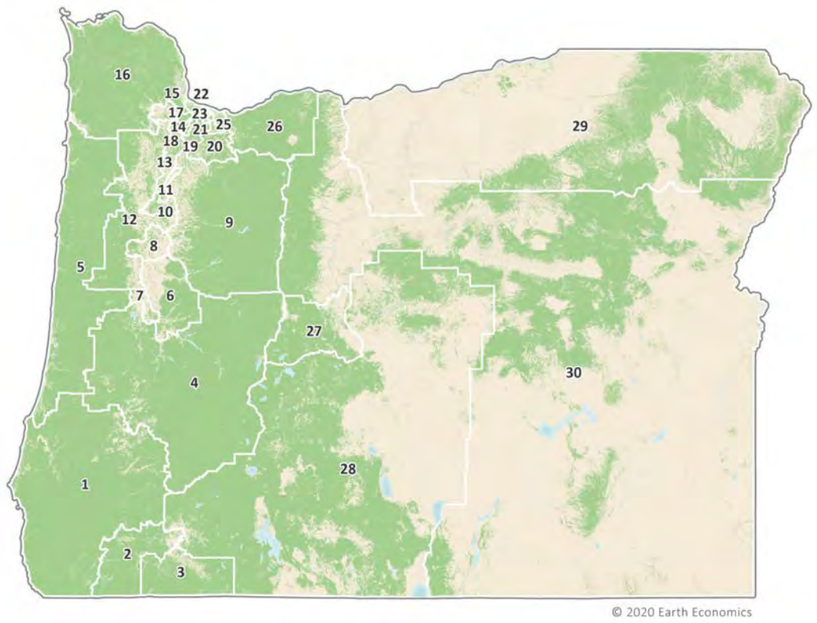
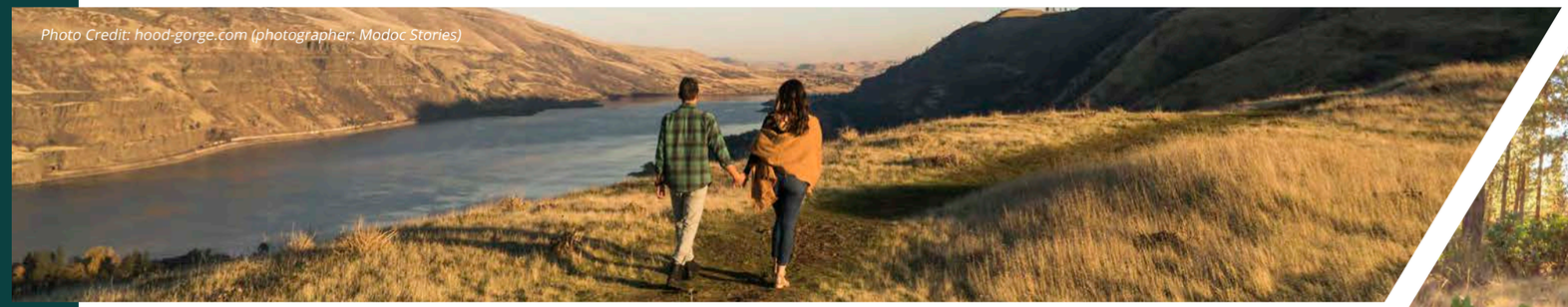


FIGURE 14. ECONOMIC CONTRIBUTION OF OUTDOOR RECREATION IN OREGON – STATE SENATE DISTRICT RESULTS

State Senate District	Trip-Related Spending (000s)	Employment	Labor Income (000s)	Output (000s)	Value Added (000s)	State and Local Taxes (000s)
1	$1,078,480	9,984	$313,170	$804,484	$294,565	$37,368
2	$217,112	2,155	$81,823	$194,798	$98,789	$10,337
3	$224,227	2,328	$86,977	$222,028	$117,881	$11,650
4	$406,845	4,057	$148,197	$361,851	$186,326	$20,949
5	$3,466,710	30,161	$993,314	$2,583,916	$1,046,249	$127,769
6	$386,237	3,789	$146,589	$357,017	$193,792	$19,930
7	$500,777	4,934	$191,113	$466,611	$254,021	$26,039
8	$157,664	1,450	$50,311	$121,912	$63,327	$7,599
9	$190,308	1,770	$68,611	$162,474	$84,201	$8,817
10	$96,238	836	$31,072	$79,527	$43,254	$4,217
11	$149,603	1,401	$55,293	$142,051	$77,243	$7,357
12	$64,476	523	$17,956	$45,885	$24,724	$2,580
13	$125,259	1,286	$51,725	$120,344	$64,287	$6,398
14	$18,666	159	$6,246	$15,526	$9,530	$731
15	$48,574	391	$16,235	$40,366	$24,777	$1,901
16	$1,409,570	10,423	$358,836	$963,722	$544,381	$50,730
17	$64,289	555	$23,775	$58,291	$35,670	$2,782
18	$82,097	782	$34,713	$83,691	$51,010	$4,061
19	$104,549	1,187	$49,722	$111,353	$60,399	$5,855
20	$190,410	2,279	$94,618	$207,120	$107,967	$11,163
21	$82,132	927	$39,644	$90,214	$50,652	$4,659
22	$109,188	1,120	$50,862	$121,310	$73,771	$5,948
23	$56,412	590	$26,278	$62,676	$38,114	$3,073
24	$121,241	1,408	$59,319	$132,575	$71,987	$6,984
25	$80,688	836	$37,586	$89,646	$54,515	$4,396
26	$446,360	5,390	$212,104	$459,313	$214,808	$25,377
27	$603,137	7,664	$300,361	$699,587	$350,808	$35,487
28	$692,836	8,060	$257,293	$631,584	$274,782	$38,036
29	$354,254	3,550	$106,510	$273,639	$124,018	$16,474
30	$894,884	8,891	$281,670	$691,685	$299,717	$43,415



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APPENDIX D
TOURISM REGION RESULTS

Tourism Region results are estimated for trip-related spending and do not include expenditures on equipment (outdoor recreation gear, apparel, equipment, and repair), which are measured at the state-level. Trip-related spending occurs while participating in, or traveling to participate in, an outdoor recreation activity. The results below show the economic effects associated with direct spending and their secondary effects. Secondary effects measure how direct spending ripples out to the businesses and employees which support the operation of directly impacted businesses.

FIGURE 15. OREGON TOURISM REGIONS*

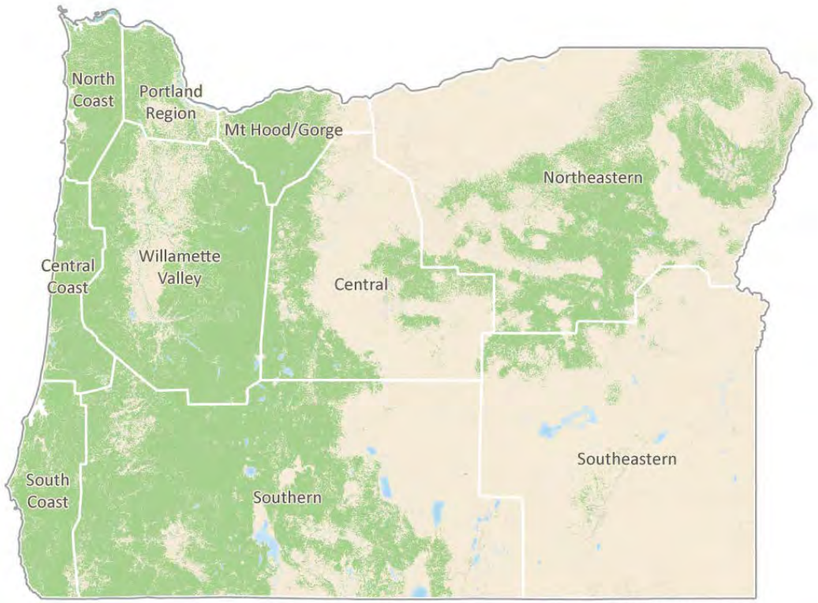

FIGURE 16. ECONOMIC CONTRIBUTION OF OUTDOOR RECREATION IN OREGON – TOURISM REGION RESULTS*

Tourism Region	Trip-Related Spending (000s)	Employment	Labor Income (000s)	Output (000s)	Value Added (000s)	State and Local Taxes (000s)
Central	$1,057,497	12,821	$483,821	$1,147,857	$560,074	$59,680
Central Coast	$2,290,546	18,310	$601,247	$1,635,250	$920,862	$82,213
Mt Hood/Gorge	$601,761	7,377	$281,465	$624,772	$293,175	$35,905
North Coast	$1,441,094	10,643	$361,286	$980,972	$551,970	$52,435
Northeastern	$516,067	4,916	$131,599	$352,398	$145,532	$21,441
Portland Region	$1,100,234	11,165	$480,690	$1,114,774	$632,609	$56,990
South Coast	$1,878,842	18,522	$598,337	$1,477,255	$284,153	$66,224
Southeastern	$252,637	1,660	$52,733	$132,219	$58,123	$10,223
Southern	$1,287,992	13,867	$463,861	$1,134,535	$523,317	$67,270
Willamette Valley	$1,996,551	19,139	$736,889	$1,795,164	$965,748	$99,702

*The Oregon Coast and Eastern Oregon regions have been subdivided to better illustrate the regions unique recreational aspects and geography

Photo Credit: Travel Oregon / Mountains Legacy

Photo Credit: Sebastien Goldberg (unsplash.com)

APPENDIX E

SPENDING BY OUTDOOR RECREATION ACTIVITY

In 2017, the Oregon Parks and Recreation Department (OPRD) categorized outdoor recreation into 56 unique acitivity types. Because each of the 56 unique activities could not be directly tied to recreational trips where monetary transactions occurred, Figure 16 of this report provides the average spending associated with each recreation trip, and the total trip-related spending for 32 of these recreation activities. Additionally, because recreation activities are oftentimes combined in the same trip (e.g., hiking and camping), the estimates in Figure 16 represent the participants primary activity to avoid double counting.

Photo Credit: Travel Oregon, Mountains Legacy

Photo Credit: Anthony Smith, courtesy of Bike Magazine

FIGURE 17. SPENDING BY OUTDOOR RECREATION ACTIVITY

Recreation Acitivty	Activity Days	$/Activity Day	Total Spending (000's)
Attending outdoor concerts / fairs / festivals / other organized events	1,931,316	$44	$85,322
Beach activities – lakes / reservoirs / rivers	5,610,906	$108	$605,978
Beach activities – ocean	24,624,271	$131	$3,220,328
Bicycling on roads / streets / sidewalks / paved trails	10,871,377	$119	$1,291,540
Bicycling on unpaved trails	2,717,844	$77	$209,582
Car camping with a tent	3,409,968	$103	$352,502
Collecting (rocks / plants / mushrooms / berries)	2,407,339	$52	$125,171
Cross-country / Nordic skiing / skijoring on ungroomed trails / off designated trails	232,129	$151	$35,048
Dog walking / going to dog parks / off-leash areas	9,391,614	$31	$288,571
Downhill (alpine) skiing / snowboarding	677,753	$179	$121,579
Fishing	3,571,222	$111	$396,866
Flat-water canoeing / sea kayaking / rowing / stand-up paddling / tubing / floating	652,034	$60	$39,028
Golf	7,128,000	$91	$645,227
Hunting	1,679,129	$96	$161,853
Kite boarding	382,004	$275	$105,042
Long-distance hiking (backpacking)	1,826,024	$112	$204,497
Motorized trail activity	2,535,568	$152	$385,373
Nature / wildlife / forest /wildflower observation	10,680,000	$88	$939,758
Outdoor photography / painting / drawing	3,158,893	$157	$497,274
Personal water craft – jet ski	501,537	$90	$45,168
Playing sports at parks	27,813,224	$22	$619,347D22
Power boating (cruising / water skiing)	6,850,931	$90	$616,984
Primitive camping	938,050	$58	$54,402
Picnicking / relaxing / hanging out / escaping heat / noise / etc.	14,642,010	$22	$322,096
Rock climbing / Mountaineering	3,560,000	$102	$362,427
Shellfishing / clamming	321,410	$82	$26,511
Sightseeing / driving or motorcycling for pleasure	509,897	$131	$66,741
Snowmobiling	160,301	$205	$32,859
Swimming / playing in outdoor pools / spray parks	2,513,786	$40	$100,543
Visiting historic sites / history- themed parks	2,862,645	$96	$275,451
Visiting nature centers	2,175,584	$77	$168,137
White-water canoeing / kayaking/ rafting	460,607	$48	$22,017
Total	156,797,374	$79	$12,423,222

APPENDIX F

INPUT-OUTPUT SECTOR MAPPING

SPENDING CATEGORY	2018 CODE	IMPLAN DESCRIPTION
Gas & Oil	154	Petroleum refineries
Gas and oil	154	Petroleum refineries
Gas_and_oil	154	Petroleum refineries
Gasoline	154	Petroleum refineries
Gasoline/diesel	154	Petroleum refineries
Groceries	406	Retail - Food and beverage stores
Groceries and takeout food	406	Retail - Food and beverage stores
Groceries, take-out food/drinks	406	Retail - Food and beverage stores
Grocery Stores/liquor stores	406	Retail - Food and beverage stores
Gear	410	Retail - Sporting goods, hobby, musical instrument and book stores
Sporting goods	410	Retail - Sporting goods, hobby, musical instrument and book stores
Sporting goods and boat equipment	410	Retail - Sporting goods, hobby, musical instrument and book stores
Sporting_goods	410	Retail - Sporting goods, hobby, musical instrument and book stores
Gift shop (NP)	412	Retail - Miscellaneous store retailers
Other	412	Retail - Miscellaneous store retailers
Other expenses	412	Retail - Miscellaneous store retailers
Souvenirs and other expenses	412	Retail - Miscellaneous store retailers
Souvenirs and other expenses	412	Retail - Miscellaneous store retailers
Souvenirs and other expenses	412	Retail - Miscellaneous store retailers
Souvenirs/other	412	Retail - Miscellaneous store retailers
Souvenirs_and_other_expenses	412	Retail - Miscellaneous store retailers
Local Transportation	418	Transit and ground passenger transportation
Local transportation	418	Transit and ground passenger transportation
Other auto expenses	418	Transit and ground passenger transportation
Other_transportation	418	Transit and ground passenger transportation
Transport	418	Transit and ground passenger transportation
Transportation	418	Transit and ground passenger transportation
Parking	420	Scenic and sightseeing transportation and support activities for transportation
Private land use fees	447	Other real estate
Rental Vehicles	450	Automotive equipment rental and leasing
Attractions/Entertainment and recreation fees	504	Other amusement and recreation industries
Entertainment and recreation fees	504	Other amusement and recreation industries
Guide fees	504	Other amusement and recreation industries
Guide fees	504	Other amusement and recreation industries
Recreation and entertainment	504	Other amusement and recreation industries
Recreation_and_entertainment	504	Other amusement and recreation industries
Hotel	507	Hotels and motels, including casino hotels
Hotel, motels, cabins, BnB, rental homes	507	Hotels and motels, including casino hotels
Hotels	507	Hotels and motels, including casino hotels
Hotels/Motels	507	Hotels and motels, including casino hotels
Lodging	507	Hotels and motels, including casino hotels
Motel	507	Hotels and motels, including casino hotels
Motel, hotel cabin or B&B	507	Hotels and motels, including casino hotels
AirBNB	508	Other accommodations
Airbnb/Homeaway/etc.	508	Other accommodations
Camping	508	Other accommodations
Camping	508	Other accommodations
Camping fee	508	Other accommodations
Camping Fees	508	Other accommodations
Food/Drink	509	Full-service restaurants
Restaurant	509	Full-service restaurants
Restaurants	509	Full-service restaurants
Restaurants	509	Full-service restaurants
Restaurants & bars	509	Full-service restaurants
Restaurants and bars	509	Full-service restaurants
Restaurants, bars, etc	509	Full-service restaurants
Other auto expenses	512	Automotive repair and maintenance, except car washes
Other boat expenses	516	Personal and household goods repair and maintenance
Donations	522	Grantmaking, giving, and social advocacy organizations
Donations (NP)	522	Grantmaking, giving, and social advocacy organizations
Admissions & Fees_Federal	528	Other federal government enterprises
Entry_fees_Federal	528	Other federal government enterprises
Entry_fees_State	531	Other state government enterprises
Entry_fees_Local	534	Other local government enterprises
Admissions	5XX	VARIES BY ADMINISTRATIVE LEVEL
Entry fees	5XX	VARIES BY ADMINISTRATIVE LEVEL
Entry_fees_federal-state	5XX	VARIES BY ADMINISTRATIVE LEVEL

Photo Credit: hood-gorge.com (photographer: Motor Stories)

Photo Credit: Justin Myers Photography

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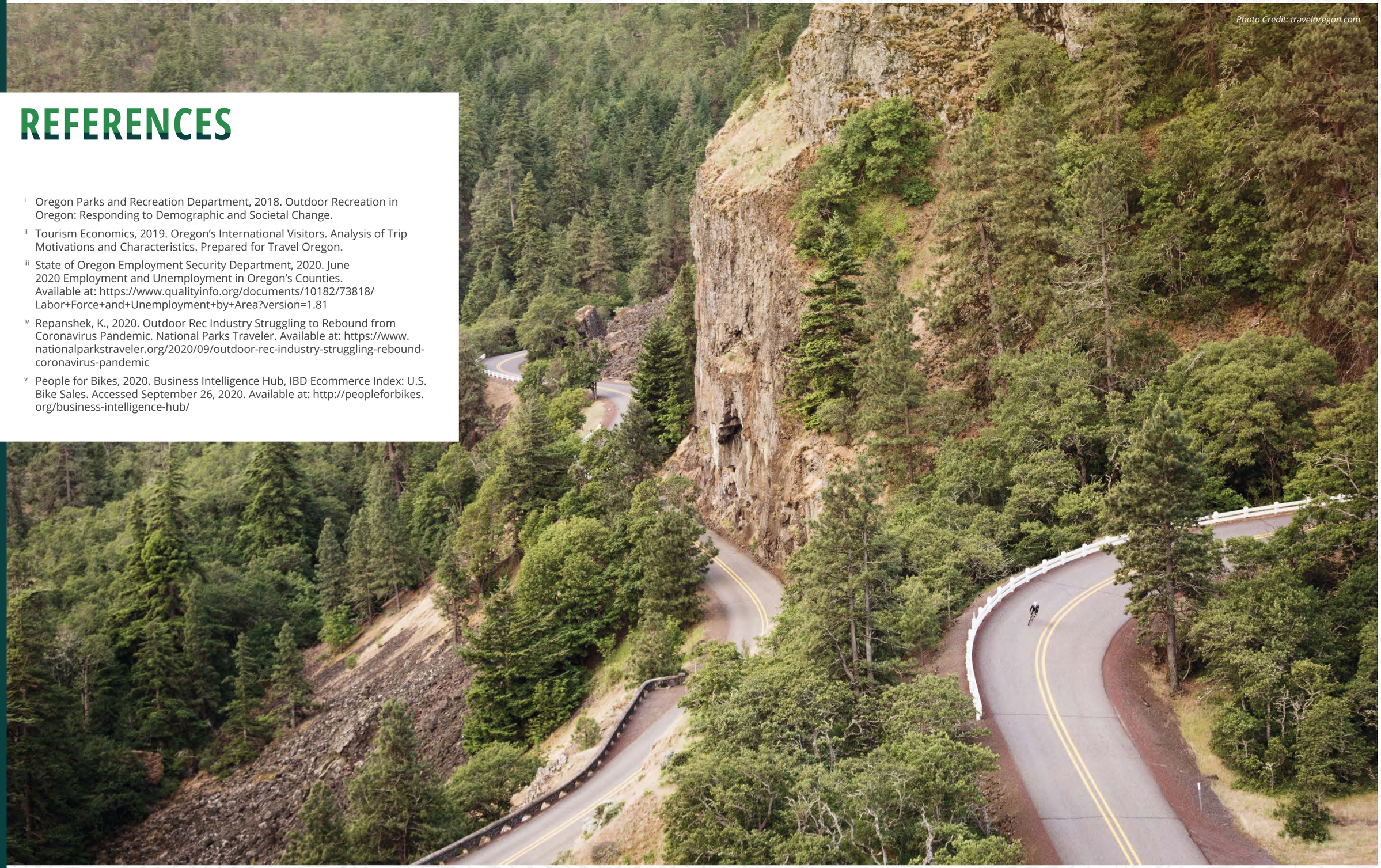

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PHOTOS: The Record-Breaking Heat Wave That's Scorching The Pacific Northwest

JUNE 29, 2021 · 4:18 PM ET

By Josie Fischels

The sun shines near the Space Needle, Monday, June 28, 2021, in Seattle. Seattle and other cities broke all-time heat records over the weekend, with temperatures soaring well above 100 degrees.

Ted S. Warren/AP

Record-breaking temperatures have soared well past 100 degrees across the Pacific Northwest, where the area is trapped beneath a blistering "heat dome."

In a region where average temperatures are closer to the 70s this time of year, houses can be seen with blacked-out windows covered with blankets to help with the heat. The area's normally mild summers mean many households don't have air conditioning.

The historic heatwave is bringing with it fears about what could follow over the rest of this summer.

The Pacific Northwest has a lack of air conditioners as hot weather is not typical. Here, Portland, Oregon residents stay at a cooling center.

Maranie Staab/Bloomberg via Getty Images

Records set one day have been broken the next.

Records have been shattered daily in parts of the Northwest, including Portland and Seattle. Portland broke records three days in a row, hitting 108 on Saturday, 112 on Sunday and then 116 on Monday.

Seattle reached 108 degrees on Monday during the heat wave in the Pacific Northwest. Here, a mother and daughter carry umbrellas to shield from the sun.

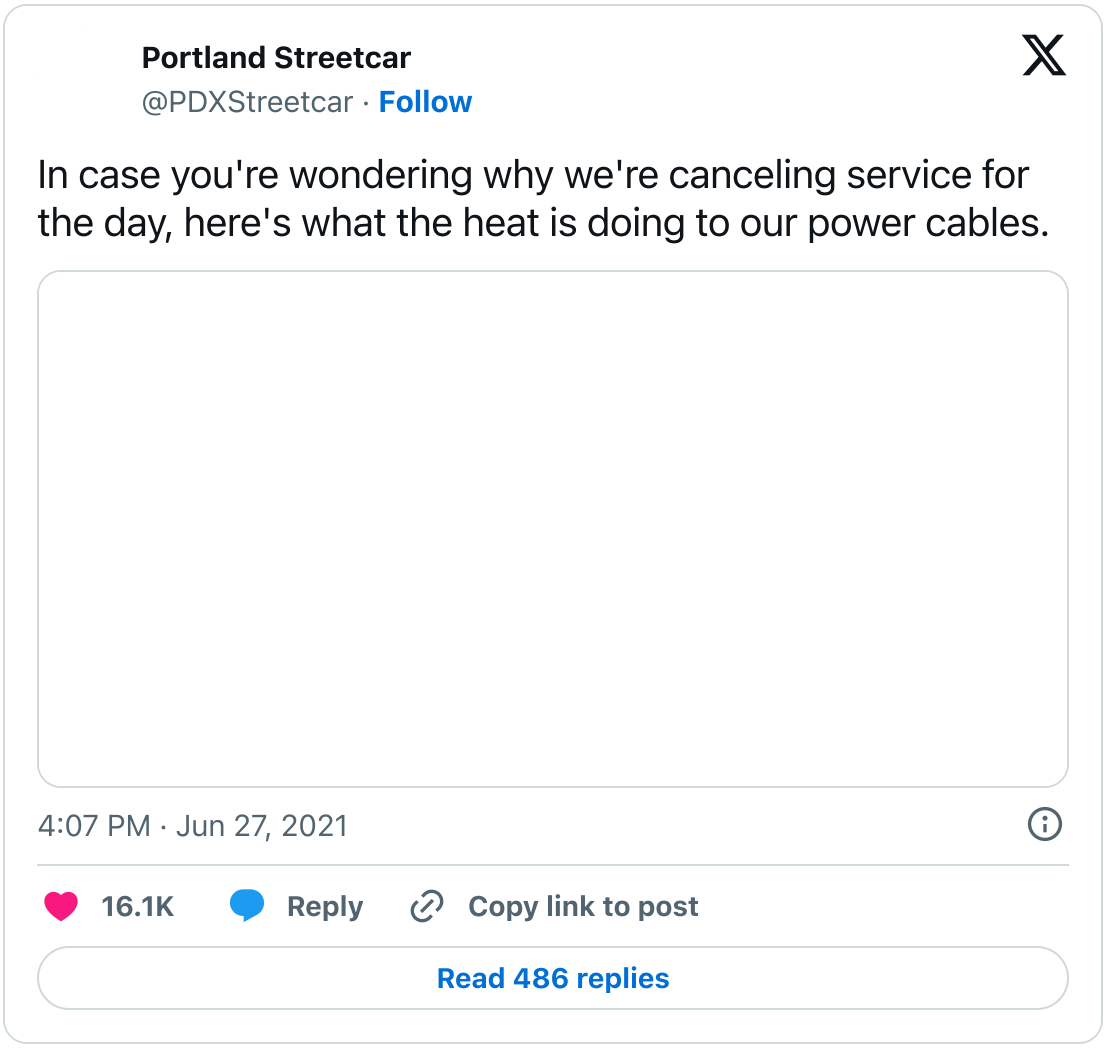
John Froschauer/AP

In Seattle, the temperature rose to 108 on Monday. In Pasco, Wash., the mercury climbed to 118 degrees, the hottest temperature the state has recorded since 1961.

Portland recorded three of its hottest days in history last Saturday and this Sunday and Monday. Here, a couple and their dog lay in the shade during the heat wave.

Maranie Staab/Bloomberg via Getty Images

In some places, the heat is so intense it has even melted power cables. In downtown Portland, the Portland Streetcar service shut down on Sunday, posting a picture on Twitter of a power cable with a hole burnt into it.



Roads have buckled under the heat in Portland

Pacific Northwest infrastructure is cracking — literally — under the pressure. In Everson, Wash., temperatures have caused the pavement to soften and expand. This can create rutting, buckling, and potholes, particularly in high-traffic areas.

Drought has created a vicious dry cycle

Widespread drought extending from the West and all the way into the Great Plains has only worsened under the heat dome. In the Northwest, a typically wet area, abnormally dry and drought conditions have expanded in a matter of weeks. On June 22, the U.S. Drought Monitor reported 79.8% of the region was in drought just ahead of the fire season.

Scientists say the warming climate is making both heat waves and droughts more frequent and intense

A sign is shown on the door of a Molly Moon's Ice Cream store in Seattle's Capitol Hill neighborhood. The store was closed Monday due to excessive heat.

Ted S. Warren/AP

Josie Fischels is an intern on NPR's News Desk.

drought heat wave pacific northwest

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FOCUS AREA

Aging

The current growth of the population ages 65 and older, driven by the large baby boom generation—those born between 1946 and 1964—is unprecedented in U.S. history.

This aging of the U.S. population has brought both challenges and opportunities to the economy, infrastructure, and institutions.

Demographic Shifts

The number of Americans ages 65 and older is projected to increase from 58 million in 2022 to 82 million by 2050 (a 42% increase), and the 65-and-older age group's share of the total population is projected to rise from 17% to 23%.[1]

The U.S population is older today than it has ever been. Between 1980 and 2022, the median age of the population increased from 30.0 to 38.9, but one-third (17) of states in the country had a median age above 40 in 2022, with Maine (44.8) and New Hampshire (43.3) at the top of the list.[2]

The older population is becoming more racially and ethnically diverse. Between 2022 and 2050 the share of the older population that identifies as non-Hispanic white is projected to drop from 75% to 60%.[3]

The rising diversity among older Americans can't match the rapidly changing racial/ethnic composition of those under age 18, creating a diversity gap between generations. In 2022, fewer than half of children ages 0 to 17 (49%) were non-Hispanic white.[4] But research shows that there is fluidity in how people identify with racial/ethnic categories: Mixed-race Americans (particularly mixed Hispanic and white) increasingly see themselves as part of the white majority.[5]

Positive Developments

Education levels are increasing. Among people ages 65 and older in 1965, only 5% had completed four years of college or more. By 2023, this share had risen to 33%.[6]

Older adults are working longer. By 2022, 24% of men and about 15% of women ages 65 and older were in the labor force. These levels are projected to rise further by 2032, to 25% for men and 17% for women.[7]

The poverty rate for Americans ages 65 and older has dropped sharply during the past 50 years, from nearly 30% in 1966 to 10% today.[8] The Census Bureau's Supplemental Poverty Measure, which accounts for non-cash benefits, tax credits, and medical expenses, shows that 14% of older Americans lived in poverty in 2022.[9]

More older adults can meet their daily care needs. Older adults are functioning better on their own, and a shrinking share are living in nursing homes and assisted living settings than a decade ago. Home

modifications and assistive devices such as walkers have helped older Americans maintain their independence.[10]

Challenges

Gains in life expectancy recently stalled. U.S. life expectancy at birth declined by 2.4 years between 2019 and 2021.[11] The drop in life expectancy was driven largely by the COVID-19 pandemic, but deaths from drug overdoses, heart disease, chronic liver disease and cirrhosis, and suicide also played a role.[12] Life expectancy rebounded slightly in 2022, to 77.5 years, but not enough to offset the decline during the pandemic.

Obesity prevalence among older Americans has increased at an alarming rate. In a single generation—between 1988-1994 and 2015-2018—the share of U.S. adults ages 65 and older with obesity nearly doubled, increasing from 22% to 40%.[13]

Wide economic disparities are found across different population subgroups. Among adults ages 65 and older, 17% and 18% of those identifying as Latino and African American, respectively, lived in poverty in 2022—more than twice the rate of those who identified as non-Hispanic white (8%).[14]

More older adults are divorced compared with previous generations. The share of divorced women ages 65 and older increased from 3% in 1980 to 15% in 2023, and for men from 4% to 12% during the same period.[15]

More older women are living alone. Over one-fourth (27%) of women ages 65 to 74 lived alone in 2023. This share jumped to 39% among women ages 75 to 84, and to 50% among women ages 85 and older.[16]

Older Americans face a caregiving gap, especially those with lower incomes and dementia.[17] Demand for elder care is expected to increase sharply with a rise in the number of Americans living with Alzheimer's disease, which could more than double by 2050 to 13 million, from 6 million today.[18]

Social Security and Medicare expenditures will increase from a combined 9.1% of gross domestic product in 2023 to 11.5% by 2035 because of the large share of older adults.[19]

Federal budget cuts and tax increases may be inevitable as more members of the large baby boom cohort reach retirement age and become eligible for entitlement programs. Policymakers can invest resources today to reduce poverty and improve the economic outlook for workers. These investments can increase young workers' future productive capacity and help offset the costs of an aging population.

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THE 2022 ANNUAL REPORT OF THE BOARD OF TRUSTEES OF THE FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

COMMUNICATION

FROM

THE BOARD OF TRUSTEES, FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

TRANSMITTING

THE 2022 ANNUAL REPORT OF THE BOARD OF TRUSTEES OF THE FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

LETTER OF TRANSMITTAL

BOARD OF TRUSTEES OF THE
FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND
FEDERAL DISABILITY INSURANCE TRUST FUNDS,
Washington, D.C., June 2, 2022

HON. NANCY PELOSI,
Speaker of the House of Representatives.

HON. KAMALA D. HARRIS,
President of the Senate.

DEAR MADAM SPEAKER AND MADAM PRESIDENT:

We have the honor of transmitting to you the 2022 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds, the 82nd such report.

Respectfully,

JANET YELLEN,
Secretary of the Treasury,
and Managing Trustee of the Trust Funds.

MARTIN J. WALSH,
Secretary of Labor,
and Trustee.

XAVIER BECERRA,
Secretary of Health and Human Services,
and Trustee.

KILOLO KIJAKAZI,
Acting Commissioner of
Social Security, and Trustee.

VACANT,
Public Trustee.

VACANT,
Public Trustee.

SCOTT L. FREY,
Chief of Staff, Social Security Administration,
and Acting Secretary, Board of Trustees.

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THE 2022 ANNUAL REPORT OF THE BOARD OF TRUSTEES OF THE FEDERAL OLD-AGE AND SURVIVORS INSURANCE AND FEDERAL DISABILITY INSURANCE TRUST FUNDS

I. INTRODUCTION

The Old-Age, Survivors, and Disability Insurance (OASDI) program makes monthly income available to insured workers and their families at retirement, death, or disability. The OASDI program consists of two parts. Retired workers, their families, and survivors of deceased workers receive monthly benefits under the Old-Age and Survivors Insurance (OASI) program. Disabled workers and their families receive monthly benefits under the Disability Insurance (DI) program.

The Social Security Act established the Board of Trustees to oversee the financial operations of the OASI and DI Trust Funds. The Board is composed of six members. Four members serve by virtue of their positions in the Federal Government: the Secretary of the Treasury, who is the Managing Trustee; the Secretary of Labor; the Secretary of Health and Human Services; and the Commissioner of Social Security. The President appoints and the Senate confirms the other two members to serve as public representatives. These two positions are currently vacant. The Deputy Commissioner of the Social Security Administration serves as Secretary of the Board.

The Social Security Act requires that the Board, among other duties, report annually to the Congress on the actuarial status and financial operations of the OASI and DI Trust Funds. The 2022 report is the 82nd such report. The assumptions for this report were set in mid-February 2022. Developments since then have added to the uncertainty regarding the path of the COVID-19 pandemic and the economy. The Trustees will continue to monitor these and any future developments and modify the projections in later reports as appropriate.

II. OVERVIEW

A. HIGHLIGHTS

This section summarizes the report's major findings.

Readers of this report should note that the data and projections presented include the Trustees' best estimates of the effects of the COVID-19 pandemic. The pandemic is projected to have continuing significant effects on the OASI and DI programs in the near term, and the future course of the pandemic is uncertain. However, the economic recovery from the brief recession in 2020 has been stronger and faster than assumed in last year's report. On balance, the projected long-range actuarial status of the OASI and DI Trust Funds has been little changed by the effects of the pandemic and ensuing recession, considering both the effects realized to date and those yet expected. The Trustees will continue to monitor developments and modify the projections in later reports.

In 2021

At the end of 2021, the OASDI program was providing benefit payments[1] to about 65 million people: 50 million retired workers and dependents of retired workers, 6 million survivors of deceased workers, and 9 million disabled workers and dependents of disabled workers. During the year, an estimated 179 million people had earnings covered by Social Security and paid payroll taxes on those earnings. The total cost of the program in 2021 was $1,145 billion. Total income was $1,088 billion, which consisted of $1,018 billion in non-interest income and $70 billion in interest earnings. Asset reserves held in special issue U.S. Treasury securities declined from $2,908 billion at the beginning of the year to $2,852 billion at the end of the year. The total cost and change in asset reserves shown for 2021 reflect the twelve months of benefits scheduled for payment, and include the benefits scheduled for payment on January 3, 2021, which were actually paid on December 31, 2020 as required by the law.[2]

[1] The definitions of "benefit payments" and other terms appear in the Glossary.

[2] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal delivery date is a Saturday, Sunday, or public legal holiday. The amount of these payments was approximately $18.7 billion for the OASI Trust Fund and $6.1 billion for the DI Trust Fund. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Short-Range Results (2022-31)

Under the Trustees' intermediate assumptions, Social Security's total cost is projected to be higher than its total income in 2022 and all later years. Total cost began to be higher than total income in 2021. Social Security's cost has exceeded its non-interest income since 2010.

To illustrate the actuarial status of the Social Security program as a whole, the operations of the OASI and DI Trust Funds are often shown on a combined basis as OASDI. However, by law, the two funds are separate entities and therefore the combined fund operations and reserves are hypothetical. The combined reserves are projected to decrease from $2,852 billion at the beginning of 2022 to $1,251 billion at the end of 2031, the last year of the short-range period.

The reserves of the combined OASI and DI Trust Funds along with projected program income are sufficient to cover projected program cost over the next 10 years under the intermediate assumptions. However, the ratio of reserves to annual cost is projected to decline from 230 percent at the beginning of 2022 to 74 percent at the beginning of 2031. Because this ratio falls below 100 percent by the beginning of the 10th projection year, the combined OASI and DI Trust Funds fail the Trustees' test of short-range financial adequacy. Considered separately, the OASI Trust Fund fails this test, but the DI Trust Fund satisfies the test. For last year's report, the Trustees projected that combined reserves would be 231 percent of annual cost at the beginning of 2022 and 66 percent at the beginning of 2031.

Long-Range Results (2022-96)

Under the Trustees' intermediate assumptions, OASDI cost is projected to exceed total income in 2022, and the dollar level of the hypothetical combined trust fund reserves declines until reserves become depleted in 2035. Figure II.D2 shows the implications of reserve depletion for the combined OASI and DI Trust Funds. Considered separately, the OASI Trust Fund reserves become depleted in 2034, and, for the first time since the 1983 Trustees Report, the DI Trust Fund reserves do not become depleted within the 75-year long-range projection period.[1] In last year's report, the projected reserve depletion years were 2034 for OASDI, 2033 for OASI, and 2057 for

[1] If the OASI Trust Fund reserves were to become depleted in 2034 as is currently projected, the operations of the hypothetical combined OASI and DI Trust Funds would not reflect the aggregated operation of the OASI Trust Fund and the DI Trust Fund because part of the OASI benefits could not be paid without a change in the law. The values shown for the hypothetical combined trust funds assume the law will have been changed to permit the transfer of resources between funds as needed.

DI. The level of DI reserves is very sensitive to changes in program cash flows and interest.

The DI program continues to have low levels of disability applications and benefit awards for 2021. Disability applications have declined substantially since 2010, and the total number of disabled-worker beneficiaries in current payment status has been falling since 2014. For this report, disability applications are assumed to rise gradually from current low levels, resulting in a rise in the age-sex-adjusted disability incidence rate to an ultimate rate of 4.8 per thousand exposed by the end of the short-range projection period. The ultimate disability incidence rate was lowered from the rate of 5.0 per thousand that was assumed in last year's report.

OASDI cost has been generally increasing much more rapidly than non-interest income since 2008 and is projected to continue to do so through about 2040. In this period, the retirement of the baby-boom generation is increasing the number of beneficiaries much faster than the increase in the number of covered workers, as subsequent lower-birth-rate generations replace the baby-boom generation at working ages. Between about 2040 and 2055, OASDI cost and non-interest income are projected to generally increase at more similar rates as the cost rate (the ratio of program cost to taxable payroll) roughly stabilizes, reflecting the return to birth rates above 2 children per woman between 1990 and 2008. Between 2055 and 2078, OASDI cost is projected to grow significantly faster than income because of the period of historically low birth rates starting with the recession of 2007-09. From 2078 to 2096, cost is projected to grow somewhat slower than income, as birth rates return to a level of 2 children per woman for 2056 and thereafter.

Over the 75-year long-range period 2022-96, the projected OASDI annual cost rate increases from 14.05 percent of taxable payroll for 2022 to 18.32 percent for 2078, and then decreases to 17.64 percent for 2096. The projected cost rate for 2096 is 4.25 percent of taxable payroll more than the projected income rate (the ratio of non-interest income to taxable payroll) for 2096. For last year's report, the Trustees estimated the OASDI cost for 2096 at 17.70 percent, or 4.35 percent of payroll more than the annual income rate for that year. Expressed in relation to the projected gross domestic product (GDP), OASDI cost generally rises from 5.0 percent of GDP for 2022 to a peak of about 6.2 percent for 2077, and then declines to 5.9 percent by 2096.

The actuarial deficit is 3.42 percent of taxable payroll for the 75-year projection period through 2096, decreased from 3.54 percent of taxable payroll for the 75-year projection period through 2095 in last year's report. The closely-related open-group unfunded obligation for OASDI is 3.24 percent of taxable

payroll over the 75-year projection period through 2096, decreased from 3.35 percent of payroll over the 75-year projection period through 2095 in last year's report. The open-group unfunded obligation for OASDI is $20.4 trillion in present value over the 75-year projection period through 2096 and is $0.6 trillion more than the measured level of $19.8 trillion over the 75-year projection period through 2095 in last year's report. The actuarial deficit rounds to 1.2 percent and the unfunded obligation rounds to 1.1 percent of GDP over the 75-year projection period through 2096, compared to 1.2 percent for each over the 75-year projection period through 2095 in last year's report.

If the assumptions, methods, starting values, and the law had all remained unchanged, the actuarial deficit would have increased to 3.59 percent of taxable payroll, and the unfunded obligation would have risen to 3.41 percent of taxable payroll and $20.6 trillion in present value due to the change in the valuation date and the extension of the valuation period through an additional year, 2096. The actuarial deficit decreased significantly in this year's report due to favorable recent experience and changes in assumptions described in detail in section IV.B.6 of this report.

To illustrate the magnitude of the 75-year actuarial deficit, consider that for the combined OASI and DI Trust Funds to remain fully solvent throughout the 75-year projection period ending in 2096: (1) revenue would have to increase by an amount equivalent to an immediate and permanent payroll tax rate increase of 3.24 percentage points[1] to 15.64 percent beginning in January 2022; (2) scheduled benefits would have to be reduced by an amount equivalent to an immediate and permanent reduction of 20.3 percent applied to all current and future beneficiaries effective in January 2022, or 24.1 percent if the reductions were applied only to those who become initially eligible for benefits in 2022 or later; or (3) some combination of these approaches would have to be adopted.

If substantial actions are deferred for several years, the changes necessary to maintain Social Security solvency would be concentrated on fewer years and fewer generations. Significantly larger changes would be necessary if action is deferred until the combined trust fund reserves become depleted in 2035. For example, maintaining 75-year solvency through 2096 with changes that begin in 2035 would require: (1) an increase in revenue by an amount equivalent to a permanent 4.07 percentage point payroll tax rate increase to

[1] The 3.24 percentage point increase in the payroll tax rate required to achieve 75-year solvency through 2096 differs somewhat from the 3.42 percent actuarial deficit. This is primarily because the rate increase required to achieve 75-year solvency reflects a zero trust fund reserve at the end of the period in 2096, whereas the 3.42 percent actuarial deficit incorporates an ending trust fund reserve equal to one year's cost. While such an increase in the payroll tax rate would cause some behavioral changes in earnings and ensuing changes in benefit levels, such changes are not included in these calculations because they are assumed to have roughly offsetting effects on OASDI actuarial status over the 75-year long-range period as a whole.

16.47 percent starting in 2035, (2) a reduction in scheduled benefits by an amount equivalent to a permanent 24.9 percent reduction in all benefits starting in 2035, or (3) some combination of these approaches.

Conclusion

Under the intermediate assumptions, the projected hypothetical combined OASI and DI Trust Fund asset reserves become depleted and unable to pay scheduled benefits in full on a timely basis in 2035. At the time of depletion of these combined reserves, continuing income to the combined trust funds would be sufficient to pay 80 percent of scheduled benefits. The OASI Trust Fund reserves are projected to become depleted in 2034, at which time OASI income would be sufficient to pay 77 percent of OASI scheduled benefits. DI Trust Fund asset reserves are not projected to become depleted during the 75-year period ending in 2096.

Lawmakers have a broad continuum of policy options that would close or reduce Social Security's long-term financing shortfall. Cost estimates for many such policy options are available at www.ssa.gov/OACT/solvency/provisions/.

The Trustees recommend that lawmakers address the projected trust fund shortfalls in a timely way in order to phase in necessary changes gradually and give workers and beneficiaries time to adjust to them. Implementing changes sooner rather than later would allow more generations to share in the needed revenue increases or reductions in scheduled benefits. Social Security will play a critical role in the lives of 66 million beneficiaries and 182 million covered workers and their families during 2022. With informed discussion, creative thinking, and timely legislative action, Social Security can continue to protect future generations.

B. TRUST FUND FINANCIAL OPERATIONS IN 2021

Table II.B1 shows the income, cost, and asset reserves for the OASI, the DI, and the combined OASI and DI Trust Funds in calendar year 2021.

Table II.B1.—Summary of 2021 Trust Fund Financial Operations
[In billions]

	OASI	DI	OASDI
Asset reserves at the end of 2020[a]	$2,811.7	$96.6	$2,908.3
Total income in 2021[b]	942.9	145.5	1,088.3
Net payroll tax contributions[c]	838.2	142.4	980.6
Interest	67.5	2.6	70.1
Taxation of benefits[c]	37.2	.5	37.6
Total cost in 2021[a]	1,001.9	142.6	1,144.6
Benefit payments[a]	993.1	140.1	1,133.2
Administrative expenses	4.0	2.5	6.5
Railroad Retirement financial interchange	4.8	.1	4.9
Net increase in asset reserves in 2021[a]	-59.1	2.8	-56.3
Asset reserves at the end of 2021	2,752.6	99.4	2,852.0

[a] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal delivery date is a Saturday, Sunday, or public legal holiday. The amount of these payments was approximately $18.7 billion for the OASI Trust Fund and $6.1 billion for the DI Trust Fund. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[b] Includes less than $50 million in reimbursements from the General Fund of the Treasury and gifts. See section III.A for details.

[c] Includes adjustments for prior calendar years. In June 2021, unusually large negative adjustments to payroll tax contributions in the amounts of $30.4 billion for OASI and $5.2 billion for DI were made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate the effects of the pandemic and recession.

Note: Components may not sum to totals because of rounding.

In 2021, net payroll tax contributions accounted for 90.1 percent of total trust fund income. Net payroll tax contributions consist of taxes paid by employees, employers, and the self-employed on earnings covered by Social Security. These taxes are paid on covered earnings up to a specified maximum annual amount, which was $142,800 in 2021. Table II.B2 shows the payroll tax rates for 2021.

Table II.B2.—Payroll Tax Contribution Rates for 2021
[In percent]

	OASI	DI	OASDI
Payroll tax contribution rate for employees	5.3	0.9	6.2
Payroll tax contribution rate for employers	5.3	.9	6.2
Payroll tax contribution rate for self-employed persons	10.6	1.8	12.4

Interest earned on invested trust fund asset reserves accounted for 6.4 percent of OASI and DI combined trust fund income in 2021. Revenue from subjecting up to 50 percent of Social Security benefits to Federal personal income taxation for beneficiaries with income (including half of benefits and all non-taxable interest received) exceeding specified levels accounted for 3.5 percent of OASDI income.

The Department of the Treasury invests all trust fund income in interest-bearing securities issued by the U.S. Government. In 2021, the combined trust fund reserves (the excess of all past income over all past expenditures) earned interest at an effective annual rate of 2.5 percent.

Retirement, survivor, and disability benefits accounted for 99.0 percent of OASI and DI combined trust fund cost in 2021. The expenses for administering the Social Security program were 0.6 percent of total cost. The net payment to the Railroad Retirement Social Security Equivalent Benefit Account from the combined OASI and DI Trust Funds accounted for 0.4 percent of total OASDI cost.

Trust fund reserves provide the basis for paying benefits. Combined trust fund reserves decreased by $56.3 billion during 2021 because income to the combined funds, including interest earned on trust fund reserves, was less than total cost.[1] In last year's report, combined reserves were projected to decrease by $77.3 billion in 2021.[2] At the end of 2021, the combined reserves of the OASI and the DI Trust Funds were $2,852 billion, or 230 percent of estimated cost[2] for 2022. In comparison, the combined reserves at the end of 2020 were 254 percent of actual cost for 2021.

[1] As noted in footnote a of table II.B1 and elsewhere in this report, asset reserves shown for the end of 2020 reflect the 12 months of benefits scheduled for payment in 2020 and thus exclude the benefits scheduled for payment on January 3, 2021, which were actually paid on December 31, 2020 as required by the law.

[2] Estimated cost is based on the intermediate set of assumptions.

C. ASSUMPTIONS ABOUT THE FUTURE

The future income and cost of the OASI and DI Trust Funds will depend on many factors, including the size and characteristics of the population receiving benefits, the level of monthly benefit amounts, the size of the workforce, and the level of covered workers' earnings. These factors will depend in turn on future birth rates, death rates, immigration, marriage and divorce rates, retirement-age patterns, disability incidence and termination rates, employment rates, productivity gains, wage increases, inflation, interest rates, and many other demographic, economic, and program-specific factors.

Table II.C1 presents key demographic, economic, and programmatic assumptions for three alternative scenarios. The intermediate assumptions reflect the Trustees' best estimates of future experience. Therefore, most of the results presented in this overview indicate outcomes under the intermediate assumptions only. Any projection of the future is, of course, uncertain. For this reason, the Trustees also present results under low-cost and high-cost alternatives to provide a range of possible future experience. The actual future costs are unlikely to be as extreme as those portrayed by the low-cost or high-cost projections. A separate section on the uncertainty of the projections, beginning on page 19, highlights the implications of these alternative scenarios.

The Trustees reexamine the assumptions each year in light of recent experience and new information. This annual review helps to ensure that the Trustees' assumptions provide the best estimate of future possibilities.

Table II.C1.—Key Assumptions[a] and Summary Measures for the Long-Range (75-year) Projection Period

Long-range assumptions	Intermediate	Low-cost	High-cost
Demographic:			
Average annual total fertility rate (children per woman), for 2032 through 2096[b]	1.99	2.19	1.69
Average annual percentage reduction in total age-sex-adjusted death rates from 2031 to 2096	.74	.28	1.25
Average annual net lawful permanent resident (LPR) immigration (in thousands) for 2032 through 2096	788	1,000	595
Average annual net other-than-LPR immigration (in thousands) for 2032 through 2096	458	684	234
Economic:			
Average annual percentage change in:			
Productivity (total U.S. economy), for 2030 and later	1.63	1.93	1.33
Average wage in covered employment from 2031 to 2096	3.55	4.77	2.33
Consumer Price Index (CPI-W), for 2026 and later	2.40	3.00	1.80
Average annual real wage differential (percent) for 2032 through 2096	1.15	1.77	.53
Unemployment rate (percent, age-sex-adjusted), for 2028 and later	4.5	3.5	5.5
Annual trust fund real interest rate (percent), for 2032 and later	2.3	2.8	1.8
Programmatic:			
Average annual disability incidence rate (per 1,000 exposed, age-sex-adjusted) for 2032 through 2096	4.8	3.9	5.8
Average annual disability recovery rate (per 1,000 beneficiaries, age-sex-adjusted) for 2032 through 2096	10.4	12.5	8.3

[a] See chapter V for details, including historical and projected values.
[b] The ultimate total fertility rates of 2.00 for the intermediate assumptions, 2.20 for the low-cost assumptions, and 1.70 for the high-cost assumptions are fully reached for women of all ages in 2056. The cohort-based projection approach assumes that the ultimate rates will be achieved over the lifetime of women attaining age 14 soon after the start of the projection period, resulting in an extended transition from current low birth rates to ultimate birth rates. See section V.A.1 for additional details.

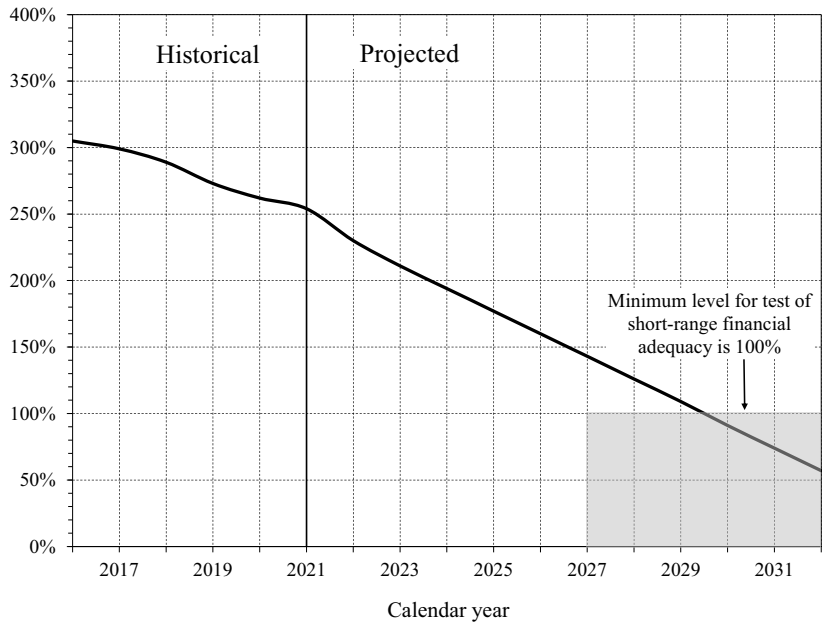
D. PROJECTIONS OF FUTURE FINANCIAL STATUS

Short-Range Actuarial Estimates

For the short-range period (2022 through 2031), the Trustees measure financial adequacy using trust fund ratios, which compare projected asset reserves at the beginning of a year to projected program cost for the year. Maintaining a trust fund ratio of 100 percent or more—that is, reserves at the beginning of a year at least equal to projected cost for the year—is a good indication that the trust fund can cover most short-term contingencies. The Trustees' test of short-range financial adequacy is met if under the intermediate assumptions (1) the estimated trust fund ratio is at least 100 percent at the beginning of the period and remains at or above 100 percent throughout the 10-year short-range period (from the beginning of 2022 through the end of 2031, which is indicated by the trust fund ratio at the beginning of 2032) or (2) the ratio is initially less than 100 percent, but reaches at least 100 percent within five years and remains at or above 100 percent throughout the remainder of the 10-year short-range period. The projected trust fund ratio under the intermediate assumptions for the OASI Trust Fund declines to 87 percent by the beginning of 2030 and remains below 100 percent for the remainder of the short-range period. Therefore, OASI fails the Trustees' test of short-range financial adequacy. The DI Trust Fund satisfies the test of short-range financial adequacy because the trust fund ratio, while below 100 percent at the beginning of the projection period, reaches 100 percent within five years and stays above 100 percent throughout the remainder of the 10-year period. The Trustees estimate that the DI trust fund ratio was at 68 percent at the beginning of 2022. The projected DI trust fund ratio then increases to 100 percent by the beginning of 2026 and continues to increase for the remainder of the short-range period. On a combined basis, OASDI fails the Trustees' test of short-range financial adequacy because the OASDI trust fund ratio declines to 91 percent by the beginning of 2030 and remains below 100 percent for the remainder of the short-range period. Figure II.D1 shows that the trust fund ratio for the combined OASI and DI Trust Funds declines steadily after 2010.

For this report, combined reserves are projected to decline in 2022, as they did beginning in 2021, and to continue to decline throughout the remainder of the short-range period.

Figure II.D1.—Short-Range OASI and DI Combined Trust Fund Ratio
[Asset reserves at beginning of year as a percentage of annual cost for the year, under intermediate assumptions]



Long-Range Actuarial Estimates

The Trustees use three types of measures to assess the actuarial status of the program over the long-range period (2022 through 2096): (1) annual cash-flow measures, including income rates, cost rates, and balances; (2) trust fund ratios; and (3) summary measures such as actuarial balances and open-group unfunded obligations. The Trustees express these measures as percentages of taxable payroll, as percentages of gross domestic product (GDP), or in dollars. The Trustees also present summary measures over the infinite horizon in appendix F. The infinite horizon values provide an additional indication of Social Security's very-long-run financial condition.

The Trustees also apply a test of long-range close actuarial balance each year. To satisfy the test, a trust fund must meet two conditions: (1) the trust fund satisfies the test of short-range financial adequacy, and (2) the trust fund ratio stays above zero throughout the 75-year projection period, such that benefits would be payable in a timely manner throughout the period. Under the intermediate assumptions, the OASI Trust Fund and the combined OASI

and DI Trust Funds fail the test of long-range close actuarial balance, while the DI Trust Fund satisfies the test.

Annual Income Rates, Cost Rates, and Balances

Figure II.D2 illustrates the year-by-year relationship among OASDI income (excluding interest), cost (including scheduled benefits), and expenditures (including payable benefits) starting in 2000 and for the full 75-year projection period (2022 through 2096). The figure shows all values as percentages of taxable payroll. Under the intermediate assumptions, demographic factors by themselves cause the projected cost rate to rise rapidly for the next two decades, level off somewhat in about 2040 through 2055, rise temporarily between 2055 and 2078, and then decline somewhat through 2096. The projected income rate is relatively stable at about 13 percent throughout the 75-year period ending in 2096.

Annual OASDI cost has exceeded non-interest income every year beginning with 2010. The Trustees project that cost will continue to exceed non-interest income throughout the 75-year valuation period. Cost is projected to exceed total income in 2022, as it did beginning in 2021, and combined OASI and DI Trust Fund reserves decline until they become depleted in 2035. After trust fund reserve depletion, continuing income is sufficient to support expenditures at a level of 80 percent of program cost for the rest of 2035, declining to 74 percent for 2096. Figure II.D2 depicts OASDI operations as a combined whole. However, under current law, the differences between scheduled and payable benefits for OASI would begin in 2034, when the OASI Trust Fund is projected to become depleted. Scheduled benefits equal payable benefits for DI throughout the entire 75-year projection period, because the DI Trust Fund is not projected to become depleted during the period.

Figure II.D2.—OASDI Income, Cost, and Expenditures as Percentages of Taxable Payroll
[Under intermediate assumptions]

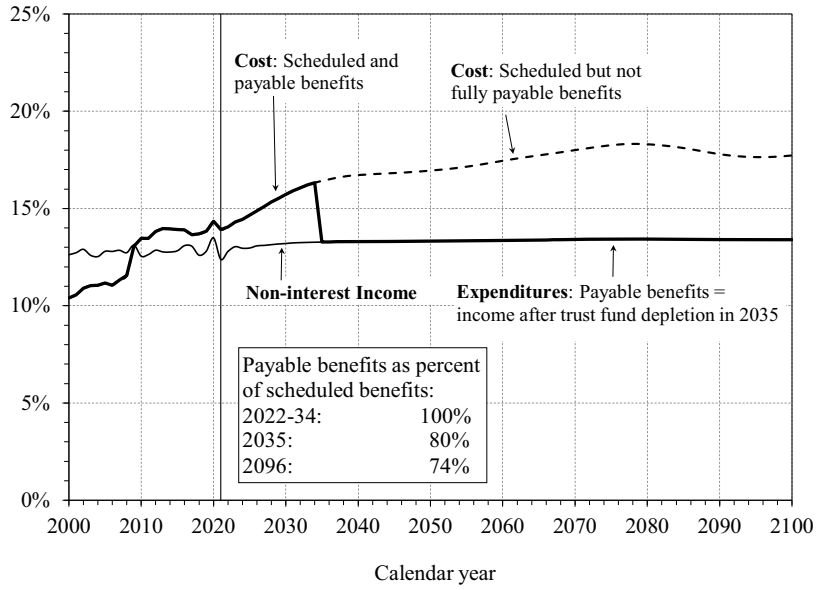
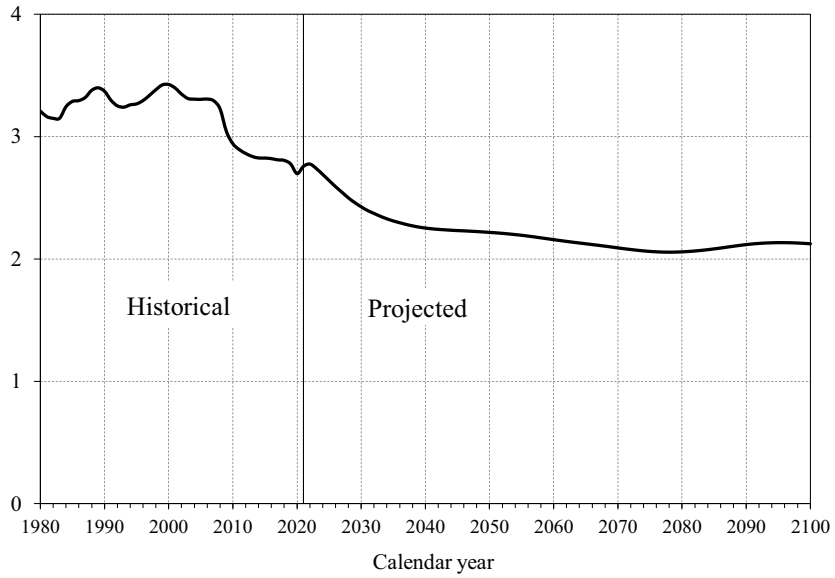


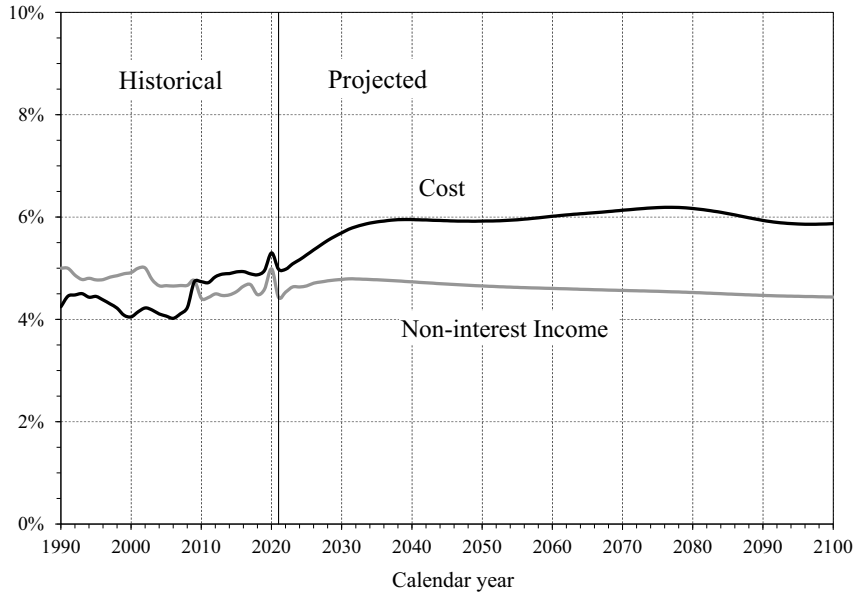
Figure II.D3 shows the estimated number of covered workers per OASDI beneficiary. Figures II.D2 and II.D3 illustrate the inverse relationship between cost rates and the number of workers per beneficiary. In particular, the projected future increase in the cost rate reflects a projected decline in the number of covered workers per beneficiary. There were about 2.8 workers for every OASDI beneficiary in 2021. This ratio had been stable, remaining between 3.2 and 3.4 from 1974 through 2008, and has generally declined since then, initially due to the economic recession of 2007-09 and the beginning of a notable demographic shift. This shift causes the ratio of workers to beneficiaries to decline, as workers of lower-birth-rate generations replace workers of the baby-boom generation. The decline in the ratio slowed substantially between 2013 and 2019 as the recovery of the economy largely offset the demographic shift during that period. The ratio declined slightly in 2020 and then increased slightly in 2021, due to effects of the pandemic-induced recession and recovery on the number of workers. The underlying demographic shift will continue to drive this ratio down over the next 10 to 15 years. The ratio of workers to beneficiaries reaches 2.3 by 2033 when the baby-boom generation will have largely retired, and will generally decline very gradually thereafter due to increasing longevity.

Figure II.D3.—Number of Covered Workers Per OASDI Beneficiary
[Under intermediate assumptions]



Another important way to look at Social Security's future financial status is to view its annual cost and non-interest income as a share of U.S. economic output (GDP). As shown in figure II.D4, Social Security's cost as a percent of GDP is generally projected to grow from 5.0 percent in 2022 to a peak of about 6.2 percent for 2077, and then decline to 5.9 percent by 2096. Social Security's non-interest income is projected to rise from 4.5 percent of GDP in 2022 to a peak of about 4.8 percent by 2031. Thereafter, non-interest income as a percent of GDP declines gradually, to about 4.4 percent for 2096, because the Trustees expect the share of employee compensation provided as noncovered fringe benefits to increase gradually.

Figure II.D4.—OASDI Cost and Non-interest Income as a Percentage of GDP
[Under intermediate assumptions]



Trust Fund Ratios

The trust fund ratio is defined as the asset reserves at the beginning of a year expressed as a percentage of the cost during the year. The trust fund ratio thus represents the proportion of a year's cost which could be paid solely with the accumulated reserves at the beginning of the year. Table II.D1 displays the projected maximum trust fund ratios during the long-range period for the OASI, DI, and combined OASI and DI funds. The table also shows the year of maximum projected trust fund ratio during the long-range projection period (2022 through 2096) and the year of trust fund asset reserve depletion. Trust fund ratios for OASI and combined OASI and DI are projected to decline from their current levels until reserve depletion. For DI, the trust fund ratio is projected to rise to 231 percent of cost in 2043, and then decline to 53 percent of cost by 2096.

Table II.D1.—Projected Maximum Trust Fund Ratios During the Long-Range Period and Trust Fund Reserve Depletion Dates
[Under Intermediate Assumptions]

	OASI	DI	OASDI
Maximum projected trust fund ratio (percent)	251	231	230
Year attained	2022	2043	2022
Projected year of trust fund reserve depletion	2034	[a]	2035

[a] The trust fund is not projected to become depleted during the 75-year period ending in 2096.

Summary Measures

The actuarial balance is a summary measure of the program's financial status through the end of the 75-year valuation period. The actuarial balance measure includes the trust fund asset reserves at the beginning of the period, all cost and income during the valuation period, and the cost of reaching a target trust fund reserve of one year's cost by the end of the period. Therefore, the actuarial balance is essentially the difference between the present values of income and cost from 1937 through the end of the valuation period, expressed as a percentage of the taxable payroll for the 75-year valuation period. A negative actuarial balance is called an actuarial deficit. The actuarial deficit represents the average amount of change in income or cost that is needed throughout the valuation period in order to achieve actuarial balance.

In this report, the actuarial deficit for the combined OASI and DI Trust Funds under the intermediate assumptions is 3.42 percent of taxable payroll. The actuarial deficit was 3.54 percent of payroll in the 2021 report. If the assumptions, methods, starting values, and the law had all remained unchanged from last year, the actuarial deficit would have increased to 3.59 percent of payroll solely due to advancing the valuation period by 1 year. The actuarial deficit is 1.2 percent of GDP in this year's report, unchanged from last year's report.

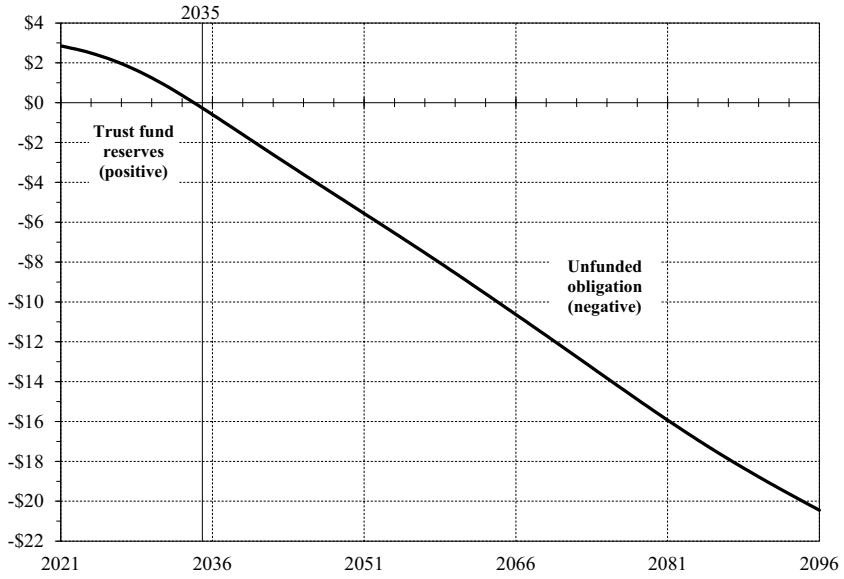
Another way to illustrate the projected financial shortfall of the OASDI program is to examine the cumulative present value of scheduled income less cost. Figure II.D5 shows the present value of cumulative OASDI income less cost from the inception of the program through each of the years from 2021 to 2096. A positive value represents the present value of trust fund reserves at the end of the selected year. A negative value is the unfunded obligation through the selected year. The asset reserves of the combined trust funds were about $2.85 trillion at the end of 2021. The combined trust fund reserves decline on a present value basis after 2021, but remain positive through 2034. However, after 2034 this cumulative amount declines and becomes negative in 2035, which means that the combined OASI and DI Trust Funds have a net unfunded obligation through the end of each year after 2034. Through the end of 2096, the combined funds have a present-value unfunded obligation of $20.4 trillion. If the assumptions, methods, starting values, and the law had all remained unchanged from last year, the unfunded obligation in this year's report would have risen to about $20.6 trillion due to the change in the valuation date and the extension of the valuation period through an additional year, 2096.

This unfunded obligation through 2096 represents 3.24 percent of taxable payroll for 2022 through 2096 (decreased from an unfunded obligation through 2095 of 3.35 percent of taxable payroll for 2021 through 2095 in last year's report) and 1.1 percent of GDP over the 75-year valuation period ending in 2096 (decreased from 1.2 percent of GDP over the 75-year period ending in 2095 in last year's report). The unfunded obligation as a share of taxable payroll over the period (3.24 percent) and the actuarial deficit (3.42 percent) are similar measures, but differ because the actuarial deficit includes the cost of having an ending trust fund reserve equal to one year's cost.

Figures II.D2, II.D4, and II.D5 show that the program's financial condition will deteriorate throughout the projection period if current law is not altered. Negative annual balances and increasing cumulative shortfalls toward the end of the 75-year period provide an indication of the additional change that will be needed by that time in order to maintain solvency beyond 75 years. Consideration of summary measures alone for a 75-year period can lead to incorrect perceptions and to policy prescriptions that do not achieve sustainable solvency.[1]

[1] Sustainable solvency for the financing of the program under a specified set of assumptions has been achieved when the projected trust fund ratio is positive throughout the 75-year projection period and is either stable or rising at the end of the period.

Figure II.D5.—Cumulative Scheduled OASDI Income Less Cost, From Program Inception Through Years 2021-2096
[Present value as of January 1, 2022, in trillions, under Intermediate Assumptions]



Appendix F presents summary measures over the infinite horizon. The infinite horizon values provide an additional indication of Social Security's financial condition extending indefinitely into the future, but results are subject to much greater uncertainty. Extending the horizon beyond 75 years increases the measured unfunded obligation. Through the infinite horizon, the unfunded obligation, or shortfall, is equivalent to 4.5 percent of future taxable payroll or 1.4 percent of future GDP.

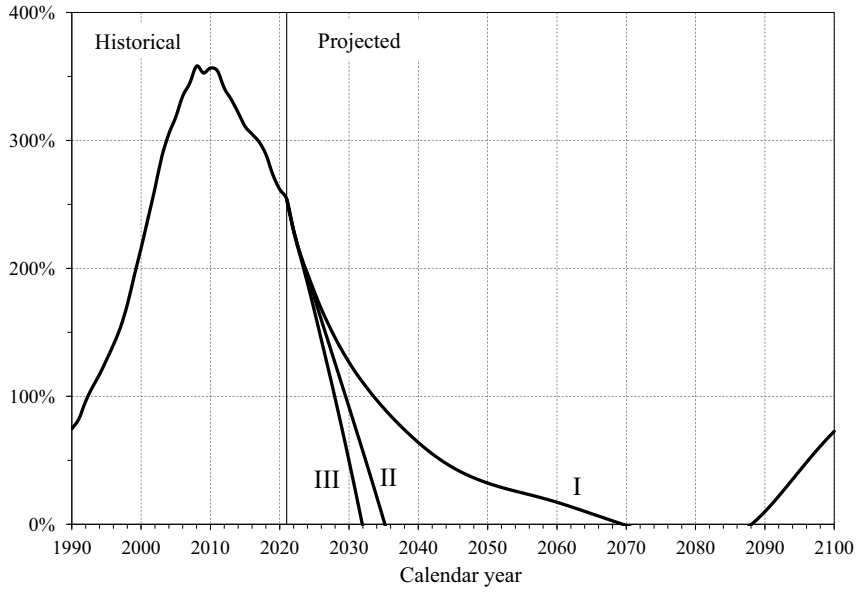
Uncertainty of the Projections

Significant uncertainty surrounds the intermediate assumptions. The Trustees use several methods to help illustrate that uncertainty.

A first approach uses alternative scenarios reflecting low-cost (alternative I) and high-cost (alternative III) sets of assumptions. Figure II.D6 shows the projected trust fund ratios for the combined OASI and DI Trust Funds under the intermediate, low-cost, and high-cost assumptions. The figure indicates that the combined trust funds are projected to become depleted in 2035 under the intermediate alternative and in 2031 under the high-cost alternative.

Under the low-cost alternative, trust fund reserves are projected to become depleted in 2069, but the trust funds would have sufficient income by the end of 2088 to permit full payment of scheduled benefits thereafter and also to pay in arrears the temporary shortfalls between 2069 and 2088. The low-cost alternative includes a higher ultimate total fertility rate, slower improvement in mortality, a higher real wage differential, a higher ultimate real interest rate, a higher ultimate annual change in the CPI, and a lower unemployment rate. The high-cost alternative, in contrast, includes a lower ultimate total fertility rate, more rapid improvement in mortality, a lower real wage differential, a lower ultimate real interest rate, a lower ultimate annual change in the CPI, and a higher unemployment rate. These alternatives are not intended to suggest that all parameters would be likely to differ from the intermediate values in the specified directions, but are intended to illustrate the effect of clearly defined scenarios that are, on balance, very favorable or unfavorable for the program's financial status. Actual future costs are unlikely to be as extreme as those portrayed by the low-cost or high-cost projections. The method for constructing the low-cost and high-cost projections does not lend itself to estimating the probability that actual experience will lie within or outside the range they define.

Figure II.D6.—Long-Range OASI and DI Combined Trust Fund Ratios Under Alternative Scenarios
[Asset reserves as a percentage of annual cost]

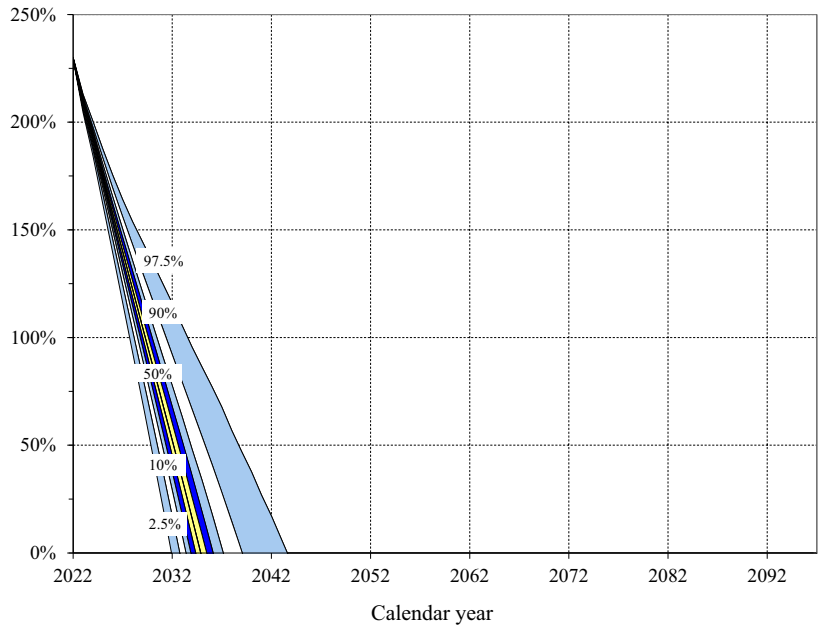


Appendix D of this report presents long-range sensitivity analysis for the OASDI program. By varying one parameter at a time, sensitivity analysis provides a second approach for illustrating the uncertainty surrounding projections into the future.

A third approach uses 5,000 independently generated stochastic simulations that reflect randomly assigned annual values and central tendencies for most of the key parameters. These simulations produce a distribution of projected outcomes and corresponding probabilities that future experience will fall within or outside a given range. The results of the stochastic simulations, discussed in more detail in appendix E, suggest that trust fund reserve depletion (the point at which reserves are insufficient to pay scheduled benefits in full and on time) is very likely before mid-century. In particular, figure II.D7 suggests that based on these stochastic simulations, trust fund reserves will become depleted between 2031 and 2043 with 95-percent confidence. In last year's report, this range was between 2031 and 2041.

The stochastic results suggest that trust fund ratios as high as the low-cost alternative or as low as the high-cost alternative are very unlikely.

Figure II.D7.—Long-Range OASI and DI Combined Trust Fund Ratios From Stochastic Modeling



Changes From Last Year's Report

The projected long-range OASDI actuarial deficit decreased from 3.54 percent of taxable payroll for last year's report to 3.42 percent of taxable payroll for this year's report. The change in the valuation date and the extension of the 75-year projection period for an additional year, 2096, would have by itself increased the actuarial deficit to 3.59 percent. However, changes in law, methods, starting values, and assumptions combined to decrease the actuarial deficit by 0.17 percent of taxable payroll, more than offsetting the increase due to the change in valuation date. For a detailed description of the specific changes identified in table II.D2, see section IV.B.6.

Table II.D2.—Reasons for Change in the 75-Year Actuarial Balance, Based on Intermediate Assumptions
[As a percentage of taxable payroll]

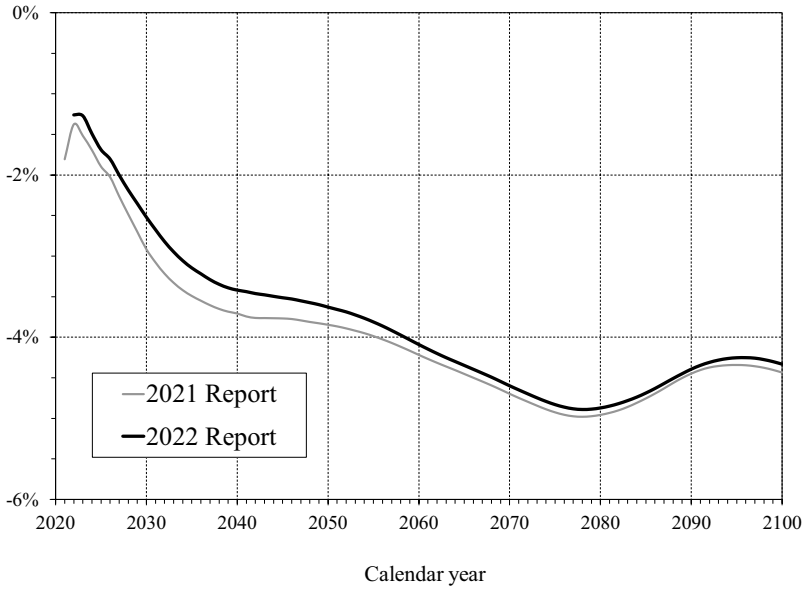
Item	OASI	DI	OASDI
Shown in last year's report:			
Income rate	11.93	1.85	13.78
Cost rate	15.39	1.92	17.31
Actuarial balance	**-3.46**	**-.08**	**-3.54**
Changes in actuarial balance due to changes in:			
Legislation / Regulation	.00	.00	.00
Valuation period[a]	-.05	-.01	-.06
Demographic data and assumptions	-.04	.00	-.04
Economic data and assumptions	.13	.00	.13
Disability data and assumptions	.00	.08	.07
Methods and programmatic data	.01	.00	.01
Total change in actuarial balance	.05	.07	.12
Shown in this report:			
Actuarial balance	**-3.41**	**-.01**	**-3.42**
Income rate	11.93	1.85	13.78
Cost rate	15.34	1.86	17.20

[a] The change in the 75-year valuation period from last year's report to this report means that the 75-year actuarial balance now includes the relatively large negative annual balance for 2096. This change in the valuation period results in a larger long-range actuarial deficit. The actuarial deficit includes the trust fund reserve at the beginning of the projection period.

Note: Components may not sum to totals because of rounding.

Figure II.D8 compares this year's projections of annual balances (non-interest income minus cost) to those in last year's report. The annual balances in this year's report are higher (less negative) in all years from 2022 through 2096. For the full 75-year projection period, the annual balances are higher, on average, by 0.18 percentage point.

Figure II.D8.—OASDI Annual Balances: 2021 and 2022 Trustees Reports
[As a percentage of taxable payroll, under the intermediate assumptions]



E. CONCLUSION

The data and projections presented in this report continue to include the Trustees' best estimates of the effects of the COVID-19 pandemic. The pandemic is projected to have continuing significant effects on the OASI and DI programs in the near term, and the future course of the pandemic is uncertain. On balance, the projected long-range actuarial status of the OASI and DI Trust Funds has been little changed by the effects of the pandemic and ensuing recession, considering both the effects realized to date and those yet expected. The Trustees will continue to monitor the development of the pandemic and adjust their projections accordingly in future reports.

Under current law, the projected cost of Social Security generally increases faster than projected income through about 2040 primarily because the ratio of workers paying taxes to beneficiaries receiving benefits will decline as the baby-boom generation retires and is replaced at working ages with subsequent lower birth-rate generations. The effects of the aging baby boom and subsequent lower birth rates will have largely stabilized between about 2040 and 2055, but annual cost is projected to grow significantly faster than income between 2055 and 2078 due to the period of historically low birth rates starting with the recession of 2007-09. Between 2078 and 2096, cost is projected to grow somewhat slower than income, reflecting a return to a stable ultimate birth rate of 2 children per woman for 2056 and thereafter. Based on the Trustees' intermediate assumptions, Social Security's cost exceeds total income in 2022, as it did beginning in 2021, and remains higher throughout the remainder of the 75-year projection period.

The OASI Trust Fund is projected to have sufficient reserves to pay full benefits on time until 2034. The DI Trust Fund is projected to have sufficient reserves to pay full benefits throughout the 75-year projection period ending in 2096. Legislative action will be needed to prevent OASI reserve depletion. In the absence of such legislation, continuing income to the trust funds at the time of reserve depletion would be sufficient to pay 77 percent of OASI benefits.

Social Security's combined trust funds are projected to cover full payment of scheduled benefits on a timely basis until the trust fund reserves become depleted in 2035. (Full payment of benefits until depletion of the hypothetical combined reserves in 2035 implicitly assumes that the law will have been changed to permit the transfer of funds between OASI and DI as needed.) At that time, projected continuing income to the combined trust funds equals about 80 percent of the program cost. By 2096, continuing income equals about 74 percent of the program cost.

The actuarial deficit for the combined trust funds under the intermediate assumptions is 3.42 percent of taxable payroll for the 75-year period through 2096, decreased (improved) from the 3.54 percent deficit for the 75-year period through 2095 in last year's report. To illustrate the magnitude of the deficit, consider that for the combined OASI and DI Trust Funds to remain fully solvent throughout the 75-year projection period ending with 2096: (1) revenue would have to be increased by an amount equivalent to an immediate and permanent payroll tax rate increase of 3.24 percentage points to 15.64 percent; (2) scheduled benefits would have to be reduced by an amount equivalent to an immediate and permanent reduction of 20.3 percent applied to all current and future beneficiaries through 2096, or 24.1 percent if the reductions were applied only to those who become initially eligible for benefits in 2022 or later; or (3) some combination of these approaches would have to be adopted. If actions are deferred for several years, the changes necessary to maintain Social Security solvency through 2096 become concentrated on fewer years and fewer generations.

If lawmakers design legislative solutions only to eliminate the overall actuarial deficit without consideration of year-by-year financing, then a substantial financial imbalance could remain for 2096, the end of the 75-year valuation period. In that case, the long-range sustainability of program financing could still be in doubt. Sustainable solvency for the financing of the program under a specified set of assumptions is achieved when the projected trust fund ratio is positive throughout the 75-year long-range period and is either stable or rising at the end of the period. Making changes now that achieve sustainable solvency could avoid the need for later legislative changes.

Lawmakers have a broad continuum of policy options that would close or reduce Social Security's long-term financing shortfall. Cost estimates for many such policy options are available at www.ssa.gov/OACT/solvency/provisions/. Broadly speaking, the approaches that lawmakers can take include increasing revenue from workers and employers by raising the tax rate or the maximum level of taxable earnings, or by dedicating revenue from other sources; lowering benefits for some or all beneficiaries by changing certain program parameters; or a combination of these approaches. There are countless variations on these options, including those that vary the timing, magnitude, and other specifics of the changes under consideration.

The Trustees recommend that lawmakers address the projected trust fund shortfalls in a timely way in order to phase in necessary changes gradually and give workers and beneficiaries time to adjust to them. Implementing changes sooner rather than later would allow more generations to share in the needed revenue increases or reductions in scheduled benefits. Social Security

will play a critical role in the lives of 66 million beneficiaries and 182 million covered workers and their families during 2022. With informed discussion, creative thinking, and timely legislative action, Social Security can continue to protect future generations.

For further information related to the contents of this report, see the following websites:

- www.ssa.gov/OACT/tr/2022/
- www.ssa.gov/OACT/solvency/provisions/
- www.cms.gov/OACT/TR/2022
- https://home.treasury.gov/policy-issues/economic-policy/social-security-and-medicare-trustee-reports

III. FINANCIAL OPERATIONS OF THE TRUST FUNDS AND LEGISLATIVE CHANGES IN THE LAST YEAR

A. OPERATIONS OF THE OLD-AGE AND SURVIVORS INSURANCE (OASI) AND DISABILITY INSURANCE (DI) TRUST FUNDS, IN CALENDAR YEAR 2021

This section presents detailed information on the operations of the OASI and DI Trust Funds[1] during calendar year 2021. Chapter IV provides projections for calendar years 2022 through 2100.

1. OASI Trust Fund

Table III.A1 presents a statement of the income and cost of the Federal Old-Age and Survivors Insurance Trust Fund in calendar year 2021, and of the asset reserves in the fund at the beginning and end of the calendar year. As shown in this table, total trust fund income in 2021 amounted to $942.9 billion, while cost totaled $1,001.9 billion, a decrease in trust fund reserves during 2021 of $59.1 billion.[2]

Total income during calendar year 2021 included $841.4 billion in payroll tax contributions. These contributions include initial appropriations of payroll taxes, made on an estimated basis, and adjustments to appropriations for prior years to reflect actual tax income. In June 2021, an unusually large negative adjustment in the amount of $30.4 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession. The OASI fund paid the General Fund $3.1 billion for the estimated amount of employee payroll-tax refunds, partially offsetting these gross contributions. Employees who work for more than one employer during a year and pay contributions on total earnings in excess of the contribution and benefit base are eligible for such refunds. Net payroll tax contributions were therefore $838.2 billion in 2021.

Net reimbursements from the General Fund of the Treasury amounted to $1 million in 2021. As shown in the table, almost all of that amount came from adjustments to prior year reimbursements based on Public Law 111-312, the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010, Public Law 112-78, the Temporary Payroll Tax Cut Continuation Act of 2011, and Public Law 112-96, the Middle Class Tax Relief

[1] See www.ssa.gov/oact/ProgData/fundsQuery.html.

[2] In order to provide values that are comparable with other years, the cost and change in asset reserves shown for 2021 reflect the 12 months of benefits scheduled for payment in 2021 and thus include the benefits scheduled for payments on January 3, 2021, which were actually paid on December 31, 2020, as required by the law.

and Job Creation Act of 2012. These acts specified General Fund reimbursement for temporary reductions in employee and self-employment payroll taxes for earnings in 2011 and 2012.

Income to the OASI Trust Fund based on the taxation of OASI benefits amounted to $37.2 billion in 2021. As first required by the 1983 Social Security Amendments, this income comes from two separate sources: (1) Federal income taxation on up to 50 percent of an individual's or couple's OASI benefits under certain circumstances, and (2) a tax withheld from the benefits paid to certain nonresident alien beneficiaries. For the direct Federal income tax portion, Treasury transfers estimated amounts to the OASI Trust Fund in advance at the beginning of each calendar quarter. Treasury makes subsequent adjustments based on the actual amounts shown on annual income tax records. There were two such adjustments made in 2021 totaling $5.1 billion. The amount of income from direct Federal income taxation on OASI benefits constituted approximately 99 percent of income from benefit taxation. The remaining one percent of the income from benefit taxation is the amounts withheld from the benefits paid to nonresident aliens.

In 2021, the OASI Trust Fund earned $67.5 billion in net interest, which consisted of: (1) interest earned on the investments held by the trust fund, (2) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (3) interest arising from the revised allocation of administrative expenses among the trust funds, and (4) interest on certain reimbursements to the trust fund.

The remaining income, about $90 thousand, consisted of gifts received under the provisions authorizing the deposit of monetary gifts or bequests in the trust funds.

Table III.A1.—Operations of the OASI Trust Fund, Calendar Year 2021
[In millions]

Total asset reserves, December 31, 2020[a]		$2,811,716
Income:		
Net payroll tax contributions:		
Payroll tax contributions[b]	$841,383	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund[b]	-3,148	
Net payroll tax contributions[b]		838,235
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L. 111-312, P.L. 112-78, and P.L. 112-96[b]	1	
Payroll tax credits due to P.L. 98-21[b]	[c]	
Net General Fund reimbursements[b]		1
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	244	
All other, not subject to withholding[b]	36,907	
Total income from taxation of benefits[b]		37,151
Investment income and interest adjustments:		
Interest on investments	67,469	
Interest adjustments[d]	1	
Total investment income and interest adjustments		67,470
Gifts		[c]
Total income		942,856
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[a e]	993,167	
Reimbursement from the General Fund for unnegotiated checks	-49	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	14	
Net benefit payments[a e]		993,133
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		4,792
Administrative expenses:		
Costs incurred by:		
Social Security Administration	3,320	
Department of the Treasury	697	
Offsetting miscellaneous receipts	-2	
Miscellaneous reimbursements from the General Fund [f]	-5	
Net administrative expenses		4,011
Total cost[a]		1,001,936
Net increase in asset reserves[a]		-59,080
Total invested assets	2,752,688	
Undisbursed balances [g]	-53	
Total asset reserves, December 31, 2021		2,752,636

[a] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. The amount of these payments made on an accelerated basis was approximately $18.7 billion. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year.

[b] Includes adjustments for prior calendar years. In June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $30,380 million was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[c] Between -$0.5 and $0.5 million.

[d] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.

[e] Includes net reductions for the recovery of overpayments.

[f] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI program.

[g] A negative balance represents a situation where the actual cash payments exceeded the amount of invested securities of the OASI Trust Fund that were redeemed to make such payments. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Components may not sum to totals because of rounding.

Of the $1,001.9 billion in total OASI cost in 2020, $993.1 billion was for net benefit payments, including recovered overpayments,[1] reimbursements from the General Fund for unnegotiated checks, and the reimbursable costs of vocational rehabilitation services.[2] Net benefit payments increased by 4.3 percent from calendar year 2020 to calendar year 2021. This increase is due primarily to: (1) an increase in the average number of beneficiaries during the year and (2) an increase in the average monthly benefit amount. The increase in the average benefit amount in 2021 was due in part to the automatic cost-of-living benefit increase of 1.3 percent which became effective for December 2020 under the automatic-adjustment provisions in section 215(i) of the Social Security Act. In addition, new beneficiaries tend to have higher monthly benefit amounts than previous beneficiary cohorts, because their initial benefits are based on average wages, which tend to rise faster than the cost of living.

The Railroad Retirement Act requires an annual financial interchange between the Railroad Retirement program and the OASDI program. The purpose of the interchange is to put the OASI and DI Trust Funds in the same financial position in which they would have been had railroad employment always been covered directly by Social Security. The Railroad Retirement Board and the Social Security Administration calculated an interchange of $4.8 billion from the OASI Trust Fund to the Social Security Equivalent Benefit Account for June 2021.

The remaining $4.0 billion of cost for the OASI Trust Fund was for net administrative expenses. The Social Security Administration charges administrative expenses incurred to administer the OASI program directly to the trust fund on an estimated basis. Periodically, as actual expenses are recorded, adjustments are made to the allocations of administrative expenses for prior periods. These adjustments affect the OASI Trust Fund, the DI Trust Fund, the Hospital Insurance (HI) Trust Fund, the Supplementary Medical Insurance (SMI) Trust Fund, and the General Fund account for the Supplemental Security Income program, and include appropriate interest adjustments. As described earlier, the trust fund accounting records such interest adjustments under investment income.

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[1] As noted in footnote a of table III.A1 and elsewhere in this report, benefit payments shown for 2021 reflect the 12 months of benefits scheduled for payment in 2021 and thus include the benefits scheduled for payment on January 3, 2021, which were actually paid on December 31, 2020, as required by the law.

[2] Vocational rehabilitation services under the OASI program are furnished to disabled widow(er) beneficiaries and to those children of retired or deceased workers who receive benefits based on disabilities that began before age 22. The trust funds reimburse the providers of such services only in those cases where the services contributed to the successful rehabilitation of the beneficiary.

For 2021, the cost incurred by the Social Security Administration to administer the OASI program was 83 percent of OASI net administrative expenses. The Social Security Administration charged such costs to the trust fund in the amount of $3.3 billion in 2021. In addition, the Department of the Treasury charged the trust fund $0.7 billion in 2021 for services provided in administering the OASI program. A relatively small offset to administrative expenses of $2 million in 2021 represents income from miscellaneous receipts due to the trust fund, which may include refunds, penalties, fees, and other receipts.

Finally, the General Fund of the Treasury makes net reimbursements for administrative costs incurred by the Social Security Administration in performing certain legislatively mandated activities that are not directly related to paying OASI benefits. These reimbursements include $2 million in costs associated with union activities related to administering the OASI program and $2 million in costs of providing information to participants in certain pension plans in 2021. These miscellaneous reimbursements totaled $5 million in 2021.

The asset reserves shown for the OASI Trust Fund at the end of calendar year 2021 totaled $2,752.6 billion, consisting of $2,752.7 billion in U.S. Government obligations and, as an offset, an extension of credit totaling $53 million against securities to be redeemed in the first few days of the following year. The effective annual rate of interest earned by the reserves in the OASI Trust Fund during calendar year 2021 was 2.4 percent, somewhat lower than the 2.6 percent earned during calendar year 2020. Table VI.A4, presented in appendix A, shows a detailed listing of OASI Trust Fund holdings by type of security, interest rate, and year of maturity at the end of calendar years 2020 and 2021.

By law, the Department of the Treasury must invest trust fund reserves in interest-bearing securities backed by the full faith and credit of the United States Government. The securities currently held by the OASI Trust Fund are entirely special issue securities sold by the Treasury only to the trust funds. These special issues are of two types: short-term certificates of indebtedness and longer-term bonds. Daily trust fund tax income is invested in the short-term certificates of indebtedness which mature on the next June 30 following the date of issue. The trust fund normally acquires long-term special-issue bonds when special issue securities of either type mature on June 30 and must be reinvested. The amount of long-term bonds acquired on June 30 is equal to the amount of special issue securities maturing (including accrued interest earnings), plus tax income for that day, less amounts required to meet cost on that day.

Section 201(d) of the Social Security Act provides that the obligations issued for purchase by the OASI and DI Trust Funds shall have maturities fixed with due regard for the needs of the funds. The usual practice has been to reinvest the maturing special issue securities, as of each June 30, so that the value of the total portfolio of special issue securities maturing in each of the next 15 years are approximately equal. However, as of June 2021, the Chief Actuary's updated baseline of November 2020, which modified the Trustees most recent projections in the 2020 Trustees Report[1], indicated that the reserves in the OASI Trust Fund would become depleted within 15 years. Therefore, the Department of the Treasury, in consultation with the Chief Actuary of the Social Security Administration, selected the amounts and maturity dates of the OASI special-issue bonds purchased on June 30, 2021, so that the maturity dates of the total portfolio of special issue securities would be spread evenly to the extent possible over the 12-year period 2022 through 2033. The bonds purchased on that date have an interest rate of 1.500 percent, reflecting the average market yield, as of the last business day of the prior month, on all of the outstanding marketable U.S. obligations that are due or callable more than 4 years in the future. Table III.A7 shows additional details on the investment transactions during 2021, including the amounts of bonds purchased on June 30, 2021.

2. DI Trust Fund

Table III.A2 presents a statement of the income and cost of the Federal Disability Insurance Trust Fund in calendar year 2021, and of the asset reserves in the fund at the beginning and end of the calendar year.

Line entries in the DI statement are similar to those in the OASI statement. The explanations of the OASI entries generally apply to DI as well.

Of the $145.5 billion in total income, $142.4 billion was net payroll tax contributions.

Of the $142.6 billion of total cost, $140.1 billion was net benefit payments.[2] The total level of net benefit payments in 2021 decreased by 2.4 percent from total net benefit payments paid in 2020, largely due to a decrease in the total amount of retroactive payments paid to newly awarded beneficiaries, as well as a decrease in the average number of total current beneficiaries, partially offset by an increase in average benefit levels. DI non-interest income, and total income, exceeded total cost in 2021.

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[1] This updated baseline reflects the effects of the COVID-19 pandemic and the recession on the intermediate projections of the 2020 Social Security Trustees Report. For more information on this updated baseline, see www.ssa.gov/OACT/solvency/UpdatedBaseline_20201124.pdf.

[2] As noted in footnote a of table III.A2 and elsewhere in this report, benefit payments shown for 2021 reflect the 12 months of benefits scheduled for payment in 2021 and thus include the benefits scheduled for payment on January 3, 2021, which were actually paid on December 31, 2020, as required by the law.

Table III.A2.—Operations of the DI Trust Fund, Calendar Year 2021
[In millions]

Total asset reserves, December 31, 2020[a]		$96,570
Income:		
Net payroll tax contributions:		
Payroll tax contributions[b]	142,900	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund[b]	-533	
Net payroll tax contributions[b]		142,367
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L. 111-312, P.L. 112-78, and P.L. 112-96[b]	c	
Payroll tax credits due to P.L. 98-21[b]	c	
Net General Fund reimbursements[b]		c
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	4	
All other, not subject to withholding[b]	455	
Total income from taxation of benefits[b]		459
Investment income and interest adjustments:		
Interest on investments	2,642	
Interest adjustments[d]	2	
Total investment income and interest adjustments		2,644
Gifts		—
Total income		145,470
Cost:		
Benefit payments:		
Monthly benefits[a e]	139,996	
Reimbursement from the General Fund for unnegotiated checks	-27	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	89	
Net benefit payments[a e]		140,058
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		107
Administrative expenses:		
Costs incurred by:		
Social Security Administration	2,349	
Department of the Treasury	122	
Demonstration projects	12	
Miscellaneous reimbursements from the General Fund[f]	-2	
Net administrative expenses		2,481
Total cost[a]		142,646
Net increase in asset reserves[a]		2,824
Total invested assets	99,438	
Undisbursed balances[g]	-44	
Total asset reserves, December 31, 2021		99,394

[a] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. The amount of these payments made on an accelerated basis was approximately $6.1 billion. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year.

[b] Includes adjustments for prior calendar years. In June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $5,155 million was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[c] Between -$0.5 and $0.5 million.

[d] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.

[e] Includes net reductions for the recovery of overpayments.

[f] Reimbursements for costs incurred in performing legislatively mandated activities not directly related to administering the DI program.

[g] A negative balance represents a situation where the actual cash payments exceeded the amount of invested securities of the DI Trust Fund that were redeemed to make such payments. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Components may not sum to totals because of rounding.

During 2021, the reserves in the DI Trust Fund increased by $2.8 billion, from $96.6 billion at the end of 2020 to $99.4 billion at the end of 2021. This $99.4 billion consisted of $99.4 billion in U.S. Government obligations and, as an offset, an extension of credit totaling $44 million against securities to be redeemed in the first few days of the following year.[1] The effective annual rate of interest earned by the asset reserves in the DI Trust Fund during calendar year 2021 was 2.8 percent, slightly lower than the 2.9 percent earned during calendar year 2020. Table VI.A5 shows a detailed listing of DI Trust Fund holdings by type of security, interest rate, and year of maturity at the end of calendar years 2020 and 2021.

Section 201(d) of the Social Security Act provides that the Treasury securities issued for purchase by the OASI and DI Trust Funds shall have maturities fixed with due regard for the needs of the funds. Each year, bond purchases for each trust fund are made on June 30, taking into account the projected reserve depletion date in the most recently issued Trustees Report. The usual practice has been to reinvest the maturing special issue securities, as of each June 30, so that the values of the securities maturing in each of the next 15 years are approximately equal. Accordingly, the Department of the Treasury, in consultation with the Chief Actuary of the Social Security Administration, selected the amounts and maturity dates of the DI special-issue bonds purchased on June 30, 2021, so that the maturity dates of the total portfolio of special issue securities would be evenly spread to the extent possible over the 15-year period 2022-36. The bonds purchased have an interest rate of 1.500 percent, reflecting the average market yield, as of the last business day of the prior month, on the outstanding marketable U.S. obligations that are due or callable more than 4 years in the future. Table III.A7 shows details on investment transactions during 2021.

3. OASI and DI Trust Funds, Combined

Table III.A3 presents a statement of the operations of the OASI and DI Trust Funds on a hypothetical combined basis.[2] The entries in this table represent the sums of the corresponding values from tables III.A1 and III.A2. The two preceding subsections that cover OASI and DI provide a description of the nature of these income and cost transactions.

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[1] As noted in footnote a of table III.A2 and elsewhere in this report, benefit payments and asset reserves shown for 2021 reflect the 12 months of benefits scheduled for payment in 2021 and thus include the benefits scheduled for payment on January 3, 2021, which were actually paid on December 31, 2020, as required by the law.

[2] The OASI and DI Trust Funds are distinct legal entities which operate independently. To illustrate the actuarial status of the program as a whole, the fund operations are often combined on a hypothetical basis.

Table III.A3.—Operations of the Combined OASI and DI Trust Funds, Calendar Year 2021
[In millions]

Total asset reserves, December 31, 2020[a]		$2,908,286
Income:		
Net payroll tax contributions:		
Payroll tax contributions[b]	$984,284	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund[b]	-3,681	
Net payroll tax contributions[b]		980,602
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L. 111-312, P.L. 112-78, and P.L. 112-96[b]	1	
Payroll tax credits due to P.L. 98-21[b]	[c]	
Net General Fund reimbursements[b]		1
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	248	
All other, not subject to withholding[b]	37,362	
Total income from taxation of benefits[b]		37,610
Investment income and interest adjustments:		
Interest on investments	70,110	
Interest adjustments[d]	3	
Total investment income and interest adjustments		70,113
Gifts		[c]
Total income		1,088,326
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[a e]	1,133,164	
Reimbursement from the General Fund for unnegotiated checks	-76	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	103	
Net benefit payments[a e]		1,133,191
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		4,900
Administrative expenses:		
Costs incurred by:		
Social Security Administration	5,669	
Department of the Treasury	819	
Offsetting miscellaneous receipts	-2	
Demonstration projects	12	
Miscellaneous reimbursements from the General Fund[f]	-6	
Net administrative expenses		6,492
Total cost[a]		1,144,582
Net increase in asset reserves[a]		-56,256
Total invested assets	2,852,126	
Undisbursed balances[g]	-96	
Total asset reserves, December 31, 2021		2,852,030

[a] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. The amount of these payments made on an accelerated basis was approximately $24.8 billion. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year.

[b] Includes adjustments for prior calendar years. In June 2021, unusually large negative adjustments to payroll tax contributions in the amount of $35,536 million were made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[c] Between -$0.5 and $0.5 million.

[d] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust funds and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust funds.

[e] Includes net reductions for the recovery of overpayments.

[f] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI and DI programs.

[g] A negative balance represents a situation where the actual cash payments exceeded the amount of invested securities of the DI Trust Fund that were redeemed to make such payments. In this situation, future redemption of additional invested securities will be required to pay for this shortfall.

Note: Components may not sum to totals because of rounding.

Table III.A4 compares estimates of total income and total cost for calendar year 2021 from the intermediate projections in the 2017 through 2021 Trustees Reports to the corresponding actual amounts for 2021.

Table III.A4.—Comparison of Actual Calendar Year 2021 Trust Fund Operations With Estimates Made in Prior Reports, Based on Intermediate Assumptions[a]
[Amounts in billions]

	Total income[b]		Total cost[c]	
	Amount	Difference from actual (percent)	Amount	Difference from actual (percent)
OASI Trust Fund:				
Estimate in 2017 report	$1,065.2	13.0	$1,053.2	5.1
Estimate in 2018 report	1,011.6	7.3	1,036.9	3.5
Estimate in 2019 report	1,005.2	6.6	1,025.7	2.4
Estimate in 2020 report	995.6	5.6	1,019.2	1.7
Estimate in 2021 report	930.1	-1.4	1,005.4	.3
Actual amount	942.9	—	1,001.9	—
DI Trust Fund:				
Estimate in 2017 report	162.5	11.7	171.3	20.1
Estimate in 2018 report	155.4	6.8	163.0	14.3
Estimate in 2019 report	155.2	6.7	154.6	8.4
Estimate in 2020 report	154.3	6.0	151.8	6.4
Estimate in 2021 report	143.7	-1.2	145.7	2.1
Actual amount	145.5	—	142.6	—
OASI and DI Trust Funds, combined:				
Estimate in 2017 report	1,227.7	12.8	1,224.5	7.0
Estimate in 2018 report	1,167.0	7.2	1,199.9	4.8
Estimate in 2019 report	1,160.4	6.6	1,180.3	3.1
Estimate in 2020 report	1,149.8	5.7	1,170.9	2.3
Estimate in 2021 report	1,073.8	-1.3	1,151.0	.6
Actual amount	1,088.3	—	1,144.6	—

[a] Percentage differences are calculated prior to rounding.
[b] "Actual" income for 2021 reflects adjustments to payroll tax contributions for prior calendar years (see appendix A for description of these adjustments). "Estimated" income also includes such adjustments, but on an estimated basis.
[c] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. The amount of these payments made on an accelerated basis was approximately $18.7 billion for the OASI Trust Fund and $6.1 billion for the DI Trust Fund. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year.

Note: Components may not sum to totals because of rounding.

A number of factors contribute to differences between estimates and subsequent actual amounts, including: (1) actual values for key demographic, economic, and other variables that differ from earlier assumed levels; and (2) legislation that was enacted or other administrative initiatives that were finalized after the Trustees completed their estimates. In addition, estimates for the 2017 through 2020 Trustees Reports did not anticipate the pandemic and recession, while the actual income and cost for 2021 do reflect the pandemic, contributing to these differences as well.

At the end of calendar year 2021, the OASDI program was providing monthly benefits to about 65.2 million people. The OASI Trust Fund was providing benefits to about 56.0 million people and the DI Trust Fund was providing benefits to about 9.2 million people. The number of people receiving benefits from the OASI Trust Fund grew by 1.4 percent while the number of people receiving DI benefits fell by 4.2 percent during calendar year 2021. These changes are in large part due to the gradual aging of the population, with the earliest cohorts of the baby-boom generation now moving above normal retirement age, where DI benefits are no longer applicable. Table III.A5 shows the estimated distributions of benefit payments in calendar years 2020 and 2021, by type of beneficiary, for each trust fund separately.

Table III.A5.—Distribution of Benefit Payments[a] by Type of Beneficiary or Payment, Calendar Years 2020 and 2021
[Amounts in millions]

	Calendar year 2020		Calendar year 2021	
	Amount	Percentage of total	Amount	Percentage of total
Total OASDI benefit payments	$1,095,875	100.0	$1,133,164	100.0
OASI benefit payments	952,388	86.9	993,167	87.6
DI benefit payments	143,487	13.1	139,996	12.4
OASI benefit payments, total	952,388	100.0	993,167	100.0
Monthly benefits:				
Retired workers and auxiliaries	823,868	86.5	861,873	86.8
Retired workers	783,504	82.3	822,440	82.8
Spouses	34,023	3.6	33,050	3.3
Children	6,341	.7	6,384	.6
Survivors of deceased workers	128,294	13.5	131,057	13.2
Aged widows and widowers	102,669	10.8	104,868	10.6
Disabled widows and widowers	2,330	.2	2,233	.2
Parents	19	[b]	19	[b]
Children	21,795	2.3	22,445	2.3
Widowed mothers and fathers caring for child beneficiaries	1,480	.2	1,492	.2
Lump-sum death payments	226	[b]	237	[b]
DI benefit payments, total	143,487	100.0	139,996	100.0
Disabled workers	135,204	94.2	132,401	94.6
Spouses	509	.4	465	.3
Children	7,774	5.4	7,131	5.1

[a] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. The amount of these payments made on an accelerated basis was approximately $18.7 billion for the OASI Trust Fund and $6.1 billion for the DI Trust Fund. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year.
[b] Less than 0.05 percent.

Note: Benefits are monthly benefits and lump-sum death payments. Components may not sum to totals because of rounding.

Net administrative expenses of the OASI and DI Trust Funds in calendar year 2021 totaled $6.5 billion, equal to 0.6 percent each of total cost and total

income. Table III.A6 shows corresponding percentages for each trust fund separately and for OASDI as a whole for the last 5 years.

Table III.A6.—Administrative Expenses as a Percentage of Total Income and of Total Cost, Calendar Years 2017-2021

	OASI Trust Fund		DI Trust Fund		OASI and DI Trust Funds, combined	
Calendar year	Total income	Total cost	Total income	Total cost	Total income	Total cost
2017	0.4	0.5	1.6	1.9	0.6	0.7
2018	.5	.4	1.7	1.9	.7	.7
2019	.4	.4	1.9	1.8	.6	.6
2020	.4	.4	1.7	1.7	.6	.6
2021	.4	.4	1.7	1.7	.6	.6

The acquisition and redemption of securities during calendar year 2021 changed the invested reserves of the OASI and DI Trust Funds. Table III.A7 presents investment transactions for each fund separately and combined.

Table III.A7.—Trust Fund Investment Transactions, Calendar Year 2021
[In millions]

	OASI Trust Fund	DI Trust Fund	OASI and DI Trust Funds, combined
Invested asset reserves, December 31, 2020[a]	$2,793,146	$90,703	$2,883,849
Acquisitions:			
Special issue securities:			
Certificates of indebtedness	940,507	150,277	1,090,784
Bonds[b]	152,354	7,180	159,534
Total acquisitions	1,092,861	157,456	1,250,318
Redemptions:			
Special issue securities:			
Certificates of indebtedness[c]	917,972	142,383	1,060,355
Bonds[c]	215,347	6,339	221,686
Total redemptions[c]	1,133,319	148,722	1,282,041
Net increase in invested asset reserves	-40,458	8,734	-31,723
Invested asset reserves, December 31, 2021[a]	2,752,688	99,438	2,852,126

[a] Invested asset reserves differ from total asset reserves by the amount of undisbursed balances. See tables VI.A4 and VI.A5 for details.

[b] Purchased on June 30, 2021. The interest rate on these purchases was 1.500 percent.

[c] Benefit payments which were scheduled to be paid on January 3, 2021 were actually paid on December 31, 2020 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. The amount of these payments made on an accelerated basis was approximately $18.7 billion for the OASI Trust Fund and $6.1 billion for the DI Trust Fund. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year.

Note: Investments are shown at par value. Components may not sum to totals because of rounding.

B. CHANGES IN LAW AND POLICY AFFECTING SOCIAL SECURITY SINCE THE 2021 REPORT

Since the Trustees submitted the 2021 report to Congress, there has been one change in policy that has a notable effect on OASDI program operations.

On July 16, 2021, pursuant to a United States District Court order, the US Citizenship and Immigration Services stopped approving first time applications under the Deferred Action for Childhood Arrivals (DACA) policy but continues to approve renewal applications. On September 10, 2021, the Administration appealed the District Court ruling. Changes in DACA policy affect OASDI program operations because those who apply for and receive deferred action status are eligible for work authorization, which leads to additional workers covered by the OASDI program and increased payroll tax revenue. The estimates presented in last year's report reflected the assumption that the DACA program would be maintained in full, consistent with the Administration's intent. The estimates presented in this year's report continue to reflect the assumption that DACA will eventually be fully in effect. However, because of the court challenges, the estimates now incorporate a roughly one-year delay in resuming approval of new applications. This change is estimated to have negligible financial effects on the OASDI program over both the short-range and long-range projection periods.

Sections IV.A.4 and IV.B.6 of this report provide further description of the magnitude of effects on the financial status of the OASDI program.

IV. ACTUARIAL ESTIMATES

This chapter presents actuarial estimates of the future financial condition of the Social Security program. These estimates show the income, cost, and asset reserves or unfunded obligation of the OASI and DI Trust Funds: (1) in dollars over the 10-year short-range period; and (2) as a percentage of taxable payroll, as a percentage of gross domestic product, and in present-value dollars over the 75-year long-range period. In addition, the chapter discusses a variety of measures of the adequacy of current program financing. This report distinguishes between: (1) the cost (obligations) of the program, which includes all past and future benefits scheduled under current law; and (2) expenditures, which include actual payments for the past plus only the portion of projected program cost that would be payable with the financing provisions in current law.

This chapter presents the estimates and measures of trust fund financial adequacy for the short-range period (2022 through 2031) first, followed by estimates and measures of actuarial status for the long-range period (2022 through 2096). Summary measures are also provided for trust fund status over the infinite horizon. As described in chapter II of this report, these estimates depend upon a broad set of demographic, economic, and programmatic factors. This chapter presents estimates under three sets of assumptions to show a wide range of possible outcomes, because assumptions related to these factors are subject to uncertainty. The intermediate set of assumptions, designated as alternative II, reflects the Trustees' best estimate of future experience; the low-cost alternative I is significantly more optimistic and the high-cost alternative III is significantly more pessimistic for the trust funds' future financial outlook. The tables of this report show the intermediate estimates first, followed by the low-cost and high-cost estimates. Chapter V describes these three sets of assumptions, along with the actuarial methods used to produce the estimates. Appendix D and appendix E present two additional methods to illustrate the uncertainty of the projections. Appendix D presents sensitivity analyses of the effects of variation in individual factors and appendix E presents probability distributions generated by a stochastic model.

A. SHORT-RANGE ESTIMATES

The Trustees consider the trust funds to be solvent at any point in time if the funds can pay scheduled benefits in full on a timely basis. A standard measure for assessing solvency is the "trust fund ratio," which is the reserves in a fund at the beginning of a year (not including advance tax transfers) expressed as a percentage of the cost during the year. A positive trust fund ratio indicates that the trust fund was solvent at the end of the prior year. The

trust fund ratio represents the proportion of a year's cost which the reserves available at the beginning of that year can cover. The Trustees assume that a trust fund ratio of 100 percent of annual program cost provides a reasonable "contingency reserve." Maintaining a reasonable contingency reserve is important because the trust funds do not have borrowing authority. After reserves are depleted, the trust funds would be unable to pay scheduled benefits in full on a timely basis if annual revenue were less than annual cost. Unexpected events, such as severe economic recessions, can quickly diminish reserves. In such cases, a reasonable contingency reserve can maintain the ability to pay scheduled benefits while giving lawmakers time to address possible changes to the program.

The test of short-range financial adequacy applies to the OASI and DI Trust Funds individually and combined on a hypothetical basis.[1] If the estimated trust fund ratio is at least 100 percent at the beginning of the projection period, the test requires that it remain at or above 100 percent throughout the 10-year period. If the ratio is initially less than 100 percent, then it must reach at least 100 percent within 5 years (without reserve depletion at any time during this period) and then remain at or above 100 percent throughout the remainder of the 10-year period. This test is applied using the estimates based on the intermediate assumptions. If either trust fund fails this test, then program solvency in the next 10 years is in question, and lawmakers should take prompt action to improve short-range financial adequacy.

1. Operations of the OASI Trust Fund

This subsection presents projections, based on the assumptions described in chapter V, of the operations and financial status of the OASI Trust Fund for the period 2022 through 2031. These estimates assume that there are no further changes in the statutory provisions and regulations under which the OASDI program currently operates beyond the changes since last year's report indicated in section III.B.[2]

Estimates of the OASI Trust Fund operations presented in table IV.A1 indicate that the asset reserves of the OASI Trust Fund are projected to decrease in years 2022 through 2031 under all three sets of assumptions. Under the intermediate and low-cost assumptions, asset reserves remain positive through the end of the short-range period, but under the high-cost assumptions, asset reserves become depleted in the fourth quarter of 2031. Trust fund ratios are similarly projected to decline throughout the 10-year projec-

[1] The OASI and DI Trust Funds are distinct legal entities which operate independently. To illustrate the actuarial status of the program as a whole, the fund operations are often combined on a hypothetical basis.

[2] The estimates shown in this subsection reflect 12 months of scheduled benefits in each year of the short-range projection period. In practice, the actual payment dates have at times shifted over calendar year boundaries as a result of the statutory requirement for early delivery of benefit payments when the normal check delivery date is a Saturday, Sunday, or legal public holiday.

tion period under all three sets of assumptions. Based on the intermediate assumptions, the reserves of the OASI Trust Fund drop below 100 percent of annual cost during 2029, to a trust fund ratio of 87 percent at the beginning of 2030, and remain below 100 percent for the remainder of the short-range period. Consequently, the OASI Trust Fund fails the test of short-range financial adequacy. See figure IV.A1 for an illustration of these results.

Table IV.A1.—Operations of the OASI Trust Fund, Calendar Years 2017-2031[a]

[Dollar amounts in billions]

	Income					Cost[b]				Asset Reserves[b]		
Calendar year	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
Historical data:												
2017 . .	$825.6	$706.5	[g]	$35.9	$83.2	$806.7	$798.7	$3.7	$4.3	$19.0	$2,820.3	347
2018 . .	831.0	715.9	[g]	34.5	80.7	853.5	844.9	3.8	4.8	-22.4	2,797.9	330
2019 . .	917.9	805.1	[g]	34.9	77.9	911.4	902.8	3.7	4.9	6.5	2,804.3	307
2020 . .	968.3	856.0	[g]	39.0	73.3	961.0	952.4	3.7	4.8	7.4	2,811.7	292
2021 . .	942.9	838.2	[g]	37.2	67.5	1,001.9	993.1	4.0	4.8	-59.1	2,752.6	281
Intermediate:												
2022 . .	1,034.4	926.6	[g]	45.7	62.0	1,096.2	1,087.1	3.8	5.3	-61.9	2,690.8	251
2023 . .	1,100.8	993.5	[g]	49.9	57.5	1,179.4	1,169.8	4.2	5.4	-78.5	2,612.2	228
2024 . .	1,144.9	1,035.9	[g]	54.4	54.6	1,254.9	1,244.8	4.3	5.8	-110.0	2,502.2	208
2025 . .	1,195.7	1,083.3	[g]	59.3	53.1	1,332.9	1,322.7	4.5	5.8	-137.3	2,364.9	188
2026 . .	1,257.7	1,131.7	[g]	73.0	52.9	1,414.7	1,404.2	4.6	5.9	-157.1	2,207.9	167
2027 . .	1,313.4	1,181.0	[g]	79.5	52.9	1,499.7	1,489.1	4.7	5.9	-186.4	2,021.5	147
2028 . .	1,370.3	1,232.7	[g]	86.1	51.4	1,591.1	1,580.2	4.9	6.0	-220.8	1,800.7	127
2029 . .	1,427.0	1,285.6	[g]	93.3	48.1	1,685.2	1,674.2	5.0	6.0	-258.2	1,542.5	107
2030 . .	1,482.7	1,338.0	[g]	101.2	43.5	1,781.9	1,770.7	5.1	6.1	-299.2	1,243.3	87
2031 . .	1,539.4	1,393.1	[g]	109.5	36.8	1,881.0	1,869.5	5.3	6.2	-341.6	901.7	66
Low-cost:												
2022 . .	1,040.6	932.2	[g]	45.7	62.7	1,095.5	1,086.4	3.8	5.3	-54.8	2,697.8	251
2023 . .	1,134.6	1,024.0	[g]	50.2	60.5	1,186.4	1,176.9	4.2	5.4	-51.8	2,646.0	227
2024 . .	1,198.1	1,082.4	[g]	54.9	60.8	1,267.3	1,257.2	4.3	5.7	-69.3	2,576.8	209
2025 . .	1,272.8	1,150.6	[g]	60.1	62.1	1,352.5	1,342.2	4.5	5.8	-79.7	2,497.1	191
2026 . .	1,361.7	1,222.3	[g]	74.4	64.9	1,442.0	1,431.3	4.8	5.9	-80.3	2,416.8	173
2027 . .	1,445.3	1,295.2	[g]	81.4	68.6	1,535.5	1,524.6	5.0	6.0	-90.3	2,326.5	157
2028 . .	1,533.1	1,372.9	[g]	88.6	71.6	1,636.3	1,625.1	5.2	6.0	-103.2	2,223.3	142
2029 . .	1,624.2	1,454.2	[g]	96.4	73.7	1,741.0	1,729.5	5.4	6.1	-116.8	2,106.6	128
2030 . .	1,717.8	1,537.4	[g]	105.0	75.4	1,849.9	1,838.1	5.6	6.2	-132.1	1,974.4	114
2031 . .	1,816.0	1,625.7	[g]	114.3	76.0	1,962.8	1,950.7	5.8	6.3	-146.8	1,827.6	101

Table IV.A1.—Operations of the OASI Trust Fund, Calendar Years 2017-2031[a] (Cont.)

[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
High-cost:												
2022 . .	$1,011.1	$904.0	[g]	$45.8	$61.4	$1,097.1	$1,088.0	$3.8	$5.3	-$86.1	$2,666.6	251
2023 . .	1,024.7	920.9	[g]	49.6	54.2	1,173.9	1,164.3	4.2	5.4	-149.2	2,517.4	227
2024 . .	1,058.7	956.3	[g]	53.4	49.0	1,233.5	1,223.3	4.3	5.8	-174.8	2,342.6	204
2025 . .	1,091.8	989.3	[g]	57.9	44.6	1,301.5	1,291.4	4.4	5.8	-209.7	2,132.9	180
2026 . .	1,135.6	1,023.4	[g]	71.0	41.3	1,375.1	1,364.8	4.4	5.9	-239.4	1,893.5	155
2027 . .	1,168.7	1,054.0	[g]	77.0	37.8	1,451.2	1,440.8	4.5	5.8	-282.5	1,611.0	130
2028 . .	1,198.9	1,083.8	[g]	83.0	32.2	1,532.9	1,522.4	4.6	5.9	-333.9	1,277.1	105
2029 . .	1,227.3	1,113.1	[g]	89.5	24.8	1,616.2	1,605.7	4.6	5.9	-388.9	888.2	79
2030 . .	1,253.6	1,140.5	[g]	96.6	16.5	1,700.8	1,690.1	4.7	5.9	-447.2	441.0	52
2031 . .	[h]	1,169.0	[g]	104.0	[h]	1,786.4	1,775.7	4.7	6.0	[h]	[h]	25

[a] The OASI Trust Fund reserves become depleted in the fourth quarter of 2031 under the high-cost assumptions. For any period during which reserves would be depleted, scheduled benefits could not be paid in full on a timely basis, income from taxing benefits would be less than would apply to scheduled benefits, and interest on trust fund reserves would be negligible. Appendix A presents a detailed description of the components of income and cost, along with complete historical values.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $30.4 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[d] Includes reimbursements from the General Fund of the Treasury to the OASI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (2) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (3) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[e] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

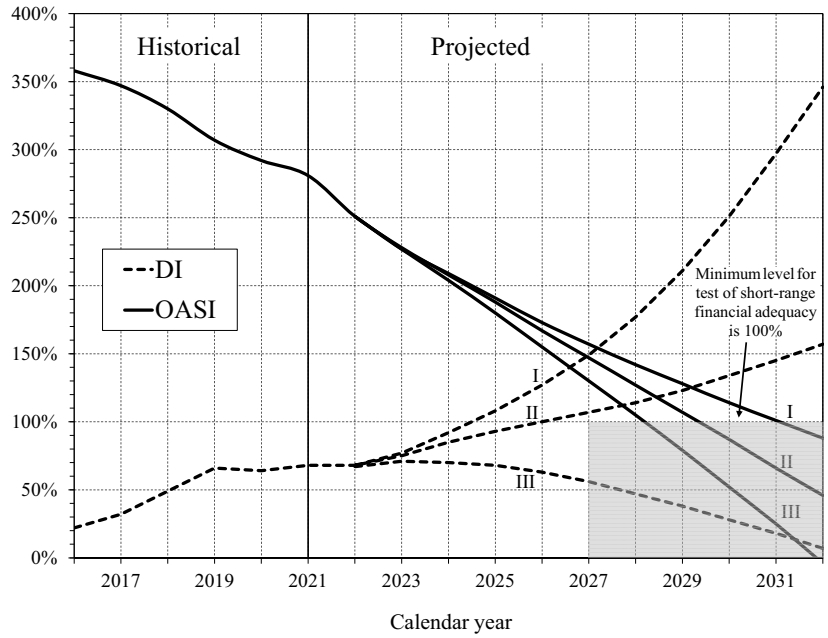
[f] The "Trust fund ratio" column represents reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year. The trust fund ratio at the beginning of 2032 is projected to be 46 percent for the intermediate, and 88 percent for the low-cost assumptions.

[g] Between -$50 million and $50 million.

[h] When the fund is depleted, values under current law would reflect permissible expenditures only, which would be less than the cost of scheduled benefits shown in this table.

Note: Components may not sum to totals because of rounding.

Figure IV.A1.—Short-Range OASI and DI Trust Fund Ratios
[Asset reserves as a percentage of annual cost]



The estimated income shown in table IV.A1 increases annually after 2022 under each set of assumptions throughout the short-range projection period. The estimated increases in income result primarily from the projected increases in OASDI taxable payroll. Employment increases in years 2022 through 2031 for all three alternatives, with the exception of small decreases in covered employment in 2022 and 2023 for the high-cost alternative: the number of covered workers increases under alternatives I, II, and III from 179 million during calendar year 2021 to about 191 million, 187 million, and 183 million, respectively, in 2031.[1] The total annual amount of taxable payroll increases in years 2022 through 2031 for each alternative. Total taxable payroll increases from $8,223 billion in 2021 to $15,379 billion, $13,169 billion, and $11,043 billion in 2031, on the basis of alternatives I, II, and III, respectively.[2] These increases in taxable payroll are due primarily to: (1) projected increases in employment levels as the working-age population increases; (2) trend increases in average earnings in covered employment (reflecting both real growth and price inflation); (3) increases in the contribution and benefit base under the automatic-adjustment provisions; and (4) growth in employment and average earnings.

[1] See table IV.B3.
[2] See table VI.G6.

Interest earnings contribute to the overall projected level of trust fund income during this period. Interest income declines generally at a slow rate under the intermediate assumptions and much faster under the high-cost assumptions, and increases generally under the low-cost assumptions, due to the net effects of changes in reserve levels and the patterns of projected interest rates. Under the intermediate assumptions, interest also declines as a share of total OASI Trust Fund income reaching 2 percent of total trust fund income for 2031, as compared to 7 percent for 2021.

Rising OASI cost from 2021 through 2031 reflects automatic benefit increases each year after initial benefit eligibility and increases each year for those becoming newly eligible based on rising average earnings levels, as well as the upward trend in the number of beneficiaries. The steady growth in the number of OASI beneficiaries in the past and the expected future growth result both from the increase in the aged population and from the increase in the proportion of the population that is insured for benefits.

The Treasury invests OASI income in financial securities, generally special public-debt obligations of the U.S. Government. The revenue used to make these purchases flows to the General Fund of the Treasury. The trust fund earns interest on these securities, and the Treasury invests the proceeds from maturing securities in new securities if not immediately needed to pay program costs. Program expenditures require the redemption of trust fund securities, generally prior to maturity, to cover the payments made by the General Fund of the Treasury on behalf of the trust fund.

2. Operations of the DI Trust Fund

Table IV.A2 shows the projected operations and financial status of the DI Trust Fund during calendar years 2022 through 2031 under the three sets of assumptions, together with values for actual experience during 2017 through 2021. Non-interest income for DI was much lower in 2019 through 2021 than in 2017 and 2018, due to the temporary payroll tax rate reallocation from OASI to DI in 2016 through 2018. For 2021, non-interest income was higher than DI cost. Non-interest income increases throughout the short-range projection period under each alternative, due to most of the same factors described previously for the OASI Trust Fund beginning on page 45. DI cost grows steadily throughout the period under each alternative. Under the intermediate and low-cost assumptions, DI reserves increase through 2031. Under the high-cost assumptions, DI reserves increase through 2024 and then decline through 2031.

Table IV.A2.—Operations of the DI Trust Fund, Calendar Years 2017-2031[a]
[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
Historical data:												
2017	$171.0	$167.1	[g]	$2.0	$1.9	$145.8	$142.8	$2.8	$0.2	$25.1	$71.5	32
2018	172.3	169.2	[g]	.5	2.6	146.8	143.7	2.9	.2	25.6	97.1	49
2019	143.9	139.4	[g]	1.6	2.9	147.9	145.1	2.7	.1	-4.0	93.1	66
2020	149.7	145.3	[g]	1.7	2.8	146.3	143.6	2.6	.1	3.5	96.6	64
2021	145.5	142.4	[g]	.5	2.6	142.6	140.1	2.5	.1	2.8	99.4	68
Intermediate:												
2022	161.5	157.4	[g]	1.5	2.6	146.4	143.4	2.9	.1	15.0	114.4	68
2023	173.1	168.7	[g]	1.6	2.8	152.7	149.6	3.0	.1	20.4	134.8	75
2024	181.0	175.9	[g]	1.7	3.3	159.1	155.9	3.1	.1	21.9	156.7	85
2025	190.0	184.0	[g]	1.9	4.1	168.5	165.1	3.3	.1	21.5	178.2	93
2026	199.6	192.2	[g]	2.3	5.1	177.7	174.1	3.5	.1	21.9	200.1	100
2027	209.2	200.5	[g]	2.5	6.1	187.4	183.6	3.7	.1	21.8	221.9	107
2028	219.4	209.3	[g]	2.7	7.3	194.5	190.6	3.9	.1	24.8	246.7	114
2029	230.0	218.3	[g]	2.9	8.8	200.6	196.4	4.0	.2	29.3	276.1	123
2030	240.8	227.2	[g]	3.0	10.5	206.4	202.0	4.2	.2	34.4	310.5	134
2031	252.3	236.6	[g]	3.2	12.5	213.7	209.1	4.4	.2	38.6	349.0	145
Low-cost:												
2022	162.5	158.3	[g]	1.5	2.7	145.6	142.6	2.9	.1	17.0	116.4	68
2023	178.9	173.9	[g]	1.6	3.4	151.6	148.5	3.0	.1	27.3	143.7	77
2024	190.2	183.8	[g]	1.7	4.7	156.5	153.3	3.1	.1	33.7	177.4	92
2025	203.7	195.4	[g]	1.9	6.4	164.0	160.6	3.3	.1	39.7	217.1	108
2026	218.5	207.6	[g]	2.2	8.7	170.8	167.2	3.5	.1	47.7	264.8	127
2027	233.9	219.9	[g]	2.4	11.6	177.5	173.6	3.8	.1	56.4	321.2	149
2028	250.9	233.1	[g]	2.5	15.3	181.8	177.7	4.0	.1	69.2	390.3	177
2029	269.5	246.9	[g]	2.6	19.9	185.3	180.9	4.2	.1	84.2	474.5	211
2030	289.4	261.1	[g]	2.8	25.6	188.7	184.1	4.5	.2	100.6	575.2	251
2031	311.2	276.1	[g]	2.9	32.2	193.7	188.8	4.7	.2	117.5	692.6	297

Table IV.A2.—Operations of the DI Trust Fund, Calendar Years 2017-2031[a] (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[c e]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
High-cost:												
2022 . . .	$157.5	$153.5	[g]	$1.5	$2.5	$147.5	$144.5	$2.9	$0.1	$10.0	$109.4	67
2023 . . .	160.2	156.4	[g]	1.6	2.2	155.2	152.1	3.0	.1	5.0	114.4	71
2024 . . .	166.4	162.4	[g]	1.8	2.2	162.8	159.6	3.1	.1	3.5	118.0	70
2025 . . .	172.3	168.0	[g]	2.0	2.3	174.0	170.6	3.3	.1	-1.7	116.3	68
2026 . . .	178.5	173.8	[g]	2.4	2.3	185.3	181.7	3.4	.1	-6.7	109.5	63
2027 . . .	183.8	179.0	[g]	2.7	2.2	197.1	193.4	3.6	.1	-13.3	96.2	56
2028 . . .	188.8	184.0	[g]	2.9	1.9	205.4	201.5	3.7	.1	-16.6	79.6	47
2029 . . .	193.6	189.0	[g]	3.0	1.6	212.3	208.2	3.9	.2	-18.6	61.0	38
2030 . . .	198.0	193.7	[g]	3.2	1.1	218.5	214.2	4.0	.2	-20.4	40.5	28
2031 . . .	202.6	198.5	[g]	3.4	.6	226.2	221.8	4.2	.2	-23.6	16.9	18

[a] Appendix A presents a detailed description of the components of income and cost, along with complete historical values.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $5.2 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[d] Includes reimbursements from the General Fund of the Treasury to the DI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (2) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (3) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[e] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

[f] The "Trust fund ratio" column represents reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year. The trust fund ratio at the beginning of 2032 is projected to be 157 percent for the intermediate, 346 percent for the low-cost, and 7 percent for the high-cost assumptions.

[g] Between -$50 million and $50 million.

Note: Components may not sum to totals because of rounding.

For the future, DI cost is projected to increase in part due to increases in average benefit levels resulting from: (1) automatic benefit increases and (2) projected increases in the amounts of average monthly earnings on which benefits are based. Future changes in DI cost also reflect changes in the number of DI beneficiaries in current-payment status. In 2021, the number of DI beneficiaries in current-payment status continued the declining trend of the prior seven years. Under the intermediate assumptions, that number of DI beneficiaries is projected to drop further through the end of 2023, then increase through the end of 2031 to a level of about 9 million. The rate of increase after 2023 is much slower than was experienced on average from 1990 to 2010, when the population with the highest disability prevalence rates was growing rapidly due to the aging of the baby-boom generation. See section V.C.5 for further details.

At the beginning of calendar year 2022, the reserves of the DI Trust Fund represented 68 percent of estimated annual cost. Under the intermediate assumptions, DI trust fund reserves and the trust fund ratio increase throughout the short-range projection period. The trust fund ratio is slightly above 100 percent at the beginning of the fifth projected year, 2026, and continues to increase for the remainder of the short-range period.

Because the reserves of the DI Trust Fund at the beginning of 2022 were less than the estimated annual cost for 2022, but are projected to increase to above annual cost within five years, and then remain above annual cost throughout the rest of the short-range period under the intermediate assumptions, the DI Trust Fund satisfies the Trustees' test of short-range financial adequacy.

3. Operations of the Combined OASI and DI Trust Funds

Table IV.A3 shows the projected operations and status of the combined OASI and DI Trust Funds for calendar years 2022 through 2031 under the three alternatives, together with actual experience in 2017 through 2021. Income and cost for the OASI Trust Fund represent over 80 percent of the corresponding amounts for the combined OASI and DI Trust Funds. Under the intermediate and low-cost assumptions, the combined OASI and DI Trust Funds would have sufficient financial resources to pay all scheduled benefits through the end of the short-range period, although it is important to note that under current law, one trust fund cannot share financial resources with another trust fund. Under the high-cost assumptions, combined OASI and DI trust fund reserves deplete in the fourth quarter of 2031. The combined OASI and DI Trust Funds do not satisfy the test of short-range financial adequacy because under the intermediate assumptions, trust fund reserves drop below 100 percent of annual cost during 2029, to a trust fund ratio of 91 percent at the beginning of 2030, and remain below 100 percent for the remainder of the short-range period.

Table IV.A3.—Operations of the Combined OASI and DI Trust Funds, Calendar Years 2017-2031[a]

[Dollar amounts in billions]

	Income					Cost[b]				Asset Reserves[b]		
Calendar year	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
Historical data:												
2017 . .	$996.6	$873.6	[g]	$37.9	$85.1	$952.5	$941.5	$6.5	$4.5	$44.1	$2,891.8	299
2018 . .	1,003.4	885.1	[g]	35.0	83.3	1,000.2	988.6	6.7	4.9	3.1	2,894.9	289
2019 . .	1,061.8	944.5	[g]	36.5	80.8	1,059.3	1,047.9	6.4	4.9	2.5	2,897.4	273
2020 . .	1,118.1	1,001.3	[g]	40.7	76.1	1,107.2	1,095.9	6.3	5.0	10.9	2,908.3	262
2021 . .	1,088.3	980.6	[g]	37.6	70.1	1,144.6	1,133.2	6.5	4.9	-56.3	2,852.0	254
Intermediate:												
2022 . .	1,195.8	1,084.0	[g]	47.2	64.6	1,242.7	1,230.6	6.7	5.4	-46.8	2,805.2	230
2023 . .	1,273.9	1,162.2	[g]	51.5	60.2	1,332.1	1,319.4	7.2	5.5	-58.2	2,747.0	211
2024 . .	1,325.8	1,211.8	[g]	56.1	57.9	1,413.9	1,400.7	7.4	5.8	-88.1	2,658.9	194
2025 . .	1,385.7	1,267.3	[g]	61.2	57.2	1,501.5	1,487.8	7.8	5.9	-115.8	2,543.1	177
2026 . .	1,457.3	1,323.9	[g]	75.4	58.0	1,592.4	1,578.3	8.1	6.0	-135.1	2,408.0	160

Table IV.A3.—Operations of the Combined OASI and DI Trust Funds, Calendar Years 2017-2031[a] (Cont.)

[Dollar amounts in billions]

Calendar year	Income					Cost[b]				Asset Reserves[b]		
	Total	Net payroll tax contributions[c]	GF reimbursements[d]	Taxation of benefits[ce]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
Intermediate (Cont.):												
2027 . .	$1,522.6	$1,381.5	[g]	$82.1	$59.0	$1,687.1	$1,672.7	$8.4	$6.0	-$164.6	$2,243.4	143
2028 . .	1,589.6	1,442.1	[g]	88.9	58.7	1,785.6	1,770.8	8.7	6.1	-196.0	2,047.4	126
2029 . .	1,656.9	1,503.9	[g]	96.2	56.9	1,885.8	1,870.6	9.1	6.2	-228.9	1,818.6	109
2030 . .	1,723.4	1,565.2	[g]	104.2	54.0	1,988.3	1,972.6	9.4	6.3	-264.8	1,553.7	91
2031 . .	1,791.7	1,629.7	[g]	112.7	49.3	2,094.7	2,078.6	9.7	6.4	-303.0	1,250.8	74
Low-cost:												
2022 . .	1,203.2	1,090.5	[g]	47.2	65.4	1,241.0	1,228.9	6.7	5.4	-37.9	2,814.2	230
2023 . .	1,313.5	1,197.9	[g]	51.8	63.9	1,338.0	1,325.3	7.2	5.4	-24.5	2,789.7	210
2024 . .	1,388.3	1,266.2	[g]	56.6	65.5	1,423.8	1,410.5	7.5	5.8	-35.6	2,754.2	196
2025 . .	1,476.5	1,346.0	[g]	62.0	68.5	1,516.5	1,502.7	7.9	5.9	-40.0	2,714.1	182
2026 . .	1,580.2	1,429.9	[g]	76.7	73.6	1,612.8	1,598.5	8.3	6.0	-32.6	2,681.5	168
2027 . .	1,679.2	1,515.2	[g]	83.8	80.2	1,713.0	1,698.2	8.7	6.1	-33.8	2,647.7	157
2028 . .	1,784.0	1,606.0	[g]	91.1	86.9	1,818.1	1,802.7	9.2	6.2	-34.0	2,613.7	146
2029 . .	1,893.7	1,701.1	[g]	99.0	93.6	1,926.3	1,910.4	9.6	6.3	-32.6	2,581.1	136
2030 . .	2,007.2	1,798.4	[g]	107.8	100.9	2,038.6	2,022.2	10.1	6.4	-31.5	2,549.6	127
2031 . .	2,127.2	1,901.8	[g]	117.2	108.2	2,156.5	2,139.5	10.6	6.5	-29.4	2,520.2	118
High-cost:												
2022 . .	1,168.6	1,057.5	[g]	47.3	63.8	1,244.6	1,232.5	6.7	5.4	-76.0	2,776.0	229
2023 . .	1,184.9	1,077.2	[g]	51.3	56.4	1,329.1	1,316.4	7.2	5.5	-144.2	2,631.8	209
2024 . .	1,225.0	1,118.7	[g]	55.2	51.2	1,396.3	1,382.9	7.4	6.0	-171.3	2,460.6	188
2025 . .	1,264.1	1,157.4	[g]	59.8	46.9	1,475.5	1,462.0	7.6	5.9	-211.4	2,249.2	167
2026 . .	1,314.2	1,197.2	[g]	73.4	43.6	1,560.4	1,546.5	7.9	6.0	-246.2	2,003.0	144
2027 . .	1,352.5	1,232.9	[g]	79.6	40.0	1,648.3	1,634.3	8.1	6.0	-295.8	1,707.2	122
2028 . .	1,387.8	1,267.8	[g]	85.9	34.1	1,738.3	1,724.0	8.3	6.0	-350.5	1,356.7	98
2029 . .	1,420.9	1,302.1	[g]	92.5	26.3	1,828.5	1,813.9	8.5	6.1	-407.5	949.2	74
2030 . .	1,451.6	1,334.2	[g]	99.8	17.6	1,919.2	1,904.4	8.7	6.1	-467.6	481.5	49
2031 . .	[h]	1,367.5	[g]	107.4	[h]	2,012.6	1,997.5	8.9	6.2	[h]	[h]	24

[a] The OASDI Trust Fund reserves become depleted in the fourth quarter of 2031 under the high-cost assumptions. For any period during which reserves would be depleted, scheduled benefits could not be paid in full on a timely basis, income from taxing benefits would be less than would apply to scheduled benefits, and interest on trust fund reserves would be negligible. Appendix A presents a detailed description of the components of income and cost, along with complete historical values.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $35.5 billion was made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[d] Includes reimbursements from the General Fund of the Treasury to the OASI and DI Trust Funds for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (2) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (3) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[e] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.

[f] The "Trust fund ratio" column represents reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year. The trust fund ratio at the beginning of 2032 is projected to be 57 percent for the intermediate, and 111 percent for the low-cost assumptions.

[g] Between -$50 million and $50 million.

[h] When the fund is depleted, values under current law would reflect permissible expenditures only, which would be less than the cost of scheduled benefits shown in this table.

Note: Components may not sum to totals because of rounding.

4. Factors Underlying Changes in 10-Year Trust Fund Ratio Estimates From Last Year's Report

Table IV.A4 presents an analysis of the factors underlying the changes in the intermediate estimates over the short-range projection period for the OASI, DI, and the combined funds from last year's report to this report.

In the 2021 report under the intermediate assumptions, the trust fund ratio for OASI reached 85 percent at the beginning of 2030—the tenth projection year for that report. The change in the short-range valuation period alone, from 2021 through 2030 to 2022 through 2031, lowered the estimated trust fund ratio for the tenth year by 22 percentage points, to 63 percent. All other changes to reflect modifications in law and regulations since last year's report, the most recent data, adjustments to the assumptions for future years, and changes in projection methods combined for a net increase in the ratio for the tenth projection year of 3 percentage points. Therefore, the total change in the tenth year projected trust fund ratio from last year's report to this year's report is a reduction of 19 percentage points to 66 percent.

The change in policy for the Deferred Actions for Childhood Arrivals program discussed in III.B did not significantly affect the tenth year OASI trust fund ratio. Changes in demographic assumptions over the short-range period also did not significantly affect the projected tenth year trust fund ratio for OASI. Several changes in economic data and assumptions combined to cause a net reduction in the OASI trust fund ratio of 5 percentage points by the beginning of 2031. Incorporating recent programmatic data and assumptions, including actual average benefits and beneficiary counts for 2021 and higher estimated near-term revenue from taxation of benefits income, resulted in an increase of 8 percentage points in the tenth year OASI trust fund ratio. Finally, the tenth year trust fund ratio was not affected significantly by changes in the short-range methodology for this report.

Table IV.A4 also shows corresponding estimates of the factors underlying the changes in the financial projections for the DI Trust Fund and for the combined OASI and DI Trust Funds. The 64-percentage-point increase in the DI trust fund ratio from the beginning of 2030 in last year's report to the beginning of 2031 in this year's report is the net effect of increases and decreases from the factors described above for the OASI Trust Fund, combined with other changes that are significant for DI but not OASI. The large increase of 57 points due to programmatic data and assumptions reflects: (1) lower recent disabled-worker application and incidence rates, (2) a more gradual return of initial disability application rates to their ultimate levels from recent lows, and (3) lowering the ultimate disabled worker incidence rate from 5.0 to 4.8 in this report.

Table IV.A4.—Reasons for Change in Trust Fund (Unfunded Obligation) Ratios at the Beginning of the Tenth Year of Projection Under Intermediate Assumptions
[In percent]

Item	OASI Trust Fund	DI Trust Fund	OASI and DI Trust Funds, combined
Trust fund ratio shown in last year's report for calendar year 2030	85	81	85
Change in trust fund ratio due to changes in:			
Legislation and regulations	[a]	[a]	[a]
Valuation period	-22	5	-19
Demographic data and assumptions	[a]	[a]	[a]
Economic data and assumptions	-5	2	-4
Programmatic data and assumptions	8	57	13
Projection methods and data	[a]	[a]	[a]
Total change in trust fund ratio	-19	64	-11
Trust fund ratio shown in this report for calendar year 2031	66	145	74

[a] Between -0.5 and 0.5 percent.

Note: Components may not sum to totals because of rounding.

B. LONG-RANGE ESTIMATES

The Trustees use three types of financial measures to assess the actuarial status of the Social Security trust funds under the financing approach specified in current law: (1) annual cash-flow measures, including income rates, cost rates, and balances; (2) trust fund ratios; and (3) summary measures such as actuarial balances and unfunded obligations.

The difference between the annual income rate and annual cost rate, both expressed as percentages of taxable payroll, is the annual balance. The level and trend of the annual balances at the end of the 75-year projection period are factors that the Trustees use to assess the financial condition of the program.

The trust fund ratio for a year is the proportion of the year's projected cost that could be paid with fund reserves available at the beginning of the year. Critical factors considered by the Trustees in assessing actuarial status include: (1) the level and year of maximum trust fund ratio, (2) the year of depletion of the fund reserves and the percent of scheduled benefits that is still payable after reserves are depleted, and (3) the stability of the trust fund ratio at the end of the long-range period.

Solvency at any point in time requires that sufficient financial resources are available to pay all scheduled benefits at that time. Solvency is generally indicated by a positive trust fund ratio. "Sustainable solvency" for the financing of the program under a specified set of assumptions is achieved when the projected trust fund ratio is positive throughout the 75-year projection period and is either stable or rising at the end of the period.

The Trustees summarize the total income and cost over valuation periods that extend through 75 years and over the infinite horizon.[1] This section presents several summarized measures, including the actuarial balance and the open-group unfunded obligation. The actuarial balance indicates the size of any surplus or shortfall as a percentage of the taxable payroll over the period. The open-group unfunded obligation indicates the size of any shortfall in present-value dollars.

This section also includes additional information that the Trustees use to assess the financial status of the Social Security program, including: (1) a comparison of the number of beneficiaries to the number of covered workers, (2) the test of long-range close actuarial balance, and (3) the reasons for the change in the actuarial balance from the last report.

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[1] See appendix F.

1. Annual Income Rates, Cost Rates, and Balances

The concepts of income rate and cost rate, expressed as percentages of taxable payroll, are important in the consideration of the long-range actuarial status of the trust funds. The annual income rate is the ratio of all non-interest income to the OASDI taxable payroll for the year. Non-interest income includes payroll taxes, taxes on scheduled benefits, and any General Fund transfers or reimbursements. The OASDI taxable payroll consists of the total earnings subject to OASDI taxes with some relatively small adjustments.[1] The annual cost rate is the ratio of the cost of the program to the taxable payroll for the year. The cost includes scheduled benefits, administrative expenses, net interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. For any year, the annual income rate minus the annual cost rate is the annual "balance" for the year.

Table IV.B1 presents a comparison of the estimated annual income rates and cost rates by trust fund and alternative. Table IV.B2 shows the separate components of the annual income rates.

Under the intermediate assumptions, the Trustees project that the OASI income rate will increase from 10.65 percent of payroll for 2021 to 11.00 percent of payroll for 2022 and 11.21 percent of payroll for 2023. The income rate in 2021 is relatively low because an unusually large negative adjustment to payroll tax contributions was made in June 2021 reflecting the excess amounts credited in 2020. The OASI income rate then decreases to 11.14 percent in 2024 and generally gradually rises thereafter, reaching 11.55 percent of taxable payroll for 2096. Income from taxation of benefits causes this gradual increase in the OASI income rate for two main reasons: (1) total scheduled benefits are rising faster than payroll; and (2) the ratio of total income tax on benefits to total benefits increases over time for reasons discussed in detail on page 152.

The OASI cost rate rises rapidly from 2021[2] to 2038. During this period, the retirement of the baby-boom generation will continue to increase the number of beneficiaries much faster than the number of workers increases, as subse-

[1] Adjustments include adding deemed wage credits based on military service for 1983-2001 and reflecting the lower effective tax rates (as compared to the combined employee-employer rate) that apply to multiple-employer "excess wages." Lower rates also applied to net earnings from self-employment before 1984 and to income from tips before 1988.

[2] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

quent lower-birth-rate generations replace the baby-boom generation at working ages. From 2040 to 2046, the cost rate declines because the aging baby-boom generation is gradually replaced at retirement ages by the lower-birth-rate generations that followed. The OASI cost rate then rises from 14.95 percent in 2046 to 16.45 percent in 2078, largely because of the period of reduced birth rates starting with the recession of 2007-09, and then declines to 15.69 percent in 2096.

Projections of income rates under the low-cost and high-cost sets of assumptions are similar to those projected for the intermediate assumptions, because income rates are largely a reflection of the payroll tax rates specified in the law, with the changes from taxation of benefits noted above. In contrast, OASI cost rates for the low-cost and high-cost assumptions are significantly different from those projected for the intermediate assumptions. For the low-cost assumptions, the OASI cost rate rises from 12.28 percent in 2022 until it peaks in 2034 at 12.85 percent of payroll. The cost rate then declines to 12.01 percent for 2055, rises to 12.14 percent for 2070, and then mostly declines to 10.98 percent in 2096, at which point the income rate reaches 11.26 percent. For the high-cost assumptions, the OASI cost rate rises from 12.81 percent in 2022 to 24.67 percent in 2088 and then declines gradually to 24.45 percent in 2096, at which point the income rate reaches 12.10 percent.

The pattern of the projected OASI annual balance is important in the analysis of the financial condition of the program. Under the intermediate assumptions, the annual balance is negative throughout the projection period. The annual deficit decreases from 1.54 percent in 2021 to 1.40 percent in 2022, mainly because of the 2021 adjustment for lower-than-expected payroll tax revenue in 2020 mentioned earlier. After 2022, the annual deficit rises to 3.50 percent for 2040. It then declines to 3.47 percent of payroll for 2046, rises to 4.85 percent for 2078, and declines thereafter, reaching 4.14 percent of taxable payroll for 2096.

Under the low-cost assumptions, the OASI annual deficit decreases from 1.32 percent of payroll for 2022 to 1.17 percent in 2023, and then mostly rises to 1.52 percent of payroll for 2034. After 2034, the annual deficit declines to 0.70 percent of payroll for 2055, and rises to 0.82 percent for 2070. After 2070, the OASI annual balance mostly improves, turning positive in 2088, and reaching 0.27 percent of payroll for 2096. Under the high-cost assumptions, the OASI annual deficit rises from 1.72 percent for 2022 to 12.56 percent for 2088, and then declines relatively modestly to 12.36 percent for 2096.

Table IV.B1.—Annual Income Rates, Cost Rates, and Balances, Calendar Years 1990-2100

[As a percentage of taxable payroll]

Calendar year	OASI			DI			OASDI		
	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]
Historical data:									
1990	11.47	9.65	1.82	1.18	1.09	0.10	12.65	10.74	1.91
1995	10.65	10.23	.42	1.87	1.44	.43	12.52	11.67	.85
2000	10.85	8.98	1.87	1.78	1.42	.36	12.62	10.40	2.23
2005	10.96	9.31	1.65	1.84	1.85	-.02	12.80	11.16	1.63
2010	10.75	11.06	-.30	1.79	2.41	-.62	12.54	13.47	-.92
2011	10.83	11.04	-.21	1.80	2.42	-.62	12.63	13.46	-.83
2012	11.05	11.35	-.30	1.81	2.47	-.66	12.85	13.82	-.96
2013	10.96	11.53	-.57	1.81	2.43	-.63	12.77	13.97	-1.20
2014	10.95	11.59	-.64	1.81	2.35	-.55	12.76	13.95	-1.19
2015	11.02	11.64	-.62	1.81	2.27	-.47	12.82	13.91	-1.09
2016	10.70	11.70	-.99	2.39	2.20	.19	13.09	13.89	-.80
2017	10.64	11.56	-.92	2.42	2.09	.33	13.06	13.65	-.59
2018	10.27	11.69	-1.41	2.32	2.01	.31	12.60	13.69	-1.10
2019	10.97	11.90	-.93	1.84	1.93	-.09	12.81	13.83	-1.02
2020	11.59	12.44	-.85	1.90	1.89	.01	13.49	14.33	-.84
2021	10.65	12.19	-1.54	1.74	1.73	[c]	12.38	13.92	-1.54
Intermediate:									
2022	11.00	12.40	-1.40	1.80	1.66	.14	12.79	14.05	-1.26
2023	11.21	12.67	-1.46	1.83	1.64	.19	13.04	14.31	-1.27
2024	11.14	12.82	-1.68	1.82	1.63	.19	12.95	14.45	-1.49
2025	11.15	13.01	-1.86	1.81	1.64	.17	12.97	14.66	-1.69
2026	11.26	13.22	-1.96	1.82	1.66	.16	13.08	14.88	-1.80
2027	11.28	13.43	-2.14	1.82	1.68	.14	13.10	15.10	-2.00
2028	11.32	13.66	-2.34	1.82	1.67	.15	13.14	15.33	-2.19
2029	11.35	13.88	-2.52	1.82	1.65	.17	13.17	15.53	-2.35
2030	11.38	14.09	-2.71	1.82	1.63	.19	13.20	15.72	-2.52
2031	11.41	14.28	-2.87	1.82	1.62	.20	13.23	15.91	-2.67
2035	11.45	14.76	-3.31	1.82	1.66	.17	13.27	16.42	-3.15
2040	11.47	14.98	-3.50	1.83	1.74	.08	13.30	16.72	-3.42
2045	11.48	14.95	-3.47	1.83	1.87	-.04	13.31	16.82	-3.51
2050	11.49	15.01	-3.52	1.83	1.94	-.11	13.32	16.95	-3.63
2055	11.50	15.17	-3.67	1.83	1.98	-.14	13.34	17.15	-3.81
2060	11.53	15.50	-3.98	1.83	1.95	-.11	13.36	17.45	-4.09
2065	11.55	15.80	-4.25	1.83	1.93	-.10	13.38	17.73	-4.35
2070	11.57	16.08	-4.51	1.83	1.93	-.09	13.40	18.00	-4.60
2075	11.59	16.36	-4.77	1.83	1.89	-.06	13.42	18.25	-4.83
2080	11.59	16.43	-4.84	1.83	1.87	-.04	13.43	18.30	-4.87
2085	11.58	16.24	-4.65	1.83	1.87	-.03	13.42	18.11	-4.69
2090	11.56	15.88	-4.32	1.83	1.91	-.08	13.40	17.79	-4.39
2095	11.55	15.69	-4.14	1.84	1.95	-.11	13.39	17.64	-4.25
2100	11.56	15.77	-4.21	1.84	1.96	-.12	13.39	17.73	-4.33
First year balance becomes negative and remains negative throughout the 75-year projection period			2010			2044			2010

Table IV.B1.—Annual Income Rates, Cost Rates, and Balances, Calendar Years 1990-2100 (Cont.)
[As a percentage of taxable payroll]

Calendar year	OASI			DI			OASDI		
	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]
Low-cost:									
2022.....	10.96	12.28	-1.32	1.79	1.63	0.16	12.75	13.91	-1.16
2023.....	11.21	12.38	-1.17	1.83	1.58	.25	13.04	13.96	-.92
2024.....	11.12	12.39	-1.27	1.81	1.53	.28	12.93	13.92	-.99
2025.....	11.12	12.42	-1.30	1.81	1.51	.31	12.93	13.93	-1.00
2026.....	11.21	12.47	-1.26	1.81	1.48	.34	13.03	13.95	-.92
2027.....	11.23	12.53	-1.30	1.81	1.45	.37	13.04	13.97	-.93
2028.....	11.26	12.60	-1.35	1.82	1.40	.42	13.07	14.00	-.93
2029.....	11.28	12.66	-1.39	1.82	1.35	.47	13.09	14.01	-.92
2030.....	11.29	12.72	-1.43	1.81	1.30	.52	13.11	14.02	-.91
2031.....	11.31	12.76	-1.45	1.81	1.26	.55	13.13	14.02	-.89
2035.....	11.33	12.84	-1.51	1.82	1.21	.60	13.15	14.06	-.91
2040.....	11.33	12.67	-1.33	1.82	1.24	.58	13.15	13.91	-.76
2045.....	11.32	12.31	-1.00	1.82	1.31	.51	13.14	13.62	-.49
2050.....	11.31	12.09	-.78	1.82	1.33	.49	13.13	13.42	-.29
2055.....	11.31	12.01	-.70	1.82	1.34	.48	13.13	13.35	-.22
2060.....	11.32	12.09	-.78	1.82	1.30	.52	13.14	13.40	-.26
2065.....	11.32	12.14	-.81	1.82	1.28	.54	13.14	13.42	-.28
2070.....	11.32	12.14	-.82	1.82	1.27	.55	13.14	13.42	-.27
2075.....	11.32	12.13	-.80	1.82	1.25	.57	13.14	13.37	-.23
2080.....	11.31	11.91	-.60	1.82	1.24	.58	13.13	13.15	-.02
2085.....	11.29	11.51	-.22	1.82	1.24	.58	13.11	12.75	.36
2090.....	11.26	11.08	.18	1.82	1.28	.54	13.08	12.36	.72
2095.....	11.25	10.97	.29	1.82	1.31	.52	13.08	12.27	.80
2100.....	11.26	11.12	.14	1.82	1.31	.52	13.09	12.43	.66
First year balance becomes negative and remains negative throughout the 75-year projection period.....			[d]	.....		[e]	.....		[d]
High-cost:									
2022.....	11.09	12.81	-1.72	1.81	1.72	.09	12.90	14.53	-1.63
2023.....	11.20	13.55	-2.35	1.82	1.79	.03	13.02	15.34	-2.31
2024.....	11.17	13.65	-2.48	1.82	1.80	.01	12.99	15.45	-2.46
2025.....	11.20	13.92	-2.72	1.82	1.86	-.04	13.02	15.78	-2.76
2026.....	11.32	14.22	-2.90	1.82	1.92	-.09	13.14	16.14	-3.00
2027.....	11.35	14.57	-3.21	1.82	1.98	-.16	13.17	16.54	-3.37
2028.....	11.40	14.98	-3.58	1.83	2.01	-.18	13.22	16.98	-3.76
2029.....	11.44	15.38	-3.94	1.83	2.02	-.19	13.27	17.40	-4.13
2030.....	11.48	15.79	-4.30	1.83	2.03	-.20	13.31	17.82	-4.50
2031.....	11.53	16.18	-4.65	1.83	2.05	-.22	13.36	18.22	-4.87

Table IV.B1.—Annual Income Rates, Cost Rates, and Balances, Calendar Years 1990-2100 (Cont.)
[As a percentage of taxable payroll]

Calendar year	OASI			DI			OASDI		
	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]	Income rate[a]	Cost rate[b]	Balance[b]
High-cost (Cont.):									
2035	11.59	17.15	-5.56	1.83	2.19	-0.35	13.43	19.34	-5.91
2040	11.65	17.92	-6.27	1.84	2.36	-.53	13.48	20.28	-6.80
2045	11.69	18.47	-6.78	1.84	2.59	-.75	13.53	21.06	-7.53
2050	11.73	19.11	-7.38	1.84	2.74	-.89	13.58	21.85	-8.27
2055	11.78	19.82	-8.03	1.85	2.84	-.99	13.63	22.65	-9.02
2060	11.84	20.66	-8.82	1.85	2.83	-.98	13.69	23.49	-9.80
2065	11.89	21.47	-9.58	1.85	2.84	-.99	13.74	24.32	-10.57
2070	11.95	22.35	-10.40	1.85	2.85	-1.00	13.80	25.21	-11.40
2075	12.02	23.32	-11.31	1.85	2.81	-.96	13.87	26.13	-12.27
2080	12.07	24.12	-12.05	1.85	2.76	-.91	13.92	26.89	-12.97
2085	12.10	24.60	-12.50	1.85	2.72	-.87	13.95	27.31	-13.36
2090	12.10	24.63	-12.53	1.85	2.73	-.88	13.96	27.36	-13.41
2095	12.10	24.48	-12.38	1.85	2.78	-.93	13.95	27.26	-13.31
2100	12.10	24.44	-12.35	1.85	2.81	-.96	13.95	27.25	-13.30
First year balance becomes negative and remains negative throughout the 75-year projection period			2010			2025			2010

[a] Income rates include certain reimbursements from the General Fund of the Treasury.

[b] Benefit payments scheduled to be paid on January 3 are actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[c] Between 0 and 0.005 percent of taxable payroll.

[d] The annual balance is projected to be negative for a temporary period and then return to positive levels before the end of the projection period.

[e] The annual balance is projected to be positive throughout the entire 75-year projection period.

Notes:
1. The income rate excludes interest income.
2. Revisions of taxable payroll may change some historical values.
3. Components may not sum to totals because of rounding.

Under the intermediate assumptions, the projected DI cost rate declines from 1.73 percent for 2021 to 1.66 percent for 2022 due primarily to changes in assumed near-term disability incidence rates. After 2022, the cost rate fluctuates, reaching 1.62 percent for 2031. Then the DI cost rate increases gradually to 1.98 percent for 2055. Thereafter, the cost rate remains relatively stable, decreasing slowly to 1.86 percent for 2083, and then increasing to 1.95 percent for 2096. The DI income rate in 2021 is relatively low, mainly from the decline in payroll tax contributions in 2021 reflecting the adjustment from lower-than-expected 2020 payroll tax contributions mentioned earlier. The DI income rate increases from 1.74 percent for 2021 to 1.83 percent for 2023, and is relatively stable thereafter, reaching 1.84 percent for 2096. The annual balance is between 0 and 0.005 percent of payroll in 2021, increases to 0.19 percent in 2024, and then fluctuates through 2032. After 2032, the annual balance declines and becomes negative in 2044. After 2044, the annual deficit increases to 0.14 percent in 2055,

decreases to 0.03 percent in 2083, and then increases to 0.12 percent of payroll for 2096.

Under the low-cost assumptions, the projected DI cost rate declines from 1.63 percent of payroll for 2022 to 1.21 percent for 2035 and then increases to 1.34 percent for 2053. The cost rate then declines through 2081 and increases slowly thereafter, reaching 1.31 percent for 2096. The annual balance is positive throughout the long-range period, reaching 0.52 percent of payroll for 2096. Under the high-cost assumptions, the DI cost rate rises from 1.72 percent of payroll in 2022 to 2.85 percent in 2057 and fluctuates thereafter, reaching 2.79 percent for 2096. The DI annual balance declines from 0.09 percent of payroll in 2022 and becomes negative in 2025, with a 0.04 percent annual deficit in 2025. After 2025, annual deficits increase to 1.00 percent of payroll in 2057 and fluctuate thereafter, reaching 0.94 percent for 2096.

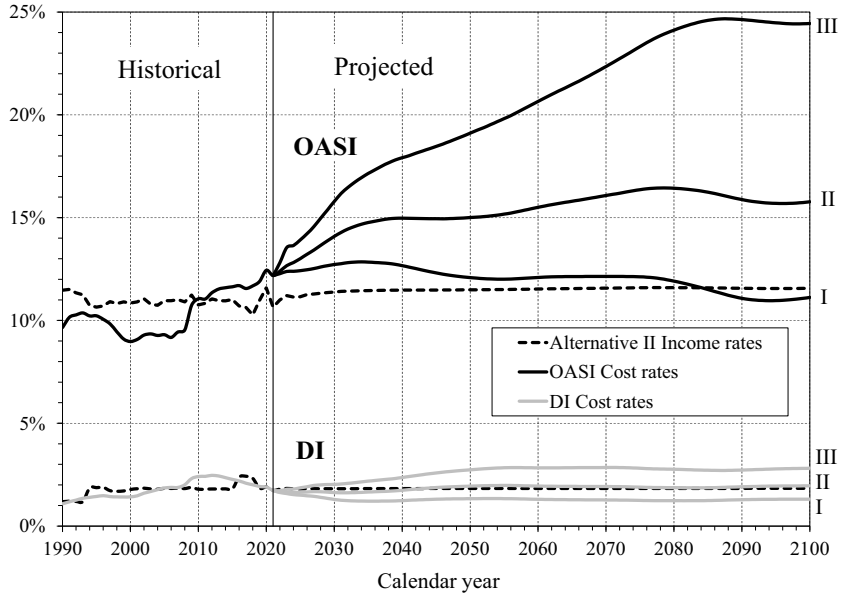
Figure IV.B1 shows the patterns of the historical and projected OASI and DI annual cost rates. The patterns in projected OASI and DI cost rates are described earlier in this chapter. Historical annual OASI cost rates shifted upward starting in 2008 and have remained at relatively high levels since then, primarily due to the retirement of the baby-boom generation. Historical annual DI cost rates rose substantially between 1990 and 2010 in large part due to: (1) aging of the working population as the baby-boom generation moved from ages 25-44 in 1990, where disability prevalence is low, to ages 45-64 in 2010, where disability prevalence is much higher; (2) a substantial increase in the percentage of women insured for DI benefits as a result of increased and more consistent rates of employment; and (3) increased disability incidence rates for women to a level similar to those for men by 2010. As of 2010, these three factors have largely stabilized. Other factors that are not yet fully understood, including the changing nature of work, have caused age-sex-adjusted incidence rates and cost rates to decline from 2010 to 2021. Figure IV.B1 shows only the income rates for alternative II because the variation in income rates by alternative is very small. Income rates generally increase slowly for each of the alternatives over the long-range period. Taxation of benefits, which is a small portion of income, is the main source of the increases in the income rate and the variation among the alternatives.

Table IV.B1 shows the annual balances for OASI, DI, and OASDI. The pattern of the annual balances is important to the analysis of the financial condition of the Social Security program as a whole. As seen in figure IV.B1, the magnitude of each of the positive balances is the distance between the appropriate cost-rate curve and the income-rate curve above it. The magnitude of each of the deficits is the distance between the appropriate cost-rate curve and the income-rate curve below it. Annual balances follow closely the pat-

tern of annual cost rates after 1990 because the payroll tax rate does not change for the OASDI program, with only small variations in the allocation between DI and OASI except for changes due to the 1994 and the 2016 through 2018 payroll tax rate reallocations.

In the future, the costs of OASI, DI, and the combined OASDI programs as a percentage of taxable payroll are unlikely to fall outside the range encompassed by alternatives I and III because alternatives I and III define a wide range of demographic and economic conditions.

Figure IV.B1.—Long-Range OASI and DI Annual Income Rates and Cost Rates
[As a percentage of taxable payroll]



Long-range OASDI cost and income are most often expressed as percentages of taxable payroll. However, the Trustees also present cost and income as shares of gross domestic product (GDP), the value of goods and services produced during the year in the United States. Under alternative II, the Trustees project OASDI cost to increase from about 5.0 percent of GDP for 2022 to about 6.0 percent for 2039. After 2039, OASDI cost as a percentage of GDP declines slightly through 2049, increases to a peak of 6.2 percent for 2077, and thereafter decreases slowly, reaching about 5.9 percent by 2096. Appendix G presents full estimates of income and cost relative to GDP.

Table IV.B2 contains historical and projected annual income rates and their components by trust fund and alternative. The annual income rates consist of the scheduled payroll tax rates, the rates of income from taxation of sched-

uled benefits, and the rates of income from General Fund reimbursements. Projected income from taxation of benefits increases over time for reasons discussed on page 152.

Table IV.B2.—Components of Annual Income Rates, Calendar Years 1990-2100
[As a percentage of taxable payroll]

	OASI				DI				OASDI			
Calendar year	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]
Historical data:												
1990 . .	11.29	0.21	-0.03	11.47	1.21	0.01	-0.03	1.18	12.50	0.21	-0.06	12.65
1995 . .	10.46	.19	-.01	10.65	1.87	.01	-.01	1.87	12.33	.20	-.01	12.52
2000 . .	10.56	.29	[d]	10.85	1.78	.02	-.02	1.78	12.34	.31	-.02	12.62
2005 . .	10.68	.29	-.01	10.96	1.81	.02	[d]	1.84	12.49	.31	-.01	12.80
2010 . .	10.30	.42	.04	10.75	1.75	.04	.01	1.79	12.05	.45	.05	12.54
2011 . .	8.82	.41	1.61	10.83	1.50	.03	.27	1.80	10.32	.44	1.88	12.63
2012 . .	8.86	.47	1.72	11.05	1.51	.01	.29	1.81	10.36	.48	2.01	12.85
2013 . .	10.54	.35	.07	10.96	1.79	.01	.01	1.81	12.33	.36	.08	12.77
2014 . .	10.49	.45	.01	10.95	1.78	.03	[d]	1.81	12.27	.48	.01	12.76
2015 . .	10.54	.47	[d]	11.02	1.79	.02	[d]	1.81	12.33	.49	.01	12.82
2016 . .	10.23	.48	[d]	10.70	2.37	.02	[d]	2.39	12.60	.49	[d]	13.09
2017 . .	10.12	.51	[d]	10.64	2.39	.03	[d]	2.42	12.52	.54	[d]	13.06
2018 . .	9.80	.47	[d]	10.27	2.32	.01	[d]	2.32	12.12	.48	[d]	12.60
2019 . .	10.51	.46	[d]	10.97	1.82	.02	[d]	1.84	12.33	.48	[d]	12.81
2020 . .	11.08	.51	[d]	11.59	1.88	.02	[d]	1.90	12.96	.53	[d]	13.49
2021 . .	10.19	.45	[d]	10.65	1.73	.01	[d]	1.74	11.93	.46	[d]	12.38
Intermediate:												
2022 . .	10.48	.52	[d]	11.00	1.78	.02	[d]	1.80	12.26	.53	[d]	12.79
2023 . .	10.67	.54	[d]	11.21	1.81	.02	[d]	1.83	12.48	.55	[d]	13.04
2024 . .	10.58	.56	[d]	11.14	1.80	.02	[d]	1.82	12.38	.57	[d]	12.95
2025 . .	10.58	.58	[d]	11.15	1.80	.02	[d]	1.81	12.37	.60	[d]	12.97
2026 . .	10.58	.68	[d]	11.26	1.80	.02	[d]	1.82	12.38	.70	[d]	13.08
2027 . .	10.57	.71	[d]	11.28	1.80	.02	[d]	1.82	12.37	.73	[d]	13.10
2028 . .	10.58	.74	[d]	11.32	1.80	.02	[d]	1.82	12.38	.76	[d]	13.14
2029 . .	10.59	.77	[d]	11.35	1.80	.02	[d]	1.82	12.38	.79	[d]	13.17
2030 . .	10.58	.80	[d]	11.38	1.80	.02	[d]	1.82	12.38	.82	[d]	13.20
2031 . .	10.58	.83	[d]	11.41	1.80	.02	[d]	1.82	12.37	.86	[d]	13.23
2035 . .	10.58	.87	[d]	11.45	1.80	.03	[d]	1.82	12.38	.90	[d]	13.27
2040 . .	10.58	.89	[d]	11.47	1.80	.03	[d]	1.83	12.38	.92	[d]	13.30
2045 . .	10.58	.90	[d]	11.48	1.80	.03	[d]	1.83	12.38	.93	[d]	13.31
2050 . .	10.58	.91	[d]	11.49	1.80	.03	[d]	1.83	12.38	.94	[d]	13.32
2055 . .	10.58	.92	[d]	11.50	1.80	.04	[d]	1.83	12.38	.96	[d]	13.34
2060 . .	10.58	.95	[d]	11.53	1.80	.04	[d]	1.83	12.38	.98	[d]	13.36
2065 . .	10.58	.97	[d]	11.55	1.80	.04	[d]	1.83	12.38	1.01	[d]	13.38
2070 . .	10.58	.99	[d]	11.57	1.80	.04	[d]	1.83	12.38	1.03	[d]	13.40
2075 . .	10.58	1.01	[d]	11.59	1.80	.04	[d]	1.83	12.38	1.05	[d]	13.42
2080 . .	10.58	1.02	[d]	11.59	1.80	.04	[d]	1.83	12.38	1.05	[d]	13.43
2085 . .	10.58	1.01	[d]	11.58	1.80	.04	[d]	1.83	12.38	1.04	[d]	13.42
2090 . .	10.58	.98	[d]	11.56	1.80	.04	[d]	1.83	12.37	1.02	[d]	13.40
2095 . .	10.58	.97	[d]	11.55	1.80	.04	[d]	1.84	12.37	1.01	[d]	13.39
2100 . .	10.58	.98	[d]	11.56	1.80	.04	[d]	1.84	12.38	1.02	[d]	13.39
Low-cost:												
2022 . .	10.45	.51	[d]	10.96	1.77	.02	[d]	1.79	12.22	.53	[d]	12.75
2023 . .	10.69	.52	[d]	11.21	1.81	.02	[d]	1.83	12.50	.54	[d]	13.04
2024 . .	10.58	.54	[d]	11.12	1.80	.02	[d]	1.81	12.38	.55	[d]	12.93
2025 . .	10.57	.55	[d]	11.12	1.79	.02	[d]	1.81	12.36	.57	[d]	12.93

Table IV.B2.—Components of Annual Income Rates, Calendar Years 1990-2100 (Cont.)
[As a percentage of taxable payroll]

Calendar year	OASI				DI				OASDI			
	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]	Payroll tax	Taxation of benefits[a]	General Fund Reimbursements[b]	Total[c]
Low-cost (Cont.):												
2026 . .	10.57	0.64	[d]	11.21	1.80	0.02	[d]	1.81	12.37	0.66	[d]	13.03
2027 . .	10.57	.66	[d]	11.23	1.79	.02	[d]	1.81	12.36	.68	[d]	13.04
2028 . .	10.57	.68	[d]	11.26	1.80	.02	[d]	1.82	12.37	.70	[d]	13.07
2029 . .	10.58	.70	[d]	11.28	1.80	.02	[d]	1.82	12.37	.72	[d]	13.09
2030 . .	10.57	.72	[d]	11.29	1.80	.02	[d]	1.81	12.37	.74	[d]	13.11
2031 . .	10.57	.74	[d]	11.31	1.80	.02	[d]	1.81	12.37	.76	[d]	13.13
2035 . .	10.57	.76	[d]	11.33	1.80	.02	[d]	1.82	12.37	.78	[d]	13.15
2040 . .	10.57	.76	[d]	11.33	1.80	.02	[d]	1.82	12.37	.78	[d]	13.15
2045 . .	10.57	.75	[d]	11.32	1.80	.02	[d]	1.82	12.37	.77	[d]	13.14
2050 . .	10.57	.74	[d]	11.31	1.80	.02	[d]	1.82	12.37	.76	[d]	13.13
2055 . .	10.57	.74	[d]	11.31	1.80	.03	[d]	1.82	12.37	.76	[d]	13.13
2060 . .	10.57	.74	[d]	11.32	1.80	.03	[d]	1.82	12.37	.77	[d]	13.14
2065 . .	10.57	.75	[d]	11.32	1.80	.03	[d]	1.82	12.37	.77	[d]	13.14
2070 . .	10.57	.75	[d]	11.32	1.80	.03	[d]	1.82	12.37	.78	[d]	13.14
2075 . .	10.57	.75	[d]	11.32	1.80	.02	[d]	1.82	12.37	.78	[d]	13.14
2080 . .	10.57	.74	[d]	11.31	1.80	.02	[d]	1.82	12.37	.76	[d]	13.13
2085 . .	10.57	.71	[d]	11.29	1.80	.03	[d]	1.82	12.37	.74	[d]	13.11
2090 . .	10.57	.69	[d]	11.26	1.80	.03	[d]	1.82	12.37	.71	[d]	13.08
2095 . .	10.57	.68	[d]	11.25	1.80	.03	[d]	1.82	12.37	.71	[d]	13.08
2100 . .	10.57	.69	[d]	11.26	1.80	.03	[d]	1.82	12.37	.72	[d]	13.09
High-cost:												
2022 . .	10.55	.53	[d]	11.09	1.79	.02	[d]	1.81	12.35	.55	[d]	12.90
2023 . .	10.63	.57	[d]	11.20	1.80	.02	[d]	1.82	12.43	.59	[d]	13.02
2024 . .	10.58	.59	[d]	11.17	1.80	.02	[d]	1.82	12.38	.61	[d]	12.99
2025 . .	10.58	.62	[d]	11.20	1.80	.02	[d]	1.82	12.38	.64	[d]	13.02
2026 . .	10.58	.73	[d]	11.32	1.80	.03	[d]	1.82	12.38	.76	[d]	13.14
2027 . .	10.58	.77	[d]	11.35	1.80	.03	[d]	1.82	12.38	.80	[d]	13.17
2028 . .	10.59	.81	[d]	11.40	1.80	.03	[d]	1.83	12.39	.84	[d]	13.22
2029 . .	10.59	.85	[d]	11.44	1.80	.03	[d]	1.83	12.39	.88	[d]	13.27
2030 . .	10.59	.90	[d]	11.48	1.80	.03	[d]	1.83	12.38	.93	[d]	13.31
2031 . .	10.59	.94	[d]	11.53	1.80	.03	[d]	1.83	12.38	.97	[d]	13.36
2035 . .	10.59	1.01	[d]	11.59	1.80	.03	[d]	1.83	12.38	1.04	[d]	13.43
2040 . .	10.59	1.06	[d]	11.65	1.80	.04	[d]	1.84	12.38	1.10	[d]	13.48
2045 . .	10.59	1.10	[d]	11.69	1.80	.04	[d]	1.84	12.38	1.15	[d]	13.53
2050 . .	10.59	1.15	[d]	11.73	1.80	.05	[d]	1.84	12.38	1.19	[d]	13.58
2055 . .	10.59	1.20	[d]	11.78	1.80	.05	[d]	1.85	12.38	1.25	[d]	13.63
2060 . .	10.59	1.25	[d]	11.84	1.80	.05	[d]	1.85	12.38	1.30	[d]	13.69
2065 . .	10.59	1.31	[d]	11.89	1.80	.05	[d]	1.85	12.38	1.36	[d]	13.74
2070 . .	10.59	1.36	[d]	11.95	1.80	.05	[d]	1.85	12.38	1.42	[d]	13.80
2075 . .	10.59	1.43	[d]	12.02	1.80	.05	[d]	1.85	12.39	1.48	[d]	13.87
2080 . .	10.59	1.48	[d]	12.07	1.80	.05	[d]	1.85	12.39	1.53	[d]	13.92
2085 . .	10.59	1.51	[d]	12.10	1.80	.05	[d]	1.85	12.38	1.56	[d]	13.95
2090 . .	10.59	1.52	[d]	12.10	1.80	.05	[d]	1.85	12.38	1.57	[d]	13.96
2095 . .	10.59	1.51	[d]	12.10	1.80	.05	[d]	1.85	12.38	1.57	[d]	13.95
2100 . .	10.59	1.51	[d]	12.10	1.80	.06	[d]	1.85	12.38	1.57	[d]	13.95

[a] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in the law.
[b] Includes payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96, and other miscellaneous reimbursements.
[c] Values exclude interest income.
[d] Between 0 and 0.005 percent of taxable payroll.

Note: Components may not sum to totals because of rounding.

2. Comparison of Workers to Beneficiaries

Under the intermediate assumptions, the Trustees project that the OASDI cost rate will rise rapidly between 2022 and 2038, primarily because the number of beneficiaries rises much more rapidly than the number of covered workers as the baby-boom generation retires. The ratio of OASDI beneficiaries to workers is dominated by the OASI program because all workers eventually die or retire, but only a relatively small minority become disabled. The trends described below are primarily due to demographic changes and thus affect the DI program roughly 20 years earlier than the OASI and OASDI programs. The baby-boom generation had lower fertility rates than their parents, and the Trustees expect that lower fertility rates will persist for all future generations; therefore, the ratio of OASDI beneficiaries to workers will rise rapidly and reach a permanently higher level after all of the baby-boom generation has retired. Due to increasing longevity, the ratio of beneficiaries to workers will generally rise slowly thereafter. Table IV.B3 provides a comparison of the numbers of covered workers and beneficiaries.

Table IV.B3.—Covered Workers and Beneficiaries, Calendar Years 1945-2100

Calendar year	Covered workers[a] (in thousands)	Beneficiaries[b] (in thousands)			Covered workers per OASDI beneficiary	OASDI beneficiaries per 100 covered workers
		OASI	DI	OASDI[c]		
Historical data:						
1945	46,390	1,106	-	1,106	41.9	2
1950	48,280	2,930	-	2,930	16.5	6
1955	65,066	7,564	-	7,564	8.6	12
1960	72,371	13,740	522	14,262	5.1	20
1965	80,539	18,509	1,648	20,157	4.0	25
1970	92,963	22,618	2,568	25,186	3.7	27
1975	100,193	26,998	4,125	31,123	3.2	31
1980	112,651	30,384	4,734	35,117	3.2	31
1985	120,437	32,763	3,874	36,636	3.3	30
1990	133,004	35,255	4,204	39,459	3.4	30
1995	140,798	37,364	5,731	43,096	3.3	31
2000	154,703	38,556	6,606	45,162	3.4	29
2005	159,034	39,961	8,172	48,133	3.3	30
2010	157,063	43,440	9,958	53,398	2.9	34
2011	158,604	44,388	10,428	54,816	2.9	35
2012	160,763	45,377	10,799	56,176	2.9	35
2013	163,086	46,517	10,954	57,471	2.8	35
2014	165,461	47,603	10,971	58,574	2.8	35
2015	168,169	48,663	10,881	59,543	2.8	35
2016	170,687	49,811	10,728	60,539	2.8	35
2017	172,744	50,962	10,517	61,480	2.8	36
2018	175,215	52,168	10,296	62,464	2.8	36
2019	176,506	53,508	10,063	63,570	2.8	36
2020	174,479	54,843	9,844	64,686	2.7	37
2021	179,256	55,546	9,486	65,032	2.8	36
Intermediate:						
2022	182,300	56,586	9,103	65,689	2.8	36
2025	183,809	60,687	8,926	69,613	2.6	38
2030	186,359	67,361	9,465	76,826	2.4	41
2035	188,698	71,872	9,810	81,682	2.3	43
2040	190,509	74,163	10,425	84,588	2.3	44

Table IV.B3.—Covered Workers and Beneficiaries, Calendar Years 1945-2100 (Cont.)

Calendar year	Covered workers[a] (in thousands)	Beneficiaries[b] (in thousands)			Covered workers per OASDI beneficiary	OASDI beneficiaries per 100 covered workers
		OASI	DI	OASDI[c]		
Intermediate (Cont.):						
2045	192,949	75,112	11,354	86,465	2.2	45
2050	196,372	76,576	12,009	88,585	2.2	45
2055	200,215	78,811	12,489	91,300	2.2	46
2060	204,245	82,062	12,613	94,675	2.2	46
2065	208,016	85,175	12,784	97,959	2.1	47
2070	211,599	88,268	12,976	101,245	2.1	48
2075	215,301	91,422	13,037	104,458	2.1	49
2080	219,668	93,560	13,193	106,753	2.1	49
2085	224,955	94,554	13,503	108,057	2.1	48
2090	230,862	94,908	14,150	109,058	2.1	47
2095	236,829	96,295	14,749	111,043	2.1	47
2100	242,393	98,979	15,168	114,147	2.1	47
Low-cost:						
2022	182,867	56,577	9,093	65,671	2.8	36
2025	185,650	60,600	8,683	69,282	2.7	37
2030	189,850	67,017	8,369	75,386	2.5	40
2035	193,237	70,871	8,178	79,049	2.4	41
2040	196,352	72,490	8,407	80,897	2.4	41
2045	201,229	72,732	9,018	81,751	2.5	41
2050	207,756	73,526	9,463	82,989	2.5	40
2055	214,885	75,209	9,810	85,018	2.5	40
2060	222,174	77,899	9,919	87,818	2.5	40
2065	229,252	80,457	10,105	90,562	2.5	40
2070	236,460	82,969	10,350	93,319	2.5	39
2075	244,398	85,468	10,557	96,025	2.5	39
2080	253,726	86,966	10,880	97,846	2.6	39
2085	264,612	87,403	11,410	98,812	2.7	37
2090	276,253	87,847	12,237	100,084	2.8	36
2095	287,594	90,396	12,920	103,316	2.8	36
2100	298,332	94,717	13,434	108,152	2.8	36
High-cost:						
2022	178,934	56,598	9,116	65,714	2.7	37
2025	180,423	60,807	9,266	70,073	2.6	39
2030	183,166	67,830	10,496	78,325	2.3	43
2035	184,640	73,199	11,483	84,681	2.2	46
2040	185,211	76,475	12,445	88,920	2.1	48
2045	184,997	78,534	13,662	92,195	2.0	50
2050	184,913	81,103	14,504	95,607	1.9	52
2055	184,922	84,294	15,092	99,385	1.9	54
2060	185,121	88,285	15,172	103,457	1.8	56
2065	184,940	92,074	15,246	107,320	1.7	58
2070	184,252	95,887	15,247	111,134	1.7	60
2075	183,085	99,703	14,978	114,681	1.6	63
2080	181,859	102,501	14,675	117,176	1.6	64
2085	180,977	103,916	14,393	118,309	1.5	65
2090	180,511	103,807	14,417	118,224	1.5	65
2095	180,311	103,167	14,655	117,822	1.5	65
2100	180,102	103,022	14,778	117,799	1.5	65

[a] Workers who are paid at some time during the year for employment on which OASDI taxes are due.

[b] Beneficiaries with monthly benefits in current-payment status as of June 30.

[c] This column is the sum of OASI and DI beneficiaries. A small number of beneficiaries receive benefits from both funds.

Notes:

1. The number of beneficiaries does not include uninsured individuals who received benefits under section 228 of the Social Security Act. The General Fund of the Treasury reimbursed the trust funds for the costs of most of these individuals.
2. Historical covered worker and beneficiary data are subject to revision.
3. Components may not sum to totals because of rounding.

The effect of the demographic shift under the three alternatives on the OASDI cost rates is clear when one considers the projected number of OASDI beneficiaries per 100 covered workers. Compared to the 2021 level of 36 beneficiaries per 100 covered workers, the Trustees project that this ratio rises to 44 by 2038 under the intermediate assumptions because the growth in beneficiaries greatly exceeds the growth in workers. This projected ratio continues to rise through 2078 and then generally declines, reaching 47 under the intermediate assumptions by 2100. Under the high-cost assumptions, this ratio generally rises to 65 by 2100. Under the low-cost assumptions, this ratio rises to 41 by 2038 and then generally declines, reaching 36 by 2100. Figure IV.B2 shows beneficiaries per 100 covered workers.

For each alternative, the curve in figure IV.B2 is strikingly similar to the corresponding cost-rate curve in figure IV.B1. This similarity emphasizes the extent to which the cost rate is determined by the age distribution of the population. The cost rate is essentially the product of the number of beneficiaries and their average benefit, divided by the product of the number of covered workers and their average taxable earnings. For this reason, the pattern of the annual cost rates is similar to that of the annual ratios of beneficiaries to workers.

Figure IV.B2.—Number of OASDI Beneficiaries Per 100 Covered Workers

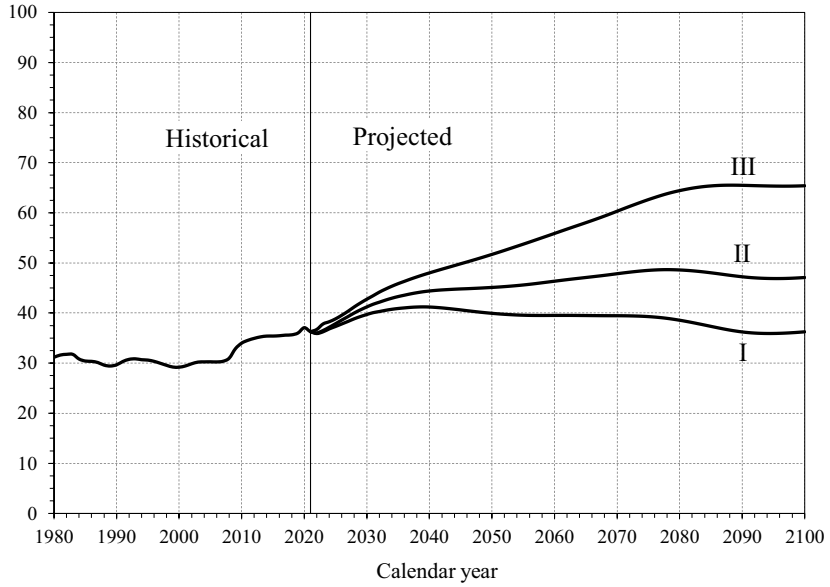


Table IV.B3 also shows the number of covered workers per OASDI beneficiary, which was about 2.8 for 2021. Under the intermediate assumptions,

this ratio declines generally throughout the long-range period, reaching 2.3 for 2038 and 2.1 by 2100. Under the low-cost assumptions, this ratio declines to 2.4 for 2038, then generally rises to 2.8 by 2100. Under the high-cost assumptions, this ratio decreases to 1.5 by 2100.

3. Trust Fund Ratios and Test of Long-Range Close Actuarial Balance

Trust fund ratios are critical indicators of the adequacy of the financial resources of the Social Security program. The trust fund ratio for a year is the amount of asset reserves in a fund at the beginning of a year expressed as a percentage of the cost for the year. Under present law, the OASI and DI Trust Funds do not have the authority to borrow other than in the form of advance tax transfers, which are limited to expected taxes for the current calendar month. If reserves held in either trust fund become depleted during a year, and continuing revenue falls short of the cost of scheduled benefits, then full scheduled benefits would not be payable on a timely basis. For this reason, the trust fund ratio is a critical financial measure.

The trust fund ratio serves an additional important purpose in assessing the actuarial status of the program. If the projected trust fund ratio is positive throughout the period and is either level or increasing at the end of the period, then projected adequacy for the long-range period is likely to continue for subsequent reports. Under these conditions, the program has achieved sustainable solvency.

Table IV.B4 shows the Trustees' projections of trust fund ratios by alternative, without regard to advance tax transfers that would be effected, for the separate and combined OASI and DI Trust Funds. The table also shows the years of trust fund reserve depletion and the percentage of scheduled benefits that would be payable thereafter, by alternative.

Under the intermediate assumptions, the OASI trust fund ratio is projected to decline from 251 percent at the beginning of 2022 until the trust fund reserves become depleted in 2034 (one year later than projected in last year's report), at which time 77 percent of scheduled benefits would be payable. The DI Trust Fund remains solvent throughout the long-range period, compared to a depletion date of 2057 in last year's report. The DI trust fund ratio increases from 68 percent at the beginning of 2022 to a peak of 231 percent in 2043. After 2043, the DI trust fund ratio declines throughout the remainder of the long-range period, reaching 47 percent in 2097. The change in reserve depletion year for the OASI Trust Fund to 2034, compared to 2033 in last year's report, is due primarily to (1) lower cost as a percentage of taxable payroll over several years in the near-term, and (2) higher projected revenue from taxation of benefits. The change from the DI reserve depletion year of 2057 projected in last year's report to 75-year solvency of the DI program in

this year's report occurs primarily because of (1) the reduction in the assumed ultimate disability incidence rate, from 5.0 to 4.8 per 1,000 exposed, and (2) changes in the near-term assumed disability incidence rates.

Under the intermediate assumptions, the trust fund ratio for the combined OASI and DI Trust Funds declines from 230 percent at the beginning of 2022 until the combined fund reserves become depleted early in 2035 (one year later than projected in last year's report), at which time 80 percent of scheduled benefits would be payable.

Under the low-cost assumptions, the trust fund ratio for the DI program increases from 2022 throughout the remainder of the projection period, from 68 percent at the beginning of 2022 to the extremely high level of 3,359 percent for 2097. For the OASI program, the trust fund ratio declines steadily, from 251 percent for 2022 until the reserves become depleted in 2039, at which time 88 percent of scheduled benefits would be payable. For the combined OASDI program, the trust fund ratio declines from 230 percent for 2022 until the combined fund reserves become depleted in 2069. However, the trust funds would have sufficient income by the end of 2088 to permit full payment of scheduled benefits thereafter and also to pay in arrears the temporary shortfalls between 2069 and 2088. By 2089, trust fund reserves become positive and the trust fund ratio increases thereafter, to a ratio of 55 percent in 2097. Because the DI trust fund ratio is positive throughout the projection period and increasing at the end of the period, under the low-cost assumptions, only the DI program achieves sustainable solvency.

Under the high-cost assumptions, the OASI trust fund ratio declines from 251 percent for 2022 until reserves become depleted in 2031, at which time 69 percent of scheduled benefits would still be payable. The DI trust fund ratio declines from 71 percent for 2023 until the reserves become depleted in 2032. At that time, 88 percent of scheduled benefits would still be payable. The combined OASI and DI trust fund ratio declines from 229 percent for 2022 until reserves become depleted in 2031, at which time 72 percent of scheduled benefits would still be payable.

The Trustees project trust fund reserve depletion within the 75-year projection period for the OASI Trust Fund under the low-cost, intermediate, and high-cost assumptions, and for the DI Trust Fund under the high-cost assumptions. It is therefore very likely that lawmakers will need to increase income, reduce program costs, or both, in order to maintain solvency for the OASI Trust Fund. The stochastic projections discussed in appendix E suggest that OASI and combined OASI and DI Trust Fund reserve depletion is highly probable before mid-century.

In the 2021 report, the Trustees projected that the combined trust fund reserves would become depleted in 2031 and 2034 under the high-cost and intermediate assumptions, respectively, and would become temporarily depleted between 2061 and 2092 under the low-cost assumptions.

Table IV.B4.—Trust Fund Ratios, Calendar Years 2022-2100[a]
[In percent]

Calendar year	Intermediate			Low-cost			High-cost		
	OASI	DI	OASDI	OASI	DI	OASDI	OASI	DI	OASDI
2022	251	68	230	251	68	230	251	67	229
2023	228	75	211	227	77	210	227	71	209
2024	208	85	194	209	92	196	204	70	188
2025	188	93	177	191	108	182	180	68	167
2026	167	100	160	173	127	168	155	63	144
2027	147	107	143	157	149	157	130	56	122
2028	127	114	126	142	177	146	105	47	98
2029	107	123	109	128	211	136	79	38	74
2030	87	134	91	114	251	127	52	28	49
2031	66	145	74	101	297	118	25	18	24
2035	[b]	189	3	52	497	91	[b]	[b]	[b]
2040	[b]	227	[b]	[b]	738	64	[b]	[b]	[b]
2045	[b]	228	[b]	[b]	929	44	[b]	[b]	[b]
2050	[b]	210	[b]	[b]	1,118	32	[b]	[b]	[b]
2055	[b]	183	[b]	[b]	1,316	25	[b]	[b]	[b]
2060	[b]	158	[b]	[b]	1,563	17	[b]	[b]	[b]
2065	[b]	138	[b]	[b]	1,821	8	[b]	[b]	[b]
2070	[b]	120	[b]	[b]	2,086	[b]	[b]	[b]	[b]
2075	[b]	105	[b]	[b]	2,387	[b]	[b]	[b]	[b]
2080	[b]	98	[b]	[b]	2,684	[b]	[b]	[b]	[b]
2085	[b]	93	[b]	[b]	2,930	[b]	[b]	[b]	[b]
2090	[b]	81	[b]	[b]	3,080	10	[b]	[b]	[b]
2095	[b]	58	[b]	[b]	3,267	42	[b]	[b]	[b]
2100	[b]	30	[b]	[b]	3,511	73	[b]	[b]	[b]
Trust fund reserves permanently become depleted in	2034	[c]	2035	2039	[c]	[d]	2031	2032	2031
Payable benefits as percent of scheduled benefits:									
At the time of permanent reserve depletion	77	[c]	80	88	[c]	[d]	69	88	72
For 2096	72	[c]	74	100	[c]	[d]	46	66	48

[a] Benefit payments scheduled to be paid on January 3 are actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund ratios reflect the 12 months of benefits scheduled for payment each year.

[b] Trust fund reserves would be depleted at the beginning of this year.

[c] Trust fund reserves would not be depleted within the projection period.

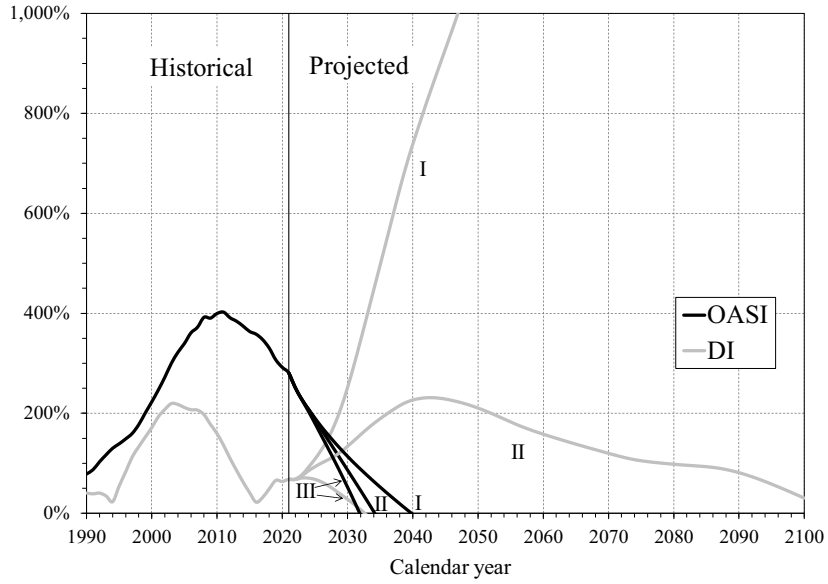
[d] Trust fund reserves would be depleted for a temporary period, and return to positive levels before the end of the period.

Note: The definition of trust fund ratio appears in the Glossary. The ratios shown for the combined trust funds for years after reserve depletion of either the DI or OASI Trust Fund are hypothetical.

Since 2013, when the Trustees modified the test of long-range close actuarial balance, the standard for each trust fund requires meeting two conditions: (1) the test of short-range financial adequacy is satisfied; and (2) the trust fund ratios stay above zero throughout the 75-year projection period, allowing scheduled benefits to be paid in a timely manner throughout the period. Both the long-range test and the short-range test are applied based on the intermediate set of assumptions. As discussed in section IV.A, the DI Trust Fund passes the test of short-range financial adequacy because the trust fund ratio, while below 100 percent at the beginning of the projection period, reaches 100 percent within 5 years and stays above 100 percent throughout the remainder of the 10-year period. The OASI and combined OASI and DI Trust Funds fail the test of short-range financial adequacy because the trust fund ratios drop below 100 percent by the end of the 10-year period. Under the intermediate assumptions, the OASI Trust Fund reserves become depleted in 2034, DI Trust Fund reserves stay positive throughout the 75-year period, and the combined OASI and DI Trust Fund reserves become depleted in 2035. Therefore, the OASI and combined OASI and DI Trust Funds fail the test of long-range close actuarial balance, and the DI program passes the test of long-range close actuarial balance.

Figure IV.B3 illustrates the trust fund ratios for the separate OASI and DI Trust Funds for each of the alternative sets of assumptions. DI Trust Fund status is more uncertain than OASI Trust Fund status because there is a high degree of uncertainty associated with future disability prevalence. A graph of the trust fund ratios for the combined trust funds appears in figure II.D6.

Figure IV.B3.—Long-Range OASI and DI Trust Fund Ratios
[Asset reserves as a percentage of annual cost]



4. Summarized Income Rates, Summarized Cost Rates, and Actuarial Balances

Summarized values for the full 75-year period are useful in analyzing the program's long-range financial adequacy over the period as a whole, both under present law and under proposed modifications to the law. All annual amounts included in a summarized value are present-value discounted to the valuation date. It is important to note that the actuarial balance indicates the solvency status of the fund only for the very end of the period.

Table IV.B5 presents summarized income rates, summarized cost rates, and actuarial balances for 25-year, 50-year, and 75-year valuation periods. Summarized income rates are the sum of the present value of non-interest income for a period (which includes scheduled payroll taxes, the projected income from the taxation of scheduled benefits, and reimbursements from the General Fund of the Treasury) and the starting trust fund asset reserves, expressed as a percentage of the present value of taxable payroll over the period. Under current law, the total OASDI payroll tax rate will remain at 12.4 percent in the future. In contrast, the Trustees expect income from taxation of benefits, expressed as a percentage of taxable payroll, to increase in most years of the long-range period for the reasons discussed on page 152. Summarized cost rates are the sum of the present value of cost for a period

(which includes scheduled benefits, administrative expenses, net interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries) and the present value of the cost of reaching a target trust fund of 100 percent of annual cost at the end of the period, expressed as a percentage of the present value of taxable payroll over the period.

The actuarial balance for a valuation period is equal to the difference between the summarized income rate and the summarized cost rate for the period. An actuarial balance of zero for any period indicates that cost for the period could be met for the period as a whole (but not necessarily at all points within the period), with a remaining trust fund reserve at the end of the period equal to 100 percent of the following year's cost. A negative actuarial balance for a period indicates that the present value of income to the program plus the existing trust fund is less than the present value of the cost of the program plus the cost of reaching a target trust fund reserve of one year's cost by the end of the period. Generally, a trust fund is deemed to be adequately financed for a period if the actuarial balance is zero or positive, meaning that the reserves at the end of the period are at least equal to annual cost. Note that solvency is possible with a small negative actuarial balance where reserves are still positive.[1]

Table IV.B5 contains summarized rates for the intermediate, low-cost, and high-cost assumptions. The low-cost and high-cost assumptions define a wide range of possibilities. Financial outcomes as good as the low-cost scenario or as bad as the high-cost scenario are unlikely to occur.

For the 25-year valuation period, the OASDI program has an actuarial balance of -0.34 percent of taxable payroll under the low-cost assumptions, -2.24 percent under the intermediate assumptions, and -4.61 percent under the high-cost assumptions. These balances indicate that the program is not adequately financed for the 25-year valuation period under any of these three sets of assumptions.

For the 50-year valuation period, the OASDI program has actuarial balances of -0.27 percent under the low-cost assumptions, -3.02 percent under the intermediate assumptions, and -6.68 percent under the high-cost assump-

[1] A program is solvent over any period for which the trust fund maintains a positive level of asset reserves. In contrast, the actuarial balance for a period includes the cost of having a target fund equal to 100 percent of the following year's cost at the end of the period. Therefore, if a program ends the period with reserves that are positive but not sufficient to cover the following year's costs, it will be solvent at the end of the period and yet still have a small negative actuarial balance for that period.

tions. These actuarial balances mean that the OASDI program is not adequately financed for the 50-year valuation period under any of these three sets of assumptions.

For the entire 75-year valuation period, the combined OASDI program has actuarial balances of -0.07 percent of taxable payroll under the low-cost assumptions, -3.42 percent under the intermediate assumptions, and -8.09 percent under the high-cost assumptions. These balances indicate that the combined OASDI program is not adequately financed for the 75-year valuation period under any of these three sets of assumptions.

Assuming the intermediate assumptions accurately capture future demographic and economic trends, solvency for the program over the next 75 years could be restored using a variety of approaches. For example, revenue could be increased in a manner equivalent to an immediate and permanent increase in the combined Social Security payroll tax rate from 12.40 percent to 15.64 percent (a relative increase of 26.1 percent),[1] cost could be reduced in a manner equivalent to an immediate and permanent reduction in scheduled benefits of 20.3 percent, or some combination of approaches could be used.

However, eliminating the actuarial deficit for the next 75-year valuation period requires raising payroll taxes or lowering benefits by more than is required just to achieve solvency, because the actuarial deficit includes the cost of attaining a target trust fund equal to 100 percent of annual program cost by the end of the period. The actuarial deficit could be eliminated for the 75-year period by increasing revenue in a manner equivalent to an immediate and permanent increase in the combined payroll tax from 12.40 percent to 15.83 percent (a relative increase of 27.7 percent),[2] reducing cost in a manner equivalent to an immediate reduction in scheduled benefits of 21.2 percent, or some combination of approaches could be used.

Under the intermediate assumptions, the OASDI program has large annual deficits toward the end of the long-range period that reach 4.25 percent of payroll for 2096 (see table IV.B1). These large deficits indicate that annual cost continues to exceed non-interest income after 2096, so continued adequate financing would require larger changes than those needed to maintain solvency for the 75-year period. Over the period extending through the

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[1] The 3.24 percentage point increase in the payroll tax rate required to achieve 75-year solvency differs somewhat from the 3.42 percent actuarial deficit. This is primarily because the rate increase required to achieve 75-year solvency reflects a zero trust fund reserve at the end of the period, whereas the 3.42 percent actuarial deficit incorporates an ending trust fund reserve equal to one year's cost. While such an increase in the payroll tax rate would cause some behavioral changes in earnings and ensuing changes in benefit levels, such changes are not included in these calculations because they are assumed to have roughly offsetting effects on OASDI actuarial status over the 75-year long-range period as a whole.

[2] The calculation of the payroll tax rate increase required to eliminate the actuarial deficit also does not include the effects of behavioral changes, because they are assumed to have roughly offsetting effects.

infinite horizon, the actuarial deficit is 4.5 percent of payroll under the intermediate assumptions.

Table IV.B5.—Components of Summarized Income Rates and Cost Rates, Calendar Years 2022-2096
[As a percentage of taxable payroll]

	Summarized income rate			Summarized cost rate			
Valuation period	Non-interest income	Beginning asset reserves[a]	Total	Cost[a]	Ending target fund[a]	Total	Actuarial balance
OASI:							
Intermediate:							
2022-46.	11.39	1.12	12.51	14.27	0.58	14.84	-2.33
2022-71.	11.46	.60	12.06	14.81	.28	15.08	-3.02
2022-96.	11.50	.44	11.93	15.18	.16	15.34	-3.41
Low-cost:							
2022-46.	11.30	.99	12.29	12.60	.50	13.11	-.82
2022-71.	11.31	.51	11.82	12.36	.23	12.59	-.77
2022-96.	11.31	.35	11.66	12.11	.14	12.25	-.59
High-cost:							
2022-46.	11.51	1.30	12.81	16.36	.67	17.03	-4.23
2022-71.	11.65	.74	12.39	18.11	.34	18.45	-6.06
2022-96.	11.75	.56	12.32	19.53	.20	19.73	-7.41
DI:							
Intermediate:							
2022-46.	1.82	.04	1.86	1.70	.07	1.78	.09
2022-71.	1.83	.02	1.85	1.81	.03	1.85	[b]
2022-96.	1.83	.02	1.85	1.84	.02	1.86	-.01
Low-cost:							
2022-46.	1.82	.04	1.85	1.32	.05	1.38	.48
2022-71.	1.82	.02	1.84	1.32	.02	1.34	.50
2022-96.	1.82	.01	1.83	1.30	.02	1.32	.52
High-cost:							
2022-46.	1.83	.05	1.88	2.16	.10	2.26	-.38
2022-71.	1.84	.03	1.87	2.44	.04	2.48	-.62
2022-96.	1.84	.02	1.86	2.52	.02	2.54	-.68
OASDI:							
Intermediate:							
2022-46.	13.22	1.16	14.38	15.97	.65	16.62	-2.24
2022-71.	13.29	.62	13.91	16.62	.31	16.93	-3.02
2022-96.	13.33	.45	13.78	17.02	.18	17.20	-3.42
Low-cost:							
2022-46.	13.11	1.03	14.14	13.93	.56	14.48	-.34
2022-71.	13.13	.53	13.66	13.67	.25	13.93	-.27
2022-96.	13.13	.36	13.50	13.41	.15	13.56	-.07
High-cost:							
2022-46.	13.34	1.34	14.69	18.52	.77	19.29	-4.61
2022-71.	13.49	.76	14.25	20.56	.38	20.93	-6.68
2022-96.	13.60	.58	14.18	22.05	.22	22.27	-8.09

[a] Benefit payments scheduled to be paid on January 3 are actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[b] Between 0 and 0.005 percent of taxable payroll.

Note: Components may not sum to totals because of rounding.

5. Open-Group Unfunded Obligation

Consistent with practice since 1965, this report focuses on a 75-year open-group valuation to evaluate the long-run financial status of the OASDI program. The open-group valuation includes non-interest income and cost for past, current, and future participants through the year 2096. The open-group unfunded obligation measures the adequacy of financing over the period as a whole for a program financed on a pay-as-you-go basis. On this basis, payroll taxes and scheduled benefits for all participants are included through 2096.

The open-group unfunded obligation increased from $19.8 trillion shown in last year's report to $20.4 trillion in this report. If there had been no changes in starting values, assumptions, laws, or methods for this report, then the open-group unfunded obligation would have increased to $20.6 trillion solely due to the change in the valuation period. This expected increase in the unfunded obligation occurs because: (1) the unfunded obligation is now discounted to January 1, 2022, rather than to January 1, 2021, which tends to increase the unfunded obligation by the annual nominal interest rate; and (2) the unfunded obligation now includes an additional year (2096). However, changes in the law, assumptions, methods, and starting values resulted in a net $0.1 trillion decrease in the unfunded obligation.

The 75-year unfunded obligation is equivalent to 3.24 percent of OASDI taxable payroll and 1.1 percent of GDP for 2022-96.[1] These percentages were 3.35 and 1.2, respectively, for last year’s report. The 75-year unfunded obligation as a percentage of taxable payroll is less than the actuarial deficit, because the unfunded obligation excludes the cost of having an ending target trust fund value.

The actuarial deficit was 3.54 percent of payroll in last year’s report, and was expected to increase to a deficit of 3.59 percent of payroll solely due to the change in the valuation period. Changes in the law, assumptions, methods, and starting values combined to account for a 0.17 percentage point decrease (improvement) in the actuarial deficit to 3.42 percent of payroll. The actuarial deficit is 1.2 percent of GDP in this year’s report, the same as in last year’s report.

As mentioned above, the open-group unfunded obligation expressed in dollars is less than it would have been if only the valuation period had been

[1] The present value of taxable payroll for 2022-96 is $631.6 trillion. The present value of GDP for 2022-96 is $1,817.7 trillion. In last year’s report, the present value of taxable payroll for 2021-95 was $591.5 trillion and the present value of GDP was $1,698.0 trillion.

changed. This net decrease occurred for a variety of reasons described in the next section, including a reduction in near-term and ultimate assumed disability incidence rates and changes in economic data and assumptions.

Table IV.B6 presents the components and the calculation of the long-range (75-year) actuarial balance under the intermediate assumptions. The present value of future cost less future non-interest income over the long-range period, minus the amount of trust fund asset reserves at the beginning of the projection period, is $20.4 trillion for the OASDI program. This amount is the 75-year "open-group unfunded obligation" (see row H). The actuarial deficit (which is the negative of the actuarial balance) combines this unfunded obligation with the present value of the ending target trust fund and expresses the total as a percentage of the present value of the taxable payroll for the period. The present value of future non-interest income minus cost, plus starting trust fund reserves, minus the present value of the ending target trust fund, is -$21.6 trillion for the OASDI program.

Table IV.B6.—Components of 75-Year Actuarial Balance and Unfunded Obligation Under Intermediate Assumptions

Item	OASI	DI	OASDI
Present value as of January 1, 2022 (in billions):			
A. Payroll tax revenue	$66,872	$11,356	$78,227
B. Reimbursements from general revenue	[a]	[a]	[a]
C. Taxation of benefits revenue	5,738	206	5,944
D. Non-interest income (A + B + C)	72,610	11,562	84,172
E. Cost	95,868	11,605	107,473
F. Cost minus non-interest income (E - D)	23,258	43	23,301
G. Trust fund asset reserves at start of period	2,753	99	2,852
H. Open-group unfunded obligation (F - G)	20,505	-56	20,449
I. Ending target trust fund[b]	1,026	128	1,154
J. Income minus cost, plus reserves at start of period, minus ending target trust fund (D - E + G - I = - H - I)	-21,531	-72	-21,603
K. Taxable payroll	631,589	631,589	631,589
Percent of taxable payroll:			
Actuarial balance (100 × J ÷ K)	-3.41	-.01	-3.42

[a] Less than $0.5 billion.

[b] The calculation of the actuarial balance includes the cost of accumulating a target trust fund reserve equal to 100 percent of annual cost at the end of the period.

Note: Components may not sum to totals because of rounding.

Consideration of summary measures alone (such as the actuarial balance and open-group unfunded obligation) for a 75-year period can lead to incorrect perceptions and to policy prescriptions that do not achieve sustainable solvency. These concerns can be addressed by considering the trend in trust fund ratios toward the end of the period. (See the discussion of "sustainable solvency" beginning on page 53.)

Another measure of trust fund finances, discussed in appendix F, is the infinite horizon unfunded obligation, which takes account of all annual balances, even those after 75 years. The extension of the time period past

75 years assumes that the current-law OASDI program and the demographic and economic trends used for the 75-year projection continue indefinitely. This infinite horizon unfunded obligation is estimated to be 4.5 percent of taxable payroll or 1.4 percent of GDP. These percentages were 4.6 and 1.4, respectively, for last year's report. Of course, the degree of uncertainty associated with estimates increases substantially for years further in the future.

6. Reasons for Change in Actuarial Balance From Last Report

Table IV.B7 shows the effects of changes on the long-range actuarial balance under the intermediate assumptions, by category, between last year's report and this report.

Table IV.B7.—Reasons for Change in the 75-Year Actuarial Balance, Based on Intermediate Assumptions
[As a percentage of taxable payroll]

Item	OASI	DI	OASDI
Shown in last year's report:			
Income rate	11.93	1.85	13.78
Cost rate	15.39	1.92	17.31
Actuarial balance	**-3.46**	**-.08**	**-3.54**
Changes in actuarial balance due to changes in:			
Legislation / Regulation	.00	.00	.00
Valuation period[a]	-.05	-.01	-.06
Demographic data and assumptions	-.04	.00	-.04
Economic data and assumptions	.13	.00	.13
Disability data and assumptions	.00	.08	.07
Methods and programmatic data	.01	.00	.01
Total change in actuarial balance	.05	.07	.12
Shown in this report:			
Actuarial balance	**-3.41**	**-.01**	**-3.42**
Income rate	11.93	1.85	13.78
Cost rate	15.34	1.86	17.20

[a] The change in the 75-year valuation period from last year's report to this report means that the 75-year actuarial balance now includes the relatively large negative annual balance for 2096. This change in the valuation period results in a larger long-range actuarial deficit. The actuarial deficit includes the trust fund reserve at the beginning of the projection period.

Note: Components may not sum to totals because of rounding.

If the law, data, assumptions, and methods had all remained unchanged from last year's Trustees Report, the long-range OASDI actuarial balance would have decreased (worsened) by 0.06 percent of taxable payroll solely due to the change in the valuation period. However, as described below, projections in this report also reflect new data and changes in law, assumptions, and methods. These changes, including the change in the valuation period, combine to increase (improve) the long-range OASDI actuarial balance by 0.12 percentage point, from -3.54 percent of taxable payroll in last year's report to -3.42 percent in this report.

Legislation/Regulation

Changes in law, regulations, and policy have a negligible effect on the long-range OASDI actuarial balance.

Since the last report, there has been one change in policy that has a notable effect on program operations but has a negligible effect on the long-range actuarial balance. On July 16, 2021, pursuant to a United States District Court order, the Department of Homeland Security stopped approving first-time applications under the Deferred Action for Childhood Arrivals (DACA) policy but continues to approve renewal applications. On September 10, 2021, the Administration appealed the District Court ruling. Changes in DACA policy affect OASDI program operations because those who apply for and receive deferred action status are eligible for work authorization, which leads to additional workers covered by the OASDI program and increased payroll tax revenue. The estimates presented in last year's report reflected the assumption that the DACA program would be maintained in full, consistent with the Administration's intent. The estimates presented in this year's report continue to reflect the assumption that DACA will eventually be fully in effect. However, because of the court challenges, the estimates now incorporate a roughly one-year delay in resuming approval of new applications.

Valuation Period

As mentioned above, changing the 75-year valuation period from 2021 through 2095 for last year's report to 2022 through 2096 for this report decreases the projected long-range OASDI actuarial balance by 0.06 percent of taxable payroll. This decrease occurs because (1) the negative annual balances after trust fund reserve depletion are now discounted to January 1, 2022, rather than to January 1, 2021, and (2) the relatively large negative annual balance for 2096 is now included in this year's 75-year projection period. Note that the actuarial balance calculation includes trust fund reserves at the beginning of the projection period. These reserves reflect the program's net financial flows for all past years, including 2021, up to the start of the valuation period.

Demographic Data and Assumptions

New demographic data and changes in demographic assumptions combine to decrease (worsen) the long-range OASDI actuarial balance by 0.04 percent of taxable payroll.

The ultimate demographic assumptions are unchanged for this year's report. However, updates to near-term demographic data and assumptions result in significant changes in the long-range actuarial balance.

First, final birth data for calendar year 2020, the base year for the fertility rate projections, indicate slightly lower rates than were assumed in last year's report for 2020. These updated data for the base year, when considered alone, result in slightly lower projected birth rates during the transition period to the ultimate level, decreasing the actuarial balance by 0.01 percent of taxable payroll.

Second, updates to lawful permanent resident (LPR) immigration data and a small revision to near-term LPR immigration assumptions to better reflect the expected effects of the recovery from the pandemic combine to decrease the actuarial balance by 0.01 percent of taxable payroll.

Finally, updates to historical population data and other-than-LPR immigration data combine to decrease the actuarial balance by 0.02 percent of taxable payroll.

Economic Data and Assumptions

New economic data and changes in economic assumptions, in combination, increase the long-range OASDI actuarial balance by 0.13 percent of taxable payroll.

The ultimate economic assumptions are unchanged for this year's report. However, updates to near-term economic data and assumptions result in significant changes in the long-range actuarial balance.

An update to educational attainment data caused an increase in the long-range actuarial balance of 0.01 percent of taxable payroll. The level of educational attainment affects the modeled labor force participation rates for ages 55 and older for men and 50 and older for women; as the level of educational attainment rises, participation rates tend to increase.

The ultimate real interest rate assumption remains at 2.3 percent for this year's report. The real interest rates for calendar years 2021 through 2024 are assumed to be negative in this year's report, with a gradual rise to the ultimate real interest rate after the economy has fully recovered. These real interest rates are on average slightly higher for the short-range projection period 2022-31 than they were in last year's report for 2021-30, which increases the actuarial balance by 0.02 percent of payroll.

The level of potential GDP is assumed to be about 1.1 percent higher than the level projected in last year's report for 2021 and later, reflecting the stronger-than-expected recovery from the pandemic-induced recession and

the expectation of a permanent level shift in total economy labor productivity, compared to the assumption for last year's report. This change increases the actuarial balance by roughly 0.03 percent of taxable payroll.

Other changes to historical data and near-term economic assumptions combine for a net increase in the actuarial balance of about 0.06 percent of taxable payroll. The pandemic and ensuing recession had a dramatic effect on the economy in 2020. However, employment, earnings, and GDP recovered much faster late in 2020, 2021, and early 2022 than had been assumed in last year's report.

Disability Data and Assumptions

New disability data and changes in disability assumptions combine to increase the long-range OASDI actuarial balance by 0.07 percent of taxable payroll.

Disabled-worker application and incidence rates dropped substantially from 2010 through 2019 before the pandemic and have fallen even further in 2020 and 2021 during the pandemic. Applications and incidence rates since 2013 have been well below expectations and are not consistent with an assumption of a full rise back to longer-term past historical averages. Based on this experience, the Trustees reduced the ultimate disability incidence rate for this report from 5.0 to 4.8 per thousand exposed. In addition, recent disability data and changes to the near-term disability incidence assumptions have been incorporated. These changes have direct effects on the number of disability beneficiaries, increasing the actuarial balance by 0.06 percent of payroll.

These changes to the ultimate and near-term disability incidence assumptions were incorporated into the labor force participation model, leading to an additional increase in the long-range actuarial balance of 0.01 percent of taxable payroll. More specifically, the labor force model now uses this year's lower disability incidence assumptions and resulting lower disability prevalence projections. A decrease in disability prevalence increases the modeled labor force participation and employment rates.

These new disability data and changes in assumptions are almost entirely responsible for the change in the DI Trust Fund reserve depletion date, from 2057 in last year's report to not becoming depleted over the next 75 years in this year's report.

Methods and Programmatic Data

The projections in this report also reflect several methodological improvements and updates based on new program-specific data. These methodological changes, programmatic data updates, and interactions combine to

increase the long-range OASDI actuarial balance by 0.01 percent of taxable payroll. Descriptions of four significant methodological changes and programmatic data updates follow.

First, a methodological improvement was made to put more emphasis on recent mortality data. To accomplish this, the weights for the most recent years (2018 and 2019 for this report) in the regressions used to calculate the starting rates of improvement and starting death rates were increased. This change in methodology decreases the actuarial balance by 0.02 percent of taxable payroll.

The second significant set of changes is related to the sample used for the long-range model for projecting average benefit levels of retired-worker and disabled-worker beneficiaries who become newly entitled for benefits. This model uses a large sample of 10 percent of all newly entitled retired-worker beneficiaries in a recent year. The sample used in last year's report was for worker beneficiaries newly entitled in 2017, while this year's report uses the results from worker beneficiaries newly entitled in 2018. This update to the sample year by itself decreases the actuarial balance slightly. Other data updates more than offset the effect of the change in sample year, resulting in a combined increase in the actuarial balance of 0.01 percent of payroll.

Third, recent data and estimates provided by the Office of Tax Analysis at the Department of the Treasury indicate higher near-term and ultimate levels of revenue from income taxation of OASDI benefits than projected in last year's report. The increase in projected ratios of income tax on benefits to benefit amounts increases the actuarial balance by 0.04 percent of taxable payroll.

The fourth significant change is updating the post-entitlement benefit adjustment factors based on new programmatic data. Post-entitlement factors are used to account for changes in benefit levels, primarily due to differential mortality by benefit level and earnings after benefit entitlement. This data update decreases the actuarial balance by 0.02 percent of payroll.

In addition to these four significant methodological changes and programmatic data updates, changes in starting levels and projected levels of OASI and DI beneficiaries and benefit amounts over the first 10 years of the projection period, updating other programmatic data, other small methodological improvements, and interactions among the various method changes and updates to programmatic experience combine to have a negligible effect on the long-range actuarial balance.

Figure IV.B4.—OASDI Annual Balances: 2021 and 2022 Trustees Reports
[As a percentage of taxable payroll, under intermediate assumptions]

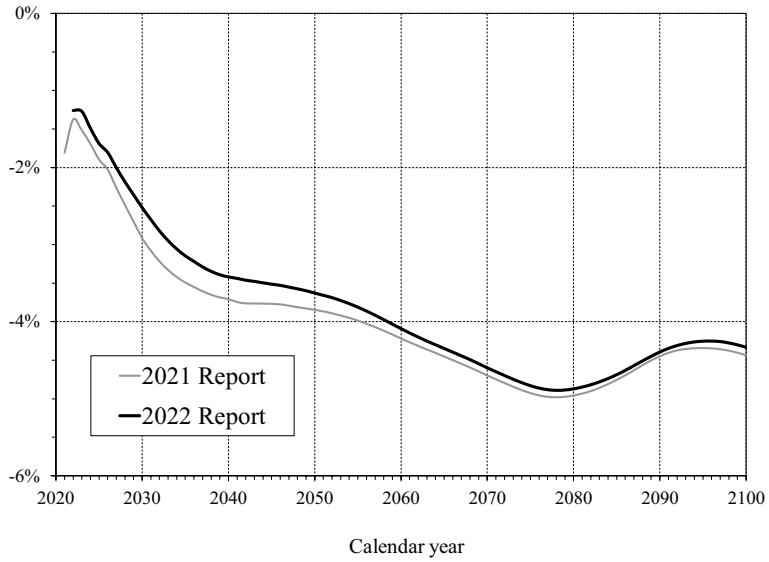

Figure IV.B4 compares the annual balances for this report and the prior year's report for the combined OASDI program over the long-range (75-year) projection period. The figure illustrates the annual effects of the changes described earlier in this section.

The annual balances in this year's report are higher (less negative) in all 75 years of the long-range projection period, primarily due to the changes in economic factors and disability incidence rates described above. For the full 75-year projection period, the annual balances average 0.18 percentage point higher in this year's report. For 2096, the projected annual deficit is 4.25 percent of taxable payroll in this report, compared to 4.35 percent in last year's report.

V. ASSUMPTIONS AND METHODS UNDERLYING ACTUARIAL ESTIMATES

The future income and cost of the OASDI program will depend on many demographic, economic, and program-specific factors. Trust fund income will depend on how these factors affect the size and composition of the working population as well as the level and distribution of earnings. Similarly, program cost will depend on how these factors affect the size and composition of the beneficiary population as well as the general level of benefits.

The Trustees make basic assumptions for several of these factors based on analysis of historical trends, historical conditions, and expected future conditions. These factors include fertility, mortality, immigration, marriage, divorce, productivity, inflation, average earnings, unemployment, real interest rates, and disability incidence and termination. Other factors depend on these basic assumptions. These other, often interdependent, factors include total population, life expectancy, labor force participation, gross domestic product, and program-specific factors. Each year, the Trustees reexamine these assumptions and methods in light of new information and make appropriate revisions. The assumptions for this report were set by the middle of February 2022.

Future levels of these factors and their interrelationships are inherently uncertain. To address these uncertainties, this report uses three sets of assumptions, designated as intermediate (alternative II), low-cost (alternative I), and high-cost (alternative III). The intermediate set represents the Trustees' best estimate of the future course of the population and the economy. With regard to the net effect on the actuarial status of the OASDI program, the low-cost set is more optimistic and the high-cost set is more pessimistic. The low-cost and high-cost sets of assumptions reflect significant potential changes in the interrelationships among factors, as well as changes in the values for individual factors.

While it is unlikely that all of the factors and interactions will differ in the specified directions from the intermediate values, many combinations of individual differences in the factors could have a similar overall effect. Outcomes with overall long-range cost as low as the low-cost scenario or as high as the high-cost scenario are very unlikely. This report also includes a section on sensitivity analysis, where factors are changed one at a time (see appendix D), and a section on stochastic projections, which provides a probability distribution of possible future outcomes, with most of the key factors being varied around the intermediate alternative (see appendix E).

Readers should interpret the estimates based on the three sets of alternative assumptions with care. These estimates are not specific predictions of the future financial status of the OASDI program. Rather, they provide a reasonable range of future income and cost.

All of the key demographic, economic, and program-specific assumptions reach their long-range ultimate values within the next 25 years. For extrapolations beyond the 75-year long-range period, the ultimate levels or trends reached by the end of the 75-year period remain unchanged. The assumed ultimate values represent average annual experience or growth rates. Actual future values will exhibit fluctuations or cyclical patterns, as in the past.

At this time, there is no consensus on what the lasting effects of the COVID-19 pandemic on long-term experience might be, if any. Given the unprecedented level of uncertainty, the Trustees have assumed that the pandemic will have no net effect on the individual long-range ultimate assumptions. However, pandemic effects are reflected in the short-range (first 10-year) period, as described in the remainder of this chapter.

The following sections briefly discuss the various assumptions and methods used in making the estimates of trust fund actuarial status, which are the focus of this report.[1] There are, of course, many interrelationships among these factors that are important but are beyond the scope of this discussion.

A. DEMOGRAPHIC ASSUMPTIONS AND METHODS

This section of the report provides a brief overview of the demographic historical data and the assumptions used for the projections.

1. Fertility Assumptions

Birth rates by single year of age, for girls and women aged 14 to 49,[2] are the basis for the fertility assumptions. These rates apply to the total number of women, across all marital statuses, in the midyear population at each age. Table V.A1 displays the historical and projected total fertility rates.[3]

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[1] Actuarial Studies published by the Office of the Chief Actuary, Social Security Administration, contain further details about the assumptions, methods, and actuarial estimates. A complete list of available studies may be found at www.ssa.gov/OACT/NOTES/actstud.html. This entire report, along with supplemental year-by-year tables and additional documentation on assumptions and methods, may be found at www.ssa.gov/OACT/TR/2022/.

[2] Birth rates at age 14 include births to girls aged 14 and under, and birth rates at age 49 include births to women aged 49 and over.

[3] The total fertility rate may be interpreted as the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, a specified year, and if she were to survive the entire childbearing period. A rate of about 2.1 would ultimately result in a nearly constant population if immigration and emigration were both zero, and if death rates were to remain at current levels.

Historically, birth rates in the United States have fluctuated widely. The total fertility rate decreased from 3.31 children per woman at the end of World War I (1918) to 2.15 during the Great Depression (1936). After 1936, the total fertility rate rose to 3.68 in 1957 and then fell to 1.74 by 1976. After 1976, the total fertility rate rose above 2.00 by 1990, where it generally remained through 2009, but it dropped below 1.90 for 2011 and has been at relatively low levels since then. It reached an all-time low of 1.64 for 2020.

In last year's report, the Trustees assumed that the COVID-19 pandemic would affect birth rates in years 2021 through 2026, with a drop in fertility rates in 2021 and 2022 that would be fully made up with elevated rates in 2024 through 2026. However, preliminary data indicate that, overall, fertility rates for 2021 increased somewhat from 2020. For this year's report, the Trustees have assumed that the pandemic will not have any significant net effect on fertility rates in either the near term or the long term.

The variations in the historical total fertility rate resulted from changes in many factors, including social attitudes, economic conditions, birth-control practices, and the racial/ethnic composition of the population. Since the baby-boom era (1946-65), women have had higher educational attainment, higher labor force participation, an older average age at first marriage, a higher propensity to remain unmarried, and higher rates of divorce. All of these factors are consistent with continued lower total fertility rates than those experienced during the baby-boom era. Based on consideration of these factors, the Trustees expect the ultimate total fertility rate to be relatively close to the average level since the end of the baby-boom era. The assumed ultimate total fertility rates are 2.20, 2.00, and 1.70 children per woman for the low-cost, intermediate, and high-cost assumptions, respectively. These are the same ultimate rates as those assumed for last year's report.

The 2022 Trustees Report continues the use of the cohort-based projection approach that was first implemented in the 2021 Trustees Report. This cohort-based approach results in a much longer transition to ultimate birth rates from the current low birth rates than the period-based approach that was used in the 2020 and prior Trustees Reports. The cohort-based approach also assumes a more gradual shift to older ages of childbearing for birth cohorts who have not yet reached age 49. For the intermediate assumptions, the projected total fertility rate gradually increases through the year the ultimate value is reached (2056). The assumed low-cost and high-cost total fertility rates trend away from the intermediate path, also reaching their ultimate levels in 2056.

2. Mortality Assumptions

Mortality projections are developed by assuming ultimate average annual percentage reductions in future mortality rates by age group and cause of death. The assumptions are used to estimate future central death rates by age group, sex, and cause of death. Adjustments were made to the death rates for 2020, 2021, 2022, and 2023 to account for the effects of the COVID-19 pandemic. Preliminary data for 2020 show that while the effects of the pandemic led to significantly higher death rates for those aged 15 and older, the death rates for those aged 1-14 were generally unaffected, and death rates for those age 0 (children in their first year of life) were significantly lower. The table below shows the multiplicative factors that were applied to the probabilities of death that would have been projected in the absence of the pandemic. Compared to the death rates used for last year's report, these factors result in higher total death rates in 2021 and 2022 and slightly lower total death rates in 2023.

Year	age 0	ages 1-14	ages 15-64	ages 65 and older
2020	0.890	1.000	1.161	1.161
2021	.960	1.040	1.195	1.175
2022	.990	1.010	1.059	1.047
2023	1.000	1.000	1.012	1.009

From the estimated central death rates, probabilities of death by single year of age and sex were calculated. Projected death rates for years after 2023 are unchanged from the levels that would have been projected in the absence of the pandemic, under the assumption that increased deaths from the residual effects of living through the pandemic (both physiological and psychological) will be roughly offset by decreased deaths that instead happened sooner (during the pandemic).

Historical death rates were calculated for years 1900 through 2019 for ages below 65 (and for all ages for years prior to 1968) using data from the National Center for Health Statistics (NCHS).[1] For ages 65 and over, final Medicare data on deaths for years 1968 through 2018 and preliminary data for 2019 were used.[2] Death rates by cause of death were produced for all ages for years 1979-2019 using data from the NCHS.

[1] These rates reflect NCHS data on deaths and Census estimates of population.
[2] These rates reflect Medicare data on deaths and enrollments.

The total age-sex-adjusted death rate[1] declined at an average annual rate of 1.02 percent between 1900 and 2019. Between 1979 and 2019, the period for which death rates were analyzed by cause, the total age-sex-adjusted death rate, for all causes combined, declined at an average rate of 0.85 percent per year.

Death rates have declined substantially in the U.S. since 1900, with rapid declines over some periods and slow or no improvement over the other periods. Many factors are responsible for historical reductions in death rates, including medical advances, increased availability of health-care services, and improvements in sanitation and nutrition. Historical death rates generally declined more slowly for older ages and more rapidly for children and infants than for the rest of the population. Between 1900 and 2019, the age-sex-adjusted death rate declined at an average rate of 0.78 percent per year for ages 65 and over, and 2.97 percent per year for ages under 15.

Mortality assumptions differ for the low-cost, intermediate, and high-cost scenarios. Throughout the projection period, the low-cost scenario contains annual percentage reductions that are smaller than those in the intermediate scenario, while those in the high-cost scenario are larger. The ultimate annual percentage reductions for each of the three alternatives are unchanged from last year's report.

The trends in the annual reductions in central death rates were calculated for the period from 2008 to 2019 for both the NCHS and Medicare data, by age group, sex, and cause of death.[2] These trends are the starting reductions for alternative II. For alternatives I and III, 50 and 150 percent of the starting reductions are used, respectively. These annual reductions, by alternative, are assumed to transition rapidly from the starting reductions until they reach the ultimate annual percentage reductions assumed for 2046 and later.

Table V.A1 contains historical and projected age-sex-adjusted death rates for the total population (all ages), for ages under 65, and for ages 65 and over. Age-sex adjustment eliminates the effect of a changing distribution of population by age and sex, allowing the pure effects of changes in death rates to be observed. Under the intermediate assumptions, projected age-sex-adjusted death rates are slightly lower than the rates in last year's report after 2023. These changes primarily result from increasing the weights for the most recent years in the regressions used to calculate the starting rates of improvement and starting death rates.

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[1] Based on the enumerated total population as of April 1, 2010, if that population were to experience the death rates by age and sex for the selected year.

[2] Cause of death is only available for the NCHS data.

The projected average annual rate of decline for the total age-sex-adjusted death rate is about 0.49 percent, 0.97 percent, and 1.51 percent between 2021 and 2096 for alternatives I, II, and III, respectively. In keeping with the patterns observed in the historical data, the assumed future rates of decline are greater for younger ages than for older ages, but to a substantially lesser degree than in the past. Accordingly, the projected age-sex-adjusted death rates for ages 65 and over decline at average annual rates of about 0.48 percent, 0.90 percent, and 1.36 percent between 2021 and 2096 for alternatives I, II, and III, respectively. The projected age-sex-adjusted death rates for ages under 15 decline at average annual rates of about 0.49 percent, 1.50 percent, and 2.92 percent between 2021 and 2096 for alternatives I, II, and III, respectively. It should be noted that these average annual rates of decline between 2021 and 2096 are not directly comparable with the rates of decline between 2020 and 2095 in last year's report, because the 75-year period used for last year's report included the pandemic year of 2020, and the death rate assumptions for 2021-23 were revised for this year's report to better reflect the current expected course of the pandemic.

Demographers express a wide range of views on the likely rate of future decline in death rates. For example, some believe that the long-standing historical tendency for mortality to decline more slowly at the oldest ages will cease in the future. Others believe that biological factors, social factors, and limitations on health care spending may slow future rates of decline in mortality.

Table V.A1.—Fertility and Mortality Assumptions,[a] Calendar Years 1940-2100

Calendar year	Total fertility rate[b]	Age-sex-adjusted death rate[c] per 100,000		
		Total	Under 65	65 and over
Historical data:				
1940	2.23	1,919.8	750.1	9,718.8
1945	2.42	1,716.6	674.8	8,662.9
1950	3.03	1,561.9	570.2	8,173.7
1955	3.50	1,453.8	508.2	7,758.4
1960	3.61	1,454.3	503.2	7,795.6
1965	2.88	1,428.8	495.2	7,653.9
1970	2.43	1,340.0	485.7	7,036.3
1975	1.77	1,204.8	426.6	6,393.6
1980	1.82	1,136.9	384.3	6,154.3
1985	1.83	1,081.0	353.3	5,932.9
1990	2.07	1,022.9	333.6	5,618.9
1995	1.98	1,002.7	317.9	5,568.6
2000	2.05	961.5	281.0	5,498.9
2005	2.06	901.9	270.7	5,110.3
2010	1.93	820.8	248.5	4,636.1
2011	1.89	820.7	249.2	4,631.3
2012	1.87	811.8	248.8	4,565.6
2013	1.85	812.4	249.6	4,564.6
2014	1.86	805.2	251.7	4,495.1
2015	1.85	815.4	255.3	4,549.7
2016	1.82	808.7	260.9	4,461.0
2017	1.76	812.8	261.6	4,487.7
2018	1.73	803.7	258.7	4,437.4
2019	1.70	[d]792.8	257.7	[d]4,360.2
2020	1.64	[e]924.4	[e]298.7	[e]5,096.0
2021	[e]1.66	[e]935.6	[e]307.4	[e]5,123.7
Intermediate:				
2025	1.75	768.2	254.0	4,196.3
2030	1.87	738.4	243.8	4,035.5
2035	1.93	708.5	232.6	3,881.3
2040	1.98	679.8	221.5	3,735.8
2045	2.00	652.7	210.8	3,599.1
2050	2.00	627.2	200.7	3,470.8
2055	2.00	603.2	191.2	3,350.4
2060	2.00	580.6	182.2	3,237.3
2065	2.00	559.4	173.7	3,131.1
2070	2.00	539.3	165.6	3,031.1
2075	2.00	520.5	158.0	2,936.9
2080	2.00	502.6	150.9	2,848.0
2085	2.00	485.8	144.1	2,764.2
2090	2.00	469.9	137.6	2,685.0
2095	2.00	454.8	131.6	2,610.1
2100	2.00	440.6	125.8	2,539.2

Table V.A1.—Fertility and Mortality Assumptions,[a] Calendar Years 1940-2100 (Cont.)

Calendar year	Total fertility rate[b]	Age-sex-adjusted death rate[c] per 100,000		
		Total	Under 65	65 and over
Low-cost:				
2025	1.89	794.3	263.4	4,333.3
2030	2.06	785.4	261.4	4,279.2
2035	2.13	774.9	257.7	4,223.1
2040	2.18	764.1	253.7	4,167.1
2045	2.20	753.3	249.5	4,112.1
2050	2.20	742.6	245.3	4,058.0
2055	2.20	732.1	241.2	4,005.1
2060	2.20	721.9	237.2	3,953.4
2065	2.20	711.9	233.3	3,902.8
2070	2.20	702.1	229.5	3,853.3
2075	2.20	692.5	225.7	3,804.9
2080	2.20	683.1	222.0	3,757.5
2085	2.20	673.9	218.4	3,711.2
2090	2.20	664.9	214.8	3,665.8
2095	2.20	656.1	211.3	3,621.4
2100	2.20	647.4	207.9	3,577.9
High-cost:				
2025	1.54	736.4	242.3	4,030.4
2030	1.59	680.4	221.9	3,737.1
2035	1.63	628.1	201.7	3,471.1
2040	1.68	581.2	183.2	3,234.7
2045	1.70	539.4	166.5	3,025.5
2050	1.70	502.1	151.5	2,840.0
2055	1.70	469.0	138.1	2,675.0
2060	1.70	439.3	126.1	2,527.8
2065	1.70	412.7	115.3	2,395.7
2070	1.70	388.8	105.6	2,276.9
2075	1.70	367.2	96.9	2,169.4
2080	1.70	347.7	89.1	2,071.8
2085	1.70	329.9	82.0	1,982.9
2090	1.70	313.7	75.6	1,901.4
2095	1.70	298.9	69.7	1,826.6
2100	1.70	285.3	64.4	1,757.6

[a] This table contains basic assumptions along with key summary values that are derived from basic assumptions.

[b] The total fertility rate for any year is the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, the selected year, and if she were to survive the entire childbearing period.

[c] Based on the enumerated total population as of April 1, 2010, if that population were to experience the death rates by age and sex observed in, or assumed for, the selected year.

[d] Estimated using final data for ages below 65 and preliminary data for ages 65 and older.

[e] Estimated, intermediate alternative.

3. Immigration Assumptions

Projections of the total Social Security area population reflect assumptions for the following four annual immigration flows:

- Lawful permanent resident (LPR) immigration: Persons who enter the Social Security area and are granted LPR status, or who are already in the Social Security area and adjust their status to become LPRs.[1]
- Legal emigration: LPRs and citizens who leave the Social Security area population.
- Other-than-LPR immigration: Persons who enter the Social Security area and stay to the end of the year without being granted LPR status, such as undocumented immigrants, and foreign workers and students entering with temporary visas.
- Other-than-LPR emigration: Other-than-LPR immigrants who leave the Social Security area population or who adjust their status to become LPRs.

Net LPR immigration is the difference between LPR immigration and legal emigration. Net other-than-LPR immigration is the difference between other-than-LPR immigration and other-than-LPR emigration. Total net immigration refers to the sum of net LPR immigration and net other-than-LPR immigration.

Immigration assumptions differ for the low-cost, intermediate, and high-cost scenarios. The low-cost scenario includes higher annual net immigration and the high-cost scenario includes lower annual net immigration. Table V.A2 contains historical and projected levels of various immigration flows.

LPR immigration has increased significantly since World War II, due to various factors and legislative changes, including the Immigration Act of 1965 and the Immigration Act of 1990.

The data show that LPR immigration dropped significantly in 2020. LPR immigration levels in 2020 are estimated to be about 354,000 lower than would have been expected in the absence of the pandemic. For all three alternatives, the Trustees assume that the COVID-19 pandemic will continue to affect LPR immigration in years 2021 through 2024. The estimated LPR immigration levels for 2021 are 118,000 lower than would have been expected in the absence of the pandemic. The LPR immigration levels for 2022 are assumed to be the same as would have been assumed in the absence of the pandemic. LPR immigration levels for 2023 and 2024 are assumed to be higher than would have been assumed in the absence of the pandemic, fully making up for the lower levels in 2020 and 2021. These pandemic

[1] Persons who enter the country with legal visas but without LPR status, such as temporary foreign workers and students, are not included in the "LPR immigration" category.

effects on LPR immigration levels are all smaller than the assumed pandemic effects in last year's report.

For the intermediate alternative, the ultimate level of annual LPR immigration, which includes residents who adjust their status to become LPRs, is assumed to be 1,050,000 persons for 2025 and later. For alternative I, ultimate annual LPR immigration is assumed to be 1,250,000 persons for 2025 and later, and for alternative III, ultimate annual LPR immigration is assumed to be 850,000 persons for 2025 and later. The ultimate levels of LPR immigration are unchanged from last year's report.

The assumed ratios of annual legal emigration to LPR immigration are 20, 25, and 30 percent for alternatives I, II, and III, respectively. This range is consistent with the limited historical data for legal emigration from the Social Security area. These ratios are unchanged from last year's report. Under the intermediate alternative, by combining the ultimate annual LPR immigration and legal emigration assumptions, ultimate annual net LPR immigration is about 788,000 persons. For the low-cost and high-cost scenarios, ultimate annual net LPR immigration is 1,000,000 persons and 595,000 persons, respectively.

The estimated number of other-than-LPR immigrants residing in the Social Security area and the annual level of other-than-LPR immigration were affected significantly by the economic recession of 2007-09. Although other-than-LPR immigration was greatly reduced during the economic downturn and immediate years thereafter, it returned to higher levels for 2014 through 2018, and is estimated to remain at a higher level in 2019, reflecting a recovery from levels experienced during the recession.

For all three alternatives, the Trustees assume that the COVID-19 pandemic affects other-than-LPR immigration in years 2020 through 2024. The estimated other-than-LPR immigration levels for 2020 and 2021 are 660,000 and 350,000 lower, respectively, than would have been estimated in the absence of the pandemic. The other-than-LPR immigration levels for 2022 are assumed to be the same as would have been assumed in the absence of the pandemic. Other-than-LPR immigration levels for 2023 and 2024 are assumed to be higher than would have been assumed in the absence of the pandemic, fully making up for the lower levels in 2020 and 2021. These pandemic effects on other-than-LPR immigration levels are all smaller than the assumed pandemic effects in last year's report.

The ultimate annual levels of other-than-LPR immigration are 1,350,000 persons for alternative II, 1,850,000 persons for alternative I, and 850,000 persons for alternative III. These ultimate levels are unchanged from those used

in last year's report. The ultimate levels are attained in 2025 for all three alternatives.

Emigration from the other-than-LPR immigrant population includes those who leave the Social Security area and those who adjust their status to become LPRs. This other-than-LPR immigrant population is highly mobile and far more likely to leave the Social Security area than is the citizen or LPR population. However, as other-than-LPR immigrants stay in the country for longer periods of time, they generally become less likely to leave the country.

Under the intermediate assumptions, the total annual number of other-than-LPR immigrants who leave the Social Security area averages about 425,000 through the 75-year projection period. The ultimate annual number of other-than-LPR immigrants who adjust status to become LPRs is assumed to be 450,000 for the intermediate assumptions, and is unchanged from last year's report. For the low-cost and high-cost scenarios, the total annual number of other-than-LPR emigrants averages about 583,000 and 266,000, respectively, through the 75-year projection period. The ultimate annual number of people adjusting status to LPR status is assumed to be 550,000 persons and 350,000 persons, for the low-cost and high-cost scenarios, respectively, and is unchanged from last year's report.

Under the assumptions described above, the projected size of the other-than-LPR immigrant population grows substantially, from about 15.4 million by the end of 2022 to about 35.5 million by the end of 2096. This growth reflects the excess of annual immigration over the combined annual numbers of emigrants (including adjustments of status) and deaths that occur within the other-than-LPR immigrant population.

Under the intermediate assumptions, projected net other-than-LPR immigration gradually decreases over time. Because the projected number of other-than-LPR immigrants leaving the Social Security area is based on rates of departure, an increase in the number of other-than-LPR immigrants residing in the Social Security area results in an increase in the number who emigrate out of the area. All other components of net other-than-LPR immigration are assumed to be stable after 2024, and thus do not contribute toward any change in annual net other-than-LPR immigration. Under the intermediate assumptions, the projected average annual level of net other-than-LPR immigration over the 75-year projection period is about 489,000 persons. For the low-cost and high-cost assumptions, projected average annual net other-than-LPR immigration is about 731,000 persons and 248,000 persons, respectively.

The projected average annual level of total net immigration (LPR and other-than-LPR, combined) is about 1,281,000 persons per year during the 75-year projection period under the intermediate assumptions. For the low-cost and high-cost assumptions, projected average annual total net immigration is about 1,736,000 persons and 847,000 persons, respectively.

Demographers express a wide range of views about the future course of immigration for the United States. Some believe that net immigration will increase substantially in the future. Others believe that potential immigrants may be increasingly attracted to other countries, that the number of potential immigrants may be lower due to lower birth rates in many countries, or that changes in the law or enforcement of the law will reduce immigration.

Table V.A2.—Immigration Assumptions,[a] Calendar Years 1940-2100
[In thousands]

	LPR immigration				Other-than-LPR immigration[b]				
Calendar year	LPR in	Legal out	Adjustments of status[c d]	Net LPR	Other-than-LPR in	Other-than-LPR out	Adjustments of status[c d]	Net other-than-LPR	Total net immigration
Historical data:									
1940	61	15	-	46	-	-	-	-	-
1945	73	18	-	55	-	-	-	-	-
1950	227	57	-	171	-	-	-	-	-
1955	280	70	-	210	-	-	-	-	-
1960	268	67	-	201	-	-	-	-	-
1965	261	77	49	232	-	-	49	-	-
1970	307	93	65	279	-	-	65	-	-
1975	340	98	53	294	-	-	53	-	-
1980	430	135	112	406	-	-	112	203	610
1985	458	144	118	432	-	-	118	261	693
1990	548	166	114	497	-	-	114	629	1,125
1995	511	192	255	575	-	-	255	563	1,137
2000	482	224	413	671	1,412	308	413	691	1,362
2005	561	290	597	869	1,823	79	597	1,147	2,015
2010	622	262	426	786	669	195	426	48	834
2011	646	264	408	791	583	245	408	-70	721
2012	621	255	401	766	777	506	401	-130	636
2013	588	249	409	748	826	327	409	91	839
2014	627	256	398	769	1,425	114	398	912	1,681
2015	689	271	395	813	1,383	312	395	677	1,490
2016	763	292	407	877	1,120	692	407	21	898
2017	722	280	398	840	938	288	398	252	1,092
2018	678	270	403	810	915	238	403	274	1,084
2019	508	238	443	713	[e]1,100	[e]940	443	[e]-283	[e]430
2020	[e]332	[e]177	[e]375	[e]531	[f]540	[e]243	[e]375	[f]-79	[f]452
2021	[f]482	[f]233	[f]450	[f]699	[f]950	[f]241	[f]450	[f]259	[f]958
Intermediate:									
2025	600	263	450	788	1,350	314	450	586	1,374
2030	600	263	450	788	1,350	347	450	553	1,341
2035	600	263	450	788	1,350	374	450	526	1,313
2040	600	263	450	788	1,350	400	450	500	1,288
2045	600	263	450	788	1,350	419	450	481	1,268
2050	600	263	450	788	1,350	432	450	468	1,256
2055	600	263	450	788	1,350	440	450	460	1,247
2060	600	263	450	788	1,350	447	450	453	1,240
2065	600	263	450	788	1,350	454	450	446	1,234
2070	600	263	450	788	1,350	459	450	441	1,228
2075	600	263	450	788	1,350	463	450	437	1,224
2080	600	263	450	788	1,350	467	450	433	1,221
2085	600	263	450	788	1,350	469	450	431	1,219
2090	600	263	450	788	1,350	471	450	429	1,217
2095	600	263	450	788	1,350	472	450	428	1,216
2100	600	263	450	788	1,350	472	450	428	1,215

Table V.A2.—Immigration Assumptions,[a] Calendar Years 1940-2100 (Cont.)
[In thousands]

	LPR immigration				Other-than-LPR immigration[b]				
Calendar year	LPR in	Legal out	Adjustments of status[c d]	Net LPR	Other-than-LPR in	Other-than-LPR out	Adjustments of status[c d]	Net other-than-LPR	Total net immigration
Low-cost:									
2025	700	250	550	1,000	1,850	361	550	939	1,939
2030	700	250	550	1,000	1,850	425	550	875	1,875
2035	700	250	550	1,000	1,850	479	550	821	1,821
2040	700	250	550	1,000	1,850	529	550	771	1,771
2045	700	250	550	1,000	1,850	567	550	733	1,733
2050	700	250	550	1,000	1,850	595	550	705	1,705
2055	700	250	550	1,000	1,850	615	550	685	1,685
2060	700	250	550	1,000	1,850	631	550	669	1,669
2065	700	250	550	1,000	1,850	643	550	657	1,657
2070	700	250	550	1,000	1,850	653	550	647	1,647
2075	700	250	550	1,000	1,850	660	550	640	1,640
2080	700	250	550	1,000	1,850	665	550	635	1,635
2085	700	250	550	1,000	1,850	669	550	631	1,631
2090	700	250	550	1,000	1,850	671	550	629	1,629
2095	700	250	550	1,000	1,850	672	550	628	1,628
2100	700	250	550	1,000	1,850	673	550	627	1,627
High-cost:									
2025	500	255	350	595	850	269	350	231	826
2030	500	255	350	595	850	271	350	229	824
2035	500	255	350	595	850	271	350	229	824
2040	500	255	350	595	850	273	350	227	822
2045	500	255	350	595	850	272	350	228	823
2050	500	255	350	595	850	269	350	231	826
2055	500	255	350	595	850	265	350	235	830
2060	500	255	350	595	850	263	350	237	832
2065	500	255	350	595	850	262	350	238	833
2070	500	255	350	595	850	263	350	237	832
2075	500	255	350	595	850	263	350	237	832
2080	500	255	350	595	850	264	350	236	831
2085	500	255	350	595	850	264	350	236	831
2090	500	255	350	595	850	265	350	235	830
2095	500	255	350	595	850	265	350	235	830
2100	500	255	350	595	850	266	350	234	829

[a] This table contains basic assumptions along with key summary values that are derived from basic assumptions.

[b] Historical other-than-LPR immigration and emigration estimates depend on a residual method. The Office of the Chief Actuary developed these estimates, as well as the resulting other-than-LPR January 1 stock estimates, for years through 2000. For years 2001 and later, the residual method uses stock estimates. For 2001 through 2004, the stock is set to values that linearly grade from the 2000 stock estimate to the DHS 2005 stock estimate. For 2005 through 2012, stock estimates come from DHS. For 2013 through 2020, stock estimates are developed by the Office of the Chief Actuary, based on the same methods used by DHS.

[c] Estimates do not include persons who attained LPR status under the special one-time provisions of the Immigration Reform and Control Act of 1986.

[d] Adjustments of status are a positive for net LPR immigration and a negative for net other-than-LPR immigration.

[e] Estimated.

[f] Estimated, intermediate alternative.

Note: Components may not sum to totals because of rounding.

4. Total Population Estimates

The starting Social Security area population for December 31, 2019, is derived from the Census Bureau's estimate of the residents of the 50 States and D.C. and U.S. Armed Forces overseas. Adjustments are made to reflect mortality assumptions for the aged population since 2010 that are consistent with Medicare and Social Security data, net immigration assumptions for the aged population since 2010, estimates of the net undercount in the 2010 census, inclusion of U.S. citizens living abroad (including residents of U.S. territories), and inclusion of non-citizens living abroad who are insured for Social Security benefits. The Office of the Chief Actuary projects the population in the Social Security area by age, sex, and marital status for December 31 of each year from 2020 through 2096 by combining the assumptions for future fertility, mortality, and immigration with assumptions for marriage and divorce. Previous sections of this chapter present the assumptions for future fertility, mortality, and immigration. Assumptions for future rates of marriage and divorce reflect historical data from the National Center for Health Statistics, the Census Bureau, and selected individual States.

This report presents a July 1 (i.e., midyear) population for each year, which is derived from surrounding December populations. Table V.A3 shows the historical and projected population for July 1 by broad age group, for the three alternatives. It also shows the aged and total dependency ratios (see table footnotes for definitions).

Table V.A3.—Social Security Area Population on July 1 and Dependency Ratios, Calendar Years 1945-2100

Calendar year	Population (in thousands)				Dependency ratio	
	Under 20	20-64	65 and over	Total	Aged[a]	Total[b]
Historical data:						
1945	49,107	87,891	10,886	147,883	0.124	0.683
1950	53,918	92,190	12,789	158,897	.139	.724
1955	63,337	96,003	15,161	174,501	.158	.818
1960	72,915	99,752	17,323	189,990	.174	.905
1965	80,002	104,864	19,153	204,019	.183	.946
1970	80,856	112,953	21,007	214,816	.186	.902
1975	78,574	122,598	23,370	224,542	.191	.832
1980	74,841	134,029	26,314	235,184	.196	.755
1985	72,892	144,585	29,131	246,608	.201	.706
1990	74,791	152,731	31,926	259,449	.209	.699
1995	79,286	160,737	34,298	274,321	.213	.707
2000	81,980	170,164	35,501	287,646	.209	.690
2005	83,942	181,084	37,135	302,161	.205	.669
2010	85,678	188,270	41,021	314,969	.218	.673
2011	85,296	189,898	41,739	316,933	.220	.669
2012	84,906	190,397	43,421	318,724	.228	.674
2013	84,608	191,129	44,803	320,539	.234	.677
2014	84,486	192,183	46,198	322,867	.240	.680
2015	84,519	193,385	47,604	325,508	.246	.683
2016	84,520	194,081	49,088	327,690	.253	.688
2017	84,394	194,553	50,602	329,550	.260	.694
2018	84,185	195,043	52,182	331,410	.268	.699
2019[c]	83,898	195,131	53,815	332,844	.276	.706
2020[d]	83,463	194,942	55,304	333,710	.284	.712
2021[d]	82,952	194,947	56,615	334,514	.290	.716
Intermediate:						
2025	82,961	197,402	63,453	343,816	.321	.742
2030	82,994	200,496	71,153	354,643	.355	.769
2035	85,401	204,083	75,644	365,128	.371	.789
2040	89,130	207,586	78,089	374,805	.376	.806
2045	93,271	210,406	79,745	383,422	.379	.822
2050	95,545	213,527	82,062	391,135	.384	.832
2055	96,630	216,933	85,132	398,696	.392	.838
2060	97,639	220,448	88,907	406,994	.403	.846
2065	99,458	224,412	92,425	416,294	.412	.855
2070	102,228	227,722	96,165	426,115	.422	.871
2075	105,314	230,304	100,216	435,833	.435	.892
2080	107,882	234,607	102,671	445,160	.438	.897
2085	109,683	240,463	104,117	454,263	.433	.889
2090	111,192	247,291	105,067	463,550	.425	.875
2095	112,997	252,895	107,421	473,313	.425	.872
2100	115,310	257,469	110,829	483,608	.430	.878

Table V.A3.—Social Security Area Population on July 1 and Dependency Ratios, Calendar Years 1945-2100 (Cont.)

Calendar year	Population (in thousands)				Dependency ratio	
	Under 20	20-64	65 and over	Total	Aged[a]	Total[b]
Low-cost:						
2025	84,987	199,402	63,321	347,710	0.318	0.744
2030	88,022	204,416	70,642	363,081	.346	.776
2035	93,861	209,879	74,529	378,269	.355	.802
2040	101,136	215,187	76,224	392,547	.354	.824
2045	107,867	220,744	77,098	405,709	.349	.838
2050	111,843	227,686	78,698	418,227	.346	.837
2055	114,762	235,291	81,181	431,234	.345	.833
2060	118,358	243,005	84,497	445,860	.348	.835
2065	123,462	251,085	87,630	462,178	.349	.841
2070	129,693	258,716	90,947	479,356	.352	.853
2075	135,913	266,236	94,485	496,634	.355	.865
2080	141,102	276,318	96,428	513,849	.349	.860
2085	145,347	288,663	97,386	531,396	.337	.841
2090	149,623	301,448	98,770	549,841	.328	.824
2095	154,699	312,268	102,492	569,459	.328	.824
2100	160,575	322,006	107,546	590,128	.334	.833
High-cost:						
2025	80,623	195,542	63,633	339,798	.325	.738
2030	76,949	196,812	71,844	345,605	.365	.756
2035	75,133	198,632	77,156	350,920	.388	.767
2040	74,482	200,435	80,622	355,539	.402	.774
2045	75,575	200,239	83,347	359,160	.416	.794
2050	76,071	198,878	86,646	361,595	.436	.818
2055	75,338	197,308	90,512	363,158	.459	.841
2060	73,800	195,769	94,871	364,441	.485	.862
2065	72,356	194,731	98,805	365,893	.507	.879
2070	71,678	192,827	102,922	367,428	.534	.905
2075	71,681	189,550	107,371	368,603	.566	.945
2080	71,798	187,090	110,170	369,058	.589	.973
2085	71,488	185,395	111,864	368,747	.603	.989
2090	70,716	185,557	111,647	367,921	.602	.983
2095	69,841	185,658	111,379	366,878	.600	.976
2100	69,223	184,967	111,654	365,844	.604	.978

[a] Ratio of the population at ages 65 and over to the population at ages 20-64.
[b] Ratio of the population at ages 65 and over and the population under age 20 to the population at ages 20-64.
[c] Estimated.
[d] Estimated, intermediate alternative.

Notes:
1. Historical data are subject to revision.
2. Components may not sum to totals because of rounding.

5. Life Expectancy Estimates

Life expectancy, or the average remaining number of years expected prior to death, is an additional way to summarize the Trustees' mortality assumptions. This report includes life expectancy in two different forms (period and cohort), which are useful for two separate purposes.

- Period life expectancy for a given year incorporates the actual or expected death rates at each age for that year. It is a useful summary statistic for illustrating the overall level of the death rates experienced in a single year. Period life expectancy for a particular year provides an individual's expected average remaining lifetime at a selected age, assuming no change in death rates after that year. Table V.A4 presents historical and projected life expectancy calculated on a period basis.
- Cohort life expectancy does not incorporate death rates for a single year, but for the series of years in which the individual will actually reach each succeeding age if he or she survives. Cohort life expectancy provides an individual's expected average remaining lifetime at a selected age in a given year, using actual or expected future death rates. Table V.A5 presents historical and projected life expectancy calculated on a cohort basis. Cohort life expectancy is somewhat greater than period life expectancy for a given year because: (1) death rates at any age tend to decline over time; and (2) cohort life expectancy uses death rates from future years, while period life expectancy uses death rates only from the given year.

Life expectancy at a given age reflects death rates at that and all older ages. Period life expectancy is somewhat related to the age-sex-adjusted death rate discussed in section V.A.2. However, life expectancy places far greater weight on death rates at relatively younger ages than those at relatively older ages. Therefore, changes in death rates at younger ages have far greater effects in changing life expectancy over time. It is important to keep this concept in mind when considering trends in life expectancy.

Table V.A4.—Period Life Expectancy[a]

Calendar year	Historical data			
	At birth		At age 65	
	Male	Female	Male	Female
1940	61.4	65.7	11.9	13.4
1945	62.9	68.4	12.6	14.4
1950	65.6	71.1	12.8	15.1
1955	66.7	72.8	13.1	15.6
1960	66.7	73.2	12.9	15.9
1965	66.8	73.8	12.9	16.3
1970	67.1	74.9	13.1	17.1
1975	68.7	76.6	13.7	18.0
1980	69.9	77.5	14.0	18.4
1985	71.1	78.2	14.4	18.6
1990	71.8	78.9	15.0	19.0
1995	72.5	79.1	15.4	19.0
2000	74.0	79.4	15.9	19.0
2005	74.8	80.0	16.7	19.5
2010	76.1	80.9	17.6	20.2
2011	76.2	80.9	17.6	20.2
2012	76.3	81.0	17.7	20.3
2013	76.3	81.0	17.7	20.3
2014	76.3	81.1	17.8	20.4
2015	76.1	80.9	17.8	20.3
2016	76.0	81.0	17.9	20.5
2017	76.0	81.0	17.9	20.5
2018	76.1	81.1	18.0	20.6
2019[b] . . .	76.2	81.3	18.1	20.7
2020[c] . . .	74.5	79.7	17.0	19.6
2021[c] . . .	74.2	79.5	16.9	19.5

Calendar year	Intermediate				Low-cost				High-cost			
	At birth		At age 65		At birth		At age 65		At birth		At age 65	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
2025	76.6	81.6	18.5	21.0	76.1	81.3	18.2	20.8	77.1	82.1	18.8	21.3
2030	77.1	82.1	18.8	21.3	76.2	81.4	18.3	20.9	78.2	83.0	19.4	21.9
2035	77.6	82.5	19.1	21.6	76.4	81.5	18.4	21.0	79.2	83.8	20.0	22.5
2040	78.2	83.0	19.4	21.9	76.6	81.7	18.5	21.1	80.2	84.7	20.6	23.0
2045	78.7	83.4	19.7	22.2	76.8	81.9	18.6	21.2	81.2	85.4	21.2	23.5
2050	79.2	83.9	20.0	22.4	77.0	82.0	18.7	21.3	82.1	86.2	21.7	24.0
2055	79.7	84.3	20.3	22.7	77.2	82.2	18.8	21.4	82.9	86.8	22.3	24.4
2060	80.2	84.7	20.6	23.0	77.4	82.3	19.0	21.5	83.7	87.5	22.7	24.9
2065	80.7	85.1	20.9	23.2	77.5	82.5	19.1	21.6	84.4	88.1	23.2	25.3
2070	81.2	85.4	21.2	23.5	77.7	82.6	19.2	21.7	85.1	88.6	23.6	25.7
2075	81.6	85.8	21.5	23.7	77.9	82.8	19.3	21.7	85.8	89.2	24.1	26.0
2080	82.0	86.2	21.7	23.9	78.1	82.9	19.4	21.8	86.4	89.6	24.5	26.4
2085	82.5	86.5	22.0	24.2	78.3	83.1	19.5	21.9	87.0	90.1	24.9	26.7
2090	82.9	86.8	22.2	24.4	78.5	83.2	19.6	22.0	87.6	90.6	25.2	27.0
2095	83.3	87.1	22.5	24.6	78.6	83.4	19.7	22.1	88.1	91.0	25.6	27.3
2100	83.7	87.5	22.7	24.8	78.8	83.5	19.8	22.2	88.6	91.4	25.9	27.6

[a] The period life expectancy at a given age for a given year is the average remaining number of years expected prior to death for a person at that exact age, born on January 1, using the mortality rates for that year over the course of his or her remaining life.

[b] Estimated using final data for ages below 65 and preliminary data for ages 65 and older.

[c] Estimated using the intermediate assumptions for all ages.

Table V.A5.—Cohort Life Expectancy[a]

Calendar year	Intermediate				Low-cost				High-cost			
	At birth[b]		At age 65[c]		At birth[b]		At age 65[c]		At birth[b]		At age 65[c]	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1940	70.2	76.4	12.7	14.7	70.1	76.3	12.7	14.7	70.3	76.6	12.7	14.7
1945	72.0	78.1	13.0	15.4	71.8	77.8	13.0	15.4	72.2	78.4	13.0	15.4
1950	73.1	79.4	13.1	16.2	72.8	79.0	13.1	16.2	73.5	79.9	13.1	16.2
1955	73.6	79.9	13.1	16.7	73.1	79.4	13.1	16.7	74.2	80.7	13.1	16.7
1960	74.2	80.2	13.2	17.4	73.6	79.5	13.2	17.4	75.1	81.3	13.2	17.4
1965	75.1	80.8	13.5	18.0	74.2	79.9	13.5	18.0	76.4	82.1	13.5	18.0
1970	76.3	81.7	13.8	18.5	75.1	80.5	13.8	18.5	77.9	83.2	13.8	18.5
1975	77.1	82.4	14.2	18.7	75.7	81.0	14.2	18.7	79.0	84.2	14.2	18.7
1980	77.8	83.0	14.7	18.8	76.1	81.3	14.7	18.8	80.1	85.1	14.7	18.8
1985	78.3	83.5	15.4	19.0	76.3	81.6	15.4	19.0	81.0	85.9	15.4	19.1
1990	78.9	84.0	16.0	19.3	76.6	81.8	16.0	19.3	81.9	86.6	16.0	19.3
1995	79.5	84.5	16.6	19.6	77.0	82.1	16.6	19.6	82.9	87.4	16.7	19.6
2000	80.1	84.9	17.3	20.0	77.2	82.3	17.3	19.9	83.7	88.0	17.4	20.1
2005	80.5	85.3	17.8	20.4	77.4	82.5	17.7	20.3	84.4	88.6	18.0	20.7
2010	81.1	85.7	18.2	20.8	77.6	82.7	18.0	20.5	85.2	89.2	18.6	21.2
2011	81.2	85.8	18.3	20.9	77.7	82.7	18.1	20.6	85.4	89.3	18.7	21.3
2012	81.3	85.8	18.4	21.0	77.7	82.7	18.1	20.6	85.5	89.4	18.8	21.5
2013	81.3	85.9	18.4	21.0	77.7	82.8	18.1	20.7	85.6	89.5	18.9	21.6
2014	81.4	86.0	18.5	21.1	77.8	82.8	18.1	20.7	85.8	89.6	19.0	21.7
2015	81.5	86.1	18.6	21.2	77.8	82.8	18.2	20.7	85.9	89.7	19.1	21.8
2016	81.6	86.1	18.6	21.3	77.9	82.9	18.2	20.8	86.1	89.8	19.2	21.9
2017	81.7	86.2	18.7	21.3	77.9	82.9	18.2	20.8	86.2	89.9	19.3	22.1
2018	81.8	86.3	18.7	21.4	77.9	82.9	18.2	20.8	86.3	90.0	19.5	22.2
2019	81.9	86.4	18.8	21.5	78.0	83.0	18.2	20.9	86.5	90.1	19.6	22.3
2020	82.0	86.5	18.9	21.5	78.1	83.1	18.2	20.9	86.7	90.3	19.7	22.4
2021	82.1	86.5	19.0	21.6	78.1	83.1	18.3	20.9	86.8	90.4	19.9	22.6
2025	82.5	86.8	19.3	21.9	78.2	83.2	18.5	21.1	87.3	90.8	20.5	23.1
2030	82.9	87.1	19.6	22.2	78.4	83.3	18.6	21.2	88.0	91.2	21.1	23.6
2035	83.3	87.5	19.9	22.5	78.6	83.5	18.7	21.3	88.6	91.7	21.7	24.1
2040	83.8	87.8	20.3	22.8	78.8	83.6	18.8	21.4	89.2	92.1	22.3	24.6
2045	84.2	88.1	20.6	23.0	78.9	83.8	18.9	21.5	89.7	92.6	22.8	25.1
2050	84.5	88.4	20.9	23.3	79.1	83.9	19.0	21.6	90.2	92.9	23.3	25.5
2055	84.9	88.7	21.2	23.6	79.3	84.0	19.1	21.7	90.7	93.3	23.8	25.9
2060	85.3	89.0	21.4	23.8	79.5	84.2	19.2	21.8	91.2	93.6	24.2	26.3
2065	85.6	89.3	21.7	24.0	79.6	84.3	19.3	21.9	91.6	94.0	24.6	26.6
2070	86.0	89.5	22.0	24.3	79.8	84.5	19.4	21.9	92.0	94.3	25.1	27.0
2075	86.3	89.8	22.2	24.5	80.0	84.6	19.6	22.0	92.5	94.6	25.4	27.3
2080	86.7	90.0	22.5	24.7	80.1	84.7	19.7	22.1	92.8	94.9	25.8	27.6
2085	87.0	90.3	22.7	24.9	80.3	84.9	19.8	22.2	93.2	95.2	26.2	27.9
2090	87.3	90.5	23.0	25.1	80.5	85.0	19.9	22.3	93.6	95.4	26.5	28.2
2095	87.6	90.7	23.2	25.3	80.6	85.1	20.0	22.4	93.9	95.7	26.8	28.5
2100	87.9	91.0	23.5	25.5	80.8	85.3	20.1	22.5	94.3	96.0	27.2	28.8

[a] The cohort life expectancy at a given age for a given year is the average remaining number of years expected prior to death for a person at that exact age, born on January 1, using the mortality rates for the series of years in which the individual will actually reach each succeeding age if he or she survives.

[b] Cohort life expectancy at birth for those born in the calendar year is based on a combination of actual, estimated, and projected death rates for birth years 1940 through 2019. For birth years after 2019, these values depend on estimated and projected death rates.

[c] Age 65 cohort life expectancy for those attaining age 65 in calendar years 1940 through 2018 depends on actual death rates or on a combination of actual, estimated, and projected death rates. After 2018, these values depend on estimated and projected death rates.

B. ECONOMIC ASSUMPTIONS AND METHODS

The three alternative sets of economic assumptions provide a reasonable range for estimating the financial status of the trust funds. The intermediate assumptions reflect the Trustees' consensus expectation of sustained moderate economic growth after completion of the recovery from the pandemic-induced recession that started in the first quarter of 2020, and their best estimate for other economic parameters. The low-cost assumptions represent a more optimistic outlook with a faster recovery to a higher level of economic output, stronger long-term economic growth, and relatively optimistic levels for other parameters. The high-cost assumptions represent a more pessimistic scenario with a recession in 2022, slower economic growth in the long term, and relatively pessimistic levels for other parameters.

Actual economic data were generally available through the end of 2021 at the time the assumptions for this report were set; some values for the fourth quarter of 2021 are preliminary estimates. The data indicate that economic activity reached a peak in the fourth quarter of 2019.[1] The recession started in the first quarter of 2020 due to the precipitous decline in economic activity in March of 2020, continuing in April of 2020, leading to the gross domestic product (GDP) in the second quarter of 2020 being more than 10 percent below the peak in the fourth quarter of 2019, expressed in constant 2012 dollars. GDP recovered rapidly and in the fourth quarter of 2021 exceeded the fourth quarter 2019 peak by about 3 percent.

Under the intermediate assumptions, the economy is projected to reach its sustainable trend level of output in the third quarter of 2023. Under the low-cost assumptions, the economy is projected to recover at a faster rate and return to a higher sustainable trend level of output, also in the third quarter of 2023. Under the high-cost assumptions, the sustainable trend level is lower, and the GDP was already above it in the second half of 2021. GDP falls to 3 percent below that lower sustainable trend level in the fourth quarter of 2022, and then recovers fully by the first quarter of 2027. Complete economic cycles have little effect on the long-range estimates of financial status of the trust funds, so the assumptions do not include cycles beyond the short-range period (2022 through 2031).

The key economic assumptions underlying the three sets of projections of the future financial status of the OASI and DI Trust Funds are discussed in the remainder of this section.

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[1] On a monthly basis, economic activity peaked in February 2020, but the decline in March was sharp enough that the output in the first quarter of 2020 was substantially below the output in the fourth quarter of 2019. See www.nber.org/news/business-cycle-dating-committee-announcement-june-8-2020.

1. Productivity Assumptions

Total U.S. economy productivity is defined as the ratio of real GDP to hours worked by all workers.[1] The rate of change in total-economy productivity is a major determinant of the growth of average earnings. Over the last six complete economic cycles (1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, measured peak to peak), the annual increases in total-economy productivity averaged 2.66, 1.07, 1.41, 1.85, 2.18, and 1.08 percent, respectively. For the period from 1969 to 2019, covering those last six complete economic cycles, the annual increase in total-economy productivity averaged 1.58 percent.

The assumed ultimate annual increases in total-economy productivity are 1.93, 1.63, and 1.33 percent for the low-cost, intermediate, and high-cost assumptions, respectively.[2] These rates of increase are unchanged from the 2021 report.

The annual change in total-economy productivity was 2.63 percent for 2020, because employment declined more than GDP during the recession, and is estimated to be 0.98 percent for 2021 under the intermediate assumptions, because employment and hours worked recovered substantially. For the intermediate assumptions, the annual rate of change in productivity is 0.69 percent for 2022, averages 1.98 percent for 2023 through 2025, 1.65 percent for 2026 through 2029, and reaches its ultimate value of 1.63 percent for 2030 and thereafter. For the low-cost assumptions, the annual rate of change in productivity is 0.85 percent for 2022, averages 2.22 percent for 2023 through 2025, and reaches its ultimate value of 1.93 percent for 2026 and thereafter. For the high-cost assumptions, the assumed recession lowers the annual rate of change in productivity to 0.03 percent for 2022. The growth rate rebounds to 2.16 percent for 2023, averages 1.28 percent for 2024 through 2029, and stabilizes at its ultimate value of 1.33 percent thereafter.

2. Price Inflation Assumptions

Changes in the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI) directly affect the OASDI program through the automatic cost-of-living benefit increases. Changes in the GDP price index (GDP defla-

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[1] Historical levels of real GDP are from the National Income and Product Accounts (NIPA) produced by the Bureau of Economic Analysis (BEA). Historical total hours worked are provided by the Bureau of Labor Statistics (BLS) and cover all U.S. Armed Forces and civilian employment.

[2] These assumptions for total-economy productivity are consistent with ultimate annual increases in private nonfarm business productivity of 2.36, 2.00, and 1.63 percent. Private nonfarm business productivity excludes the farm, government, nonprofit institution, and private household sectors.

tor) affect the nominal levels of GDP, wages, self-employment income, average earnings, and taxable payroll. For a given real rate of growth in average earnings, a higher price inflation rate immediately results in a higher nominal rate of growth in both earnings and revenues, while the resulting added growth in nominal benefit levels occurs with a delay, causing an overall increase (improvement) in the actuarial balance. Similarly, a lower price inflation rate causes an overall decrease in the actuarial balance.

The annual increases in the CPI averaged 4.91, 8.54, 5.30, 2.73, 2.63, and 1.73 percent over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively.[1] The annual increases in the GDP deflator averaged 5.04, 7.54, 4.61, 2.08, 2.52, and 1.61 percent for the respective economic cycles. For the period from 1969 to 2019, covering the last six complete economic cycles, the annual increases in the CPI and the GDP deflator averaged 3.89 and 3.45 percent, respectively. The annual rate of change for 2020, which was affected by the recession, was 1.21 percent for the CPI and 1.30 percent for the GDP deflator. During the subsequent recovery, demand for goods increased while supply has been constrained, leading to 2021 growth rates of 5.26 percent for the CPI and 4.16 percent for the GDP deflator.

The assumed ultimate annual increases in the CPI are 3.00, 2.40, and 1.80 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These values are unchanged from the 2021 report.

For the intermediate assumptions, the annual rate of change in the CPI is 4.54 percent for 2022, 2.33 percent for 2023, and reaches the ultimate growth rate of 2.40 percent for 2024 and thereafter. For the low-cost assumptions, the annual rate of change in the CPI is 5.14 percent for 2022, and reaches its ultimate growth rate of 3.00 percent for 2023 and thereafter. For the high-cost assumptions, the annual rate of change in the CPI is 3.92 percent for 2022, averages 1.45 percent for 2023 through 2025, and reaches its ultimate growth rate of 1.80 percent for 2026 and thereafter.

The annual increase in the GDP deflator differs from the annual increase in the CPI because the two indices are constructed using different computational methods and coverage (the set of goods and services used in the measurement). The difference between the rate of change in the CPI and the rate

[1] BLS produces a series called the Consumer Price Index Research Series Using Current Methods (CPI-U-RS) that approximates the measured rate of inflation since 1978 had the method currently used been in effect since then. BLS does not revise the CPI values published in earlier years, for which different methods were used. These CPI published values are shown in table V.B1. The Trustees use an adjusted CPI series based on the CPI-U-RS when setting the ultimate price inflation assumption because it provides a time series that is consistent with the current method for computing the CPI.

of change in the GDP deflator is called the price differential in this report. For the period including 1969 through 2019, covering the last six complete economic cycles, the average annual price differential was 0.46 percentage point. For 2020, the annual price differential was -0.09 percentage point, and for 2021 it is estimated to be 1.10 percentage points.

The fluctuations in the price differential for 2020-21 primarily reflect a decline and subsequent rebound in oil prices, as well as price increases concentrated in consumer goods categories during the economic recovery. Changes in oil prices affect the CPI much more than the GDP deflator because oil represents a much larger share of U.S. consumption than of U.S. production. Oil prices are assumed to grow at a relatively stable rate after 2022. For the intermediate assumptions, the price differential is 0.05 percentage point for 2022, 0.22 percentage point for 2023, and 0.35 percentage point for 2024 and later.

The assumed ultimate price differentials are 0.25, 0.35, and 0.45 percentage point for the low-cost, intermediate, and high-cost alternatives, respectively. Varying the ultimate projected price differential across alternatives recognizes the historical variation in this measure. Accordingly, the assumed ultimate annual increases in the GDP deflator are 2.75 (3.00 less 0.25), 2.05 (2.40 less 0.35), and 1.35 (1.80 less 0.45) percent for the low-cost, intermediate, and high-cost alternatives, respectively. The ultimate price differentials for the three alternatives are unchanged from the 2021 report.

3. Average Earnings Assumptions

The average level of nominal earnings in OASDI covered employment for each year has a direct effect on the size of the taxable payroll and on the future level of average benefits. In addition, under the automatic adjustment provisions in the law, growth in the average wage in the U.S. economy directly affects certain parameters used in the OASDI benefit formulas, as well as the contribution and benefit base, the exempt amounts under the retirement earnings test, the amount of earnings required for a quarter of coverage, and in certain circumstances, the automatic cost-of-living benefit increases.

Projected growth rates in average covered earnings are derived from projections of average U.S. earnings. Average U.S. earnings is defined as the ratio of the sum of total U.S. wages and net proprietors' income to the sum of total U.S. civilian employment and Armed Forces. The growth rate in average U.S. earnings for any period is equal to the combined growth rates for total U.S. economy productivity, average hours worked, the ratio of earnings to

total labor compensation (which includes fringe benefits), the ratio of total labor compensation to GDP, and the GDP deflator.

The average annual change in average hours worked was -0.21 percent over the last six complete economic cycles covering the period from 1969 to 2019. The annual change in average hours worked averaged -0.89, -0.55, -0.11, 0.10, -0.50, and -0.05 percent over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively. From 2019 to 2021, the first two years after the peak of the last complete cycle, the average annual change in average hours worked per week is estimated to be an increase of 0.84 percent, as a result of unusual effects on employment during the pandemic period.

The assumed ultimate annual rates of change for average hours worked are 0.05, -0.05, and -0.15 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These values are unchanged from the 2021 report.

The average annual change in the ratio of earnings to total labor compensation was -0.14 percent from 1969 to 2019. Most of this decrease was due to the relative increase in the cost of employer-sponsored group health insurance (ESGHI) for wage workers. Assuming that the level of total employee compensation is not affected by the amount of ESGHI, any increase or decrease in the cost of ESGHI leads to a commensurate decrease or increase in other components of employee compensation, including wages. Projections of future ratios of earnings to total labor compensation follow this principle. The Trustees assume that the total amount of future ESGHI premiums will be affected by provisions of the Affordable Care Act of 2010 (ACA). A key provision of ACA affecting the projected growth in ESGHI premiums, the excise tax on ESGHI premiums (commonly referred to as the “Cadillac Tax”), was repealed in December 2019. As a result, the Trustees have assumed starting with the 2020 Trustees Report that ESGHI premiums will increase faster, and wages therefore more slowly, than was assumed in the 2010 through 2019 reports. Data from BEA indicate that the other significant component of non-wage employee compensation is employer contributions to retirement plans. This component is assumed to grow faster than employee compensation in the future as life expectancy and potential time in retirement increase.

The average annual rate of change in the ratio of wages to employee compensation was -0.17 percent from 1969 to 2019. It increased sharply to 0.35 percent from 2019 to 2021 due to the unusual effects during the pandemic period. The average rates from 2021 to 2031 are about 0.02, -0.03, and -0.09 percent for the low-cost, intermediate, and high-cost assumptions, respectively. For the long-range period, from 2031 to 2096, the average rates

are about -0.02, -0.12, and -0.22 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These long-range rates are unchanged from those assumed for the 2021 report. Under the intermediate assumptions, the ratio of wages to employee compensation declines from 0.820 for 2021 to 0.758 for 2096.

Because earnings and compensation are the same for self-employed workers, the ratio of earnings to total labor compensation includes self-employment income both in the numerator and in the denominator. As a result, the rate of change in the ratio of earnings to total labor compensation (which, under the intermediate assumptions, averages -0.10 percent from 2031 to 2096) is higher (less negative) than the rate of change in the ratio of wages to employee compensation.

The ratio of total labor compensation (i.e., employee compensation and net proprietors' income) to GDP varies over the economic cycle and with changes in the relative sizes of different sectors of the economy. Over the last six complete economic cycles from 1969 to 2019, this ratio has averaged 0.622. The ratio declined from a recent high of 0.649 for 2001 to 0.600 in 2010, increased to 0.610 in 2012, and averaged 0.611 for 2014 through 2019. This ratio increased to 0.633 for 2020 and 0.626 for 2021 and is assumed to reach 0.630 by 2031. For years after 2031, the relative sizes of different sectors of the economy are assumed to remain about constant,[1] and therefore the ratio of total labor compensation to GDP remains at about the 2031 level for each set of assumptions.

The projected average annual growth rate in average nominal U.S. earnings from 2031 to 2096 is 3.56 percent for the intermediate assumptions. This growth rate reflects the projected average annual growth rate of -0.10 percent for the ratio of earnings to total labor compensation, and also reflects the assumed ultimate annual growth rates of 1.63 percent for productivity, -0.05 percent for average hours worked, and 2.05 percent for the GDP deflator. Similarly, the projected average annual growth rates in average nominal U.S. earnings are 4.77 percent for the low-cost assumptions and 2.36 percent for the high-cost assumptions.

Over long periods, the average annual growth rate in the average wage in OASDI covered employment (henceforth the "average covered wage") is expected to be very close to the average annual growth rate in average U.S. earnings. The estimated annual rate of change in the average covered wage is

[1] The sole exception is the employment in the U.S. Armed Forces, which has declined in size over the last 40 years, and is assumed to remain at its 2020 level throughout the 75-year projection period.

5.54 percent for 2021 under the intermediate assumptions. From 2021 to 2031, the annual rate of change in the average covered wage averages 5.46, 4.22, and 2.78 percent for the low-cost, intermediate, and high-cost assumptions, respectively. The projected average annual growth rates in the average covered wage from 2031 to 2096 are 4.77, 3.55, and 2.33 percent for the low-cost, intermediate, and high-cost assumptions, respectively.

4. Assumed Real Wage Differential

The real increase in the average covered wage has traditionally been expressed in the form of a real wage differential—the annual percentage change in the average covered wage minus the annual percentage change in the CPI. For the period from 1969 to 2019, covering the last six complete economic cycles, the real wage differential averaged 0.79 percentage point, the result of averages of 1.03, 0.04, 0.44, 1.47, 0.83, and 0.76 percentage points over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively.

For the years 2032 through 2096, the projected average annual real wage differentials for OASDI covered employment are 1.77, 1.15, and 0.53 percentage points for the low-cost, intermediate, and high-cost assumptions, respectively. The rounded average annual real wage differentials are unchanged from the 2021 report.

The real wage differential was 1.61 percentage points for 2020 and is estimated to be 0.28 percentage point for 2021 under the intermediate assumptions. For the intermediate assumptions, the real wage differential is projected to increase to 1.98 percentage points in 2022, and then generally decline to its long-run average of 1.15 percentage points for 2032 through 2096. For the low-cost assumptions, the real wage differential is 1.86 percentage points for 2022, 3.87 percentage points in 2023, and reaches its long-run average of 1.77 percentage points for 2032 through 2096. For the high-cost assumptions, the real wage differential is 0.58 percentage point for 2021 and 0.57 percentage point for 2023. It then averages 1.27 percentage points for 2024 through 2027, and gradually reaches its long-run average of 0.53 percentage point for 2032 through 2096.

Table V.B1.—Principal Economic Assumptions

Calendar year	Annual percentage change[a] in— Productivity (Total U.S. economy)	Earnings as a percent of total labor compensation	Average hours worked	GDP price index	Average annual wage in covered employment	Consumer Price Index	Real-wage differential[b]
Historical data:							
5-year periods:							
1960 to 1965 . . .	3.27	-0.18	0.16	1.36	3.22	1.24	1.98
1965 to 1970 . . .	2.06	-.30	-.68	4.02	5.84	4.23	1.61
1970 to 1975 . . .	2.09	-.49	-.89	6.61	6.58	6.76	-.22
1975 to 1980 . . .	.95	-.33	-.18	7.21	8.88	8.91	-.04
1980 to 1985 . . .	1.73	-.36	.01	5.24	6.52	5.22	1.29
1985 to 1990 . . .	1.34	-.20	-.07	3.14	4.79	3.83	.96
1990 to 1995 . . .	1.31	-.11	.33	2.45	3.54	3.03	.51
1995 to 2000 . . .	2.33	.28	.14	1.67	5.31	2.43	2.88
2000 to 2005 . . .	2.63	-.38	-.79	2.32	2.69	2.49	.20
2005 to 2010 . . .	1.86	-.03	-.49	1.91	2.51	2.30	.22
2010 to 2015 . . .	.43	.16	.37	1.71	2.94	1.61	1.32
2015 to 2020 . . .	1.27	.11	.01	1.68	2.93	1.70	1.23
Economic cycles:[c]							
1969 to 1973 . . .	2.66	-.34	-.89	5.04	5.94	4.91	1.03
1973 to 1979 . . .	1.07	-.43	-.55	7.54	8.58	8.54	.04
1979 to 1990 . . .	1.41	-.29	-.11	4.61	5.78	5.30	.44
1990 to 2001 . . .	1.85	.05	.10	2.08	4.19	2.73	1.47
2001 to 2007 . . .	2.18	-.18	-.50	2.52	3.45	2.63	.83
2007 to 2019 . . .	1.08	.04	-.05	1.61	2.49	1.73	.76
2019 to 2021 . . .	[d]1.80	[d].35	.84	2.72	[d]4.17	3.22	[d].95
Single years:							
2011	.05	.32	.93	2.07	3.15	3.56	-.41
2012	.48	.47	-.01	1.88	3.33	2.10	1.23
2013	.61	-.33	.24	1.77	1.22	1.37	-.15
2014	.39	.27	.29	1.86	3.60	1.50	2.09
2015	.60	.05	.41	.96	3.42	-.41	3.83
2016	.38	.10	-.43	1.00	1.23	.98	.26
2017	.91	.13	.11	1.93	3.46	2.13	1.33
2018	.98	-.08	.34	2.40	3.58	2.55	1.03
2019	1.45	.17	-.30	1.77	3.60	1.66	1.94
2020	2.63	.22	.33	1.30	2.82	1.21	1.61
2021	[d].98	[d].47	1.36	4.16	[d]5.54	5.26	[d].28
Intermediate:							
2022	.69	.08	.03	4.49	6.52	4.54	1.98
2023	1.83	.04	-.58	2.11	4.77	2.33	2.44
2024	2.00	[e]	-.58	2.05	4.31	2.40	1.91
2025	2.12	-.03	-.32	2.05	4.07	2.40	1.67
2026	1.73	-.03	-.05	2.05	3.96	2.40	1.56
2027	1.62	-.05	-.05	2.05	3.86	2.40	1.46
2028	1.61	-.05	-.05	2.05	3.77	2.40	1.37
2029	1.62	-.05	-.05	2.05	3.69	2.40	1.29
2030	1.63	-.09	-.05	2.05	3.65	2.40	1.25
2031	1.63	-.09	-.05	2.05	3.64	2.40	1.24
2031 to 2096 . . .	1.63	-.10	-.05	2.05	3.55	2.40	1.15

Table V.B1.—Principal Economic Assumptions (Cont.)

Calendar year	Annual percentage change[a] in— Productivity (Total U.S. economy)	Earnings as a percent of total labor compensation	Average hours worked	GDP price index	Average annual wage in covered employment	Consumer Price Index	Real-wage differential[b]
Low-cost:							
2022	0.85	0.10	0.03	4.90	6.99	5.14	1.86
2023	2.46	.06	-.58	2.80	6.87	3.00	3.87
2024	2.33	.01	-.38	2.75	5.82	3.00	2.82
2025	1.89	[e]	.04	2.75	5.01	3.00	2.01
2026	1.93	.01	.05	2.75	5.04	3.00	2.04
2027	1.93	[e]	.05	2.75	5.07	3.00	2.07
2028	1.93	.01	.05	2.75	5.02	3.00	2.02
2029	1.93	.02	.05	2.75	4.95	3.00	1.95
2030	1.93	-.01	.05	2.75	4.90	3.00	1.90
2031	1.93	-.01	.05	2.75	4.91	3.00	1.91
2031 to 2096	1.93	-.01	.05	2.75	4.77	3.00	1.77
High-cost:							
2022	.03	.04	-.33	4.03	4.50	3.92	.58
2023	2.16	.06	-1.16	.83	1.59	1.02	.57
2024	1.50	-.02	-.44	1.08	3.23	1.53	1.70
2025	1.10	-.07	[e]	1.34	2.98	1.79	1.19
2026	1.29	-.08	-.05	1.35	3.04	1.80	1.24
2027	1.24	-.11	-.15	1.35	2.74	1.80	.94
2028	1.24	-.11	-.15	1.35	2.50	1.80	.70
2029	1.30	-.12	-.15	1.35	2.43	1.80	.63
2030	1.33	-.17	-.15	1.35	2.39	1.80	.59
2031	1.33	-.18	-.15	1.35	2.38	1.80	.58
2031 to 2096	1.33	-.18	-.15	1.35	2.33	1.80	.53

[a] For rows with a single year listed, the value is the annual percentage change from the prior year. For rows with a range of years listed, the value is the compound average annual percentage change.
[b] For rows with a single year listed, the value is the annual percentage change in the average annual wage in covered employment less the annual percentage change in the Consumer Price Index. For rows with a range of years listed, the value is the average of annual values of the real wage differential, beginning with the year following the first year of the range. Values are rounded after all computations.
[c] Economic cycles are shown from peak to peak, except for the last cycle, which is not yet complete.
[d] Estimated values for 2021 vary slightly by alternative and are shown for the intermediate assumptions.
[e] Greater than -0.005 and less than 0.005 percent.

5. Labor Force, Employment, and Unemployment Projections

Employment is a fundamental component of economic output (GDP), taxable payroll, and the determination of OASDI benefit eligibility and benefit levels. U.S. employment is projected in two components: the size of the labor force (those employed or seeking employment) and the unemployment rate (the proportion of those in the labor force who are not employed). Table V.B2 provides the historical and projected rates of change in employment, which follow from the rates of change in the labor force, adjusted for the varying unemployment rates from year to year.

The model used by the Office of the Chief Actuary projects the civilian labor force by age, sex, marital status, and presence of children. Projections of the labor force participation rates reflect changes in disability prevalence, educa-

tional attainment, marriage patterns, the average level of Social Security retirement benefits, the state of the economy, and life expectancy.

The annual rate of growth in the size of the labor force decreased from an average of about 2.6 percent during the 1969-73 economic cycle and 2.7 percent during the 1973-79 cycle to 1.7 percent during the 1979-90 cycle, 1.2 percent during the 1990-2001 cycle, 1.1 percent during the 2001-07 cycle, and 0.5 percent during the 2007-19 cycle. From 2019 to 2021, during the current (incomplete) economic cycle, labor force growth averaged -0.7 percent per year, reflecting the shrinking of the labor force during the pandemic-induced recession of 2020 and its aftermath. Going forward, labor force growth is expected to remain subdued due to a slowing of growth in the working-age population—a consequence of the baby-boom generation reaching retirement ages and succeeding lower-birth-rate cohorts reaching working ages. Under the intermediate assumptions, the labor force is projected to increase by an average of 0.8 percent per year from 2021 to 2031 and 0.4 percent per year from 2031 to 2096.

Labor force participation rates are projected with a model that uses demographic and economic assumptions specific to each alternative. More optimistic economic assumptions in the low-cost alternative are consistent with higher labor force participation rates, while demographic assumptions in the low-cost alternative (such as slower improvement in longevity) are consistent with lower labor force participation rates. These economic and demographic influences have largely offsetting effects. Therefore, the projected labor force participation rates do not vary substantially across alternatives.

Historically, labor force participation rates reflect trends in demographics and pensions. Between the mid-1960s and the mid-1980s, labor force participation rates at ages 50 and over declined for men but were fairly stable for women. During this period, the baby-boom generation reached working age and more women entered the labor force. This increasing supply of labor allowed employers to offer attractive early retirement options. Between the mid-1980s and the mid-1990s, participation rates at ages 55 and older roughly stabilized for men and increased for women. Since the mid-1990s, however, participation rates for both sexes at ages 50 and over have generally risen.

Many economic and demographic factors, including longevity, disability prevalence, the business cycle, incentives for retirement in Social Security and private pensions, education, and marriage patterns, will influence future labor force participation rates. The Office of the Chief Actuary models some of these factors explicitly. In particular for this year’s report, future disability prevalence is assumed to be lower than in the 2021 report due to the change

in the ultimate disability incidence assumption from 5.0 to 4.8 per thousand exposed. This change increases the projected total labor force by 0.2 percent for 2096. To model the effects of other factors related to increases in life expectancy, projected participation rates are adjusted upward for mid-career and older ages to reflect projected increases in life expectancy. For the intermediate projections, this adjustment increases the total labor force by 2.9 percent for 2096.

For men age 16 and over, the projected age-adjusted labor force participation rates[1] for 2096 are 72.8, 72.5, and 71.9 percent for the low-cost, intermediate, and high-cost assumptions, respectively. For women age 16 and over, the projected age-adjusted labor force participation rates for 2096 are 62.5, 62.1, and 61.7 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These age-adjusted labor force participation rates for 2096 are higher under all three alternatives than the age-adjusted rates for 2020 of 70.1 percent for men and 58.6 percent for women (based on actual age-specific rates published by the Bureau of Labor Statistics), primarily due to the projected continued recovery from the latest recession and the Trustees' projected increases in life expectancy.

The total civilian unemployment rates are presented in table V.B2. For years through 2031, the table presents total civilian rates without adjustment for the changing age-sex distribution of the population. For years after 2031, the table presents age-sex-adjusted rates, using the age-sex distribution of the 2011 civilian labor force. Age-sex-adjusted rates allow for more meaningful comparisons across longer time periods.

The total civilian unemployment rate reflects the projected levels of unemployment for various age-sex groups of the population. Each group's unemployment rate gradually approaches an assumed stable value within the first ten years of the projection period for all alternatives, and thus the total age-sex-adjusted civilian unemployment rate reaches its ultimate assumed value within the first ten years of the projection period.

The assumed ultimate age-sex-adjusted unemployment rates are 3.5, 4.5, and 5.5 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These values are unchanged from the 2021 report. The Trustees assume that, as the economy continues to recover from the most recent recession, the unemployment rate will decrease from 5.4 percent for 2021 to the assumed 4.5 percent for 2026 under the intermediate assumptions. Under the low-cost assumptions, the ultimate unemployment rate is reached in 2023.

[1] The Office of the Chief Actuary adjusts the labor force participation rates to the 2011 age distribution of the civilian noninstitutional U.S. population.

Under the high-cost assumptions, the unemployment rate declines to 5.3 percent in 2022, then rises to 6.7 percent in 2023, and then gradually decreases to the ultimate unemployment rate in 2028.[1]

6. Gross Domestic Product Projections

The value of real GDP is equal to the product of three components: (1) productivity (i.e., output per hour worked), (2) average weekly total employment,[2] and (3) average hours worked per week, times 52. Consequently, the growth rate in real GDP is equal to the combined growth rates for productivity, total employment, and average hours worked. For the period from 1969 to 2019, which covers the last six complete economic cycles, the average annual growth in real GDP was 2.7 percent, combining average growth rates of 1.6 percent for productivity, 1.3 percent for total employment, and -0.2 percent for average hours worked ($1.027 = 1.016 \times 1.013 \times 0.998$). The real GDP growth rate was -3.4 percent for 2020 and is estimated to be 5.7 percent for 2021.

For the intermediate assumptions, the average annual growth in real GDP is 2.3 percent from 2021 to 2031, combining the average growth rates of 1.65 percent for productivity, 0.86 percent for total employment, and -0.18 percent for average hours worked. The projected average annual growth in real GDP of 2.3 percent from 2021 to 2031 is higher than the underlying sustainable trend rate of 2.1 percent, due to the assumed recovery from the recession. After 2031, the annual growth in real GDP follows the sustainable trend rate and averages 2.0 percent, which combines the projected ultimate annual growth rate of 1.63 percent for productivity, average annual growth rate of 0.40 percent for total employment, and the ultimate annual growth rate of -0.05 percent for average hours worked per week. The projected growth rate of real GDP is lower than the past average growth rate mainly because the working-age population is expected to grow more slowly than in the past.

For the low-cost assumptions, the annual growth in real GDP averages 3.1 percent from 2021 to 2031 and 2.7 percent from 2031 to 2096. For the high-cost assumptions, the annual growth in real GDP averages 1.5 percent from 2021 to 2031 and 1.2 percent from 2031 to 2096.

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[1] The assumed ultimate unemployment rates are age-sex-adjusted rates. For the intermediate and high-cost assumptions, the age-sex-adjusted unemployment rate in 2028 through 2031 is 4.5 and 5.5 percent, respectively, while the unadjusted rate is 4.4 and 5.4 percent, respectively, as shown in table V.B2.

[2] Total employment is the sum of the U.S. Armed Forces and total civilian employment, which can be expressed as a product of the total civilian labor force and the complement of the unemployment rate.

7. Interest Rates

Table V.B2 presents average annual nominal and real interest rates for newly issued trust fund securities. The nominal rate is the average of the nominal interest rates for special U.S. Government obligations issuable to the trust funds in each of the 12 months of the year. Interest for these securities is compounded semiannually, or at redemption if sooner. The real interest rate is defined as the annual yield rate for investments in these securities divided by the annual rate of growth in the CPI for the first year after issuance. The real rate shown for each year reflects the actual realized (historical) or expected (future) real yield on securities issuable in the prior year.

To develop a reasonable range of assumed ultimate future real interest rates for the three alternatives, the Office of the Chief Actuary examined historical experience for the last six complete economic cycles. For the period from 1969 to 2019, the real interest rate averaged 2.4 percent per year. The real interest rates averaged 1.6, -1.0, 5.1, 4.1, 2.0, and 0.8 percent per year over the economic cycles 1969-73, 1973-79, 1979-90, 1990-2001, 2001-07, and 2007-19, respectively. The assumed ultimate real interest rates are 2.8 percent, 2.3 percent, and 1.8 percent for the low-cost, intermediate, and high-cost assumptions, respectively. These rates are unchanged from the 2021 report.

The average annual nominal interest rate was approximately 1.0 percent for securities newly issuable in 2020, implying an effective annual yield of 1.0 percent for securities held one year. The CPI rose from 2020 to 2021 by approximately 5.3 percent. The annual real interest rate for 2021 was therefore -4.1 percent ($1.010 / 1.053 = 0.959 = 1 - 0.041$). From 2021 to 2031, projected nominal interest rates depend on changes in the economic cycle and in the CPI. When combined with the ultimate CPI assumptions of 3.0, 2.4, and 1.8 percent, the assumed ultimate real interest rates produce ultimate nominal interest rates of 5.8 percent for the low-cost assumptions, 4.7 percent for the intermediate assumptions, and 3.6 percent for the high-cost assumptions. These nominal rates for newly issued trust fund securities reach their ultimate levels by 2031.

Table V.B2.—Additional Economic Factors

Calendar year	Average annual unemployment rate[a]	Annual percentage change[b] in— Labor force[c]	Total employment[d]	Real GDP[e]	Average annual interest rate Nominal[f]	Real[g]
Historical data:						
5-year periods:						
1960 to 1965	5.5	1.3	1.6	5.1	4.0	2.5
1965 to 1970	3.9	2.2	2.1	3.5	5.9	1.0
1970 to 1975	6.1	2.5	1.5	2.7	6.7	[h]
1975 to 1980	6.8	2.7	2.9	3.7	8.5	-.9
1980 to 1985	8.3	1.5	1.5	3.3	12.1	6.9
1985 to 1990	5.9	1.7	2.0	3.3	8.5	5.1
1990 to 1995	6.6	1.0	.9	2.6	7.0	4.3
1995 to 2000	4.6	1.5	1.8	4.3	6.2	3.9
2000 to 2005	5.4	.9	.7	2.6	4.6	2.4
2005 to 2010	6.8	.6	-.4	1.0	3.8	1.8
2010 to 2015	7.2	.4	1.3	2.1	2.0	.5
2015 to 2020	5.0	.5	-.2	1.1	2.0	.5
Economic cycles:[i]						
1969 to 1973	5.3	2.6	1.8	3.6	6.5	1.6
1973 to 1979	6.8	2.7	2.4	3.0	7.7	-1.0
1979 to 1990	7.1	1.7	1.7	3.0	10.3	5.1
1990 to 2001	5.5	1.2	1.2	3.2	6.5	4.1
2001 to 2007	5.3	1.1	1.1	2.8	4.5	2.0
2007 to 2019	6.4	.5	.6	1.7	2.4	.8
2019 to 2021	6.7	[j]-.7	[j]-1.6	[j]1.0	1.2	-1.6
Single years:						
2011	8.9	-.2	.6	1.5	2.4	-.7
2012	8.1	.9	1.8	2.3	1.5	.3
2013	7.4	.3	1.0	1.8	1.9	.1
2014	6.2	.3	1.6	2.3	2.3	.4
2015	5.3	.8	1.7	2.7	2.0	2.7
2016	4.9	1.3	1.7	1.7	1.8	1.0
2017	4.4	.7	1.2	2.3	2.3	-.3
2018	3.9	1.1	1.6	2.9	2.9	-.2
2019	3.7	.9	1.1	2.3	2.2	1.2
2020	8.1	-1.7	-6.2	-3.4	1.0	1.0
2021	5.4	[j].3	[j]3.2	[j]5.7	1.4	-4.1

Table V.B2.—Additional Economic Factors (Cont.)

Calendar year	Average annual unemployment rate[a]	Annual percentage change[b] in—			Average annual interest rate	
		Labor force[c]	Total employment[d]	Real GDP[e]	Nominal[f]	Real[g]
Intermediate:						
2022	4.0	1.7	3.1	3.9	1.8	-3.0
2023	4.0	1.6	1.6	2.8	2.3	-.5
2024	4.2	1.2	1.0	2.4	2.9	-.1
2025	4.4	.6	.4	2.2	3.3	.5
2026	4.5	.4	.4	2.0	3.7	.9
2027	4.5	.4	.5	2.0	4.1	1.3
2028	4.4	.4	.4	2.0	4.3	1.7
2029	4.4	.5	.5	2.0	4.5	1.9
2030	4.4	.4	.4	2.0	4.6	2.1
2031	4.4	.4	.4	2.0	4.7	2.2
2035	4.5	.4	.4	2.0	4.7	2.3
2040	4.5	.3	.3	1.9	4.7	2.3
2045	4.5	.3	.3	1.9	4.7	2.3
2050	4.5	.4	.4	2.0	4.7	2.3
2055	4.5	.4	.4	2.0	4.7	2.3
2060	4.5	.4	.4	2.0	4.7	2.3
2065	4.5	.4	.4	2.0	4.7	2.3
2070	4.5	.3	.3	1.9	4.7	2.3
2075	4.5	.4	.4	2.0	4.7	2.3
2080	4.5	.4	.4	2.0	4.7	2.3
2085	4.5	.5	.5	2.1	4.7	2.3
2090	4.5	.5	.5	2.1	4.7	2.3
2095	4.5	.5	.5	2.1	4.7	2.3
2100	4.5	.4	.4	2.0	4.7	2.3
Low-cost:						
2022	3.8	2.0	3.7	4.6	2.4	-3.6
2023	3.5	2.0	2.3	4.2	3.4	-.5
2024	3.5	1.1	1.1	3.1	3.9	.5
2025	3.5	.8	.8	2.8	4.4	.9
2026	3.5	.7	.7	2.7	4.8	1.4
2027	3.5	.7	.7	2.7	5.1	1.8
2028	3.5	.6	.6	2.6	5.4	2.1
2029	3.5	.7	.7	2.7	5.6	2.4
2030	3.5	.6	.6	2.6	5.7	2.6
2031	3.5	.6	.6	2.6	5.8	2.7
2035	3.5	.6	.6	2.5	5.8	2.8
2040	3.5	.5	.5	2.5	5.8	2.8
2045	3.5	.6	.6	2.6	5.8	2.8
2050	3.5	.7	.7	2.7	5.8	2.8
2055	3.5	.7	.7	2.7	5.8	2.8
2060	3.5	.7	.7	2.7	5.8	2.8
2065	3.5	.6	.6	2.6	5.8	2.8
2070	3.5	.6	.6	2.6	5.8	2.8
2075	3.5	.7	.7	2.7	5.8	2.8
2080	3.5	.8	.7	2.7	5.8	2.8
2085	3.5	.8	.8	2.8	5.8	2.8
2090	3.5	.8	.8	2.8	5.8	2.8
2095	3.5	.7	.7	2.7	5.8	2.8
2100	3.5	.7	.7	2.7	5.8	2.8

Table V.B2.—Additional Economic Factors (Cont.)

Calendar year	Average annual unemployment rate[a]	Annual percentage change[b] in— Labor force[c]	Total employment[d]	Real GDP[e]	Average annual interest rate Nominal[f]	Real[g]
High-cost:						
2022	5.3	0.6	0.7	0.4	1.1	-2.4
2023	6.7	1.2	-.4	.6	1.2	.1
2024	6.2	1.1	1.7	2.8	2.2	-.3
2025	5.8	.7	1.1	2.2	2.6	.4
2026	5.6	.4	.7	1.9	2.9	.8
2027	5.4	.4	.5	1.6	3.1	1.1
2028	5.4	.3	.3	1.4	3.2	1.3
2029	5.4	.3	.3	1.5	3.4	1.4
2030	5.4	.3	.3	1.4	3.6	1.6
2031	5.4	.2	.2	1.4	3.6	1.8
2035	5.5	.2	.2	1.4	3.6	1.8
2040	5.5	.1	.1	1.3	3.6	1.8
2045	5.5	[h]	[h]	1.2	3.6	1.8
2050	5.5	[h]	[h]	1.2	3.6	1.8
2055	5.5	[h]	[h]	1.2	3.6	1.8
2060	5.5	[h]	[h]	1.2	3.6	1.8
2065	5.5	[h]	[h]	1.2	3.6	1.8
2070	5.5	-.1	-.1	1.1	3.6	1.8
2075	5.5	-.1	-.1	1.1	3.6	1.8
2080	5.5	-.1	-.1	1.1	3.6	1.8
2085	5.5	-.1	-.1	1.1	3.6	1.8
2090	5.5	[h]	[h]	1.2	3.6	1.8
2095	5.5	[h]	[h]	1.2	3.6	1.8
2100	5.5	[h]	[h]	1.2	3.6	1.8

[a] The Office of the Chief Actuary adjusts the civilian unemployment rates for 2032 and later to the age-sex distribution of the civilian labor force in 2011. For years through 2031, the values are the total rates without adjustment for the changing age-sex distribution.

[b] For rows with a single year listed, the value is the annual percentage change from the prior year. For rows with a range of years listed, the value is the compounded average annual percentage change.

[c] The U.S. civilian labor force.

[d] Total U.S. military and civilian employment.

[e] The value of the total output of goods and services in 2012 dollars.

[f] The average of the nominal interest rates, compounded semiannually, for special public-debt obligations issuable to the trust funds in each of the 12 months of the year.

[g] The realized or expected annual real yield for each year on securities issuable in the prior year.

[h] Greater than -0.05 and less than 0.05 percent.

[i] Economic cycles are shown from peak to peak, except for the last cycle, which is not yet complete.

[j] Historical data are not available for the full year. Estimated values vary slightly by alternative and are shown for the intermediate assumptions.

C. PROGRAM-SPECIFIC ASSUMPTIONS AND METHODS

The Office of the Chief Actuary at the Social Security Administration uses a set of models to project future income and cost under the OASDI program. These models rely not only on the demographic and economic assumptions described in the previous sections, but also on a number of program-specific assumptions and methods. Values of many program parameters change from year to year as prescribed by formulas set out in the Social Security Act. These program parameters affect the level of payroll taxes collected and the level of benefits paid. The office uses complex models to project the numbers of future workers covered under OASDI and the levels of their covered earnings, as well as the numbers of future beneficiaries and the expected levels of their benefits. The following subsections provide descriptions of these program-specific assumptions and methods.

1. Automatically Adjusted Program Parameters

The Social Security Act requires that certain parameters affecting the determination of OASDI benefits and taxes be adjusted annually to reflect changes in particular economic measures. Formulas prescribed in the law, applied to reported statistics, change these program parameters annually. The law bases these automatic adjustments on measured changes in the national average wage index (AWI) and the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI).[1] This section shows values for program parameters adjusted using these indices from the time that these adjustments became effective through 2031. Projected values for future years depend on the economic assumptions described in the preceding section of this report.

Tables V.C1 and V.C2 present the historical and projected values of the CPI-based benefit increases, the AWI series, and the values of many of the wage-indexed program parameters. Each table shows projections under the three alternative sets of assumptions. Table V.C1 includes:

- *The annual cost-of-living benefit increase percentages.* The automatic cost-of-living adjustment provisions in the Social Security Act specify increases in OASDI monthly benefits based on increases in the CPI. Volatility in oil prices has resulted in substantial volatility in cost-of-living adjustments over the last two decades. A large cost-of-living adjustment for December 2008 was followed by no cost-of-living adjustments for December 2009 and December 2010. More recent volatility in oil

[1] The *Federal Register* publishes details of these indexation procedures annually. Also see www.ssa.gov/OACT/COLA/.

prices again affected the CPI, resulting in no cost-of-living adjustment for December 2015. Cost-of-living adjustments resumed in December 2016. All three sets of assumptions include annual cost-of-living adjustments for all future years.

- *The annual levels of and percentage increases in the AWI.* Under section 215(b)(3) of the Social Security Act, Social Security benefit computations index taxable earnings (for most workers first becoming eligible for benefits in 1979 or later) using the AWI for each year after 1950. This procedure converts a worker's past earnings to approximately average-wage-indexed equivalent values near the time of his or her benefit eligibility. Other program parameters presented in this section that are subject to the automatic-adjustment provisions also rely on the AWI.
- *The wage-indexed contribution and benefit base.* For any year, the contribution and benefit base is the maximum amount of earnings subject to the OASDI payroll tax and creditable toward benefit computation. The Social Security Act defers any increase in the contribution and benefit base if there is no cost-of-living adjustment effective for December of the preceding year. There was no increase in the contribution and benefit base for 2010, 2011, or 2016 because there was no cost-of-living adjustment for the immediate prior December in each case. Under all three sets of assumptions, the contribution and benefit base is projected to increase for all future years.
- *The wage-indexed retirement earnings test exempt amounts.* The exempt amounts are the annual amount of earnings below which beneficiaries do not have benefits withheld. A lower exempt amount applies for years prior to the year of attaining normal retirement age. A higher exempt amount applies beginning with the year in which a beneficiary attains normal retirement age. Starting in 2000, the retirement earnings test no longer applies beginning with the month of attaining normal retirement age. The Social Security Act defers any increase in these exempt amounts if there is no cost-of-living adjustment effective for December of the preceding year. There was no increase in these exempt amounts for 2010, 2011, or 2016 because there was no cost-of-living adjustment for the immediate prior December. Under all three sets of assumptions, the exempt amounts increase for all future years.

Table V.C1.—Cost-of-Living Benefit Increases, Average Wage Index, Contribution and Benefit Bases, and Retirement Earnings Test Exempt Amounts, 1975-2031

Calendar year	Cost-of-living benefit increase[a] (percent)	Average wage index (AWI)[b] Amount	Average wage index (AWI)[b] Increase (percent)	Contribution and benefit base[c]	Retirement earnings test exempt amount Under NRA[d]	Retirement earnings test exempt amount At NRA[e]
Historical data:						
1975	8.0	$8,630.92	7.5	$14,100	$2,520	$2,520
1976	6.4	9,226.48	6.9	15,300	2,760	2,760
1977	5.9	9,779.44	6.0	16,500	3,000	3,000
1978	6.5	10,556.03	7.9	17,700	3,240	4,000
1979	9.9	11,479.46	8.7	22,900	3,480	4,500
1980	14.3	12,513.46	9.0	25,900	3,720	5,000
1981	11.2	13,773.10	10.1	29,700	4,080	5,500
1982	7.4	14,531.34	5.5	32,400	4,440	6,000
1983	3.5	15,239.24	4.9	35,700	4,920	6,600
1984	3.5	16,135.07	5.9	37,800	5,160	6,960
1985	3.1	16,822.51	4.3	39,600	5,400	7,320
1986	1.3	17,321.82	3.0	42,000	5,760	7,800
1987	4.2	18,426.51	6.4	43,800	6,000	8,160
1988	4.0	19,334.04	4.9	45,000	6,120	8,400
1989	4.7	20,099.55	4.0	48,000	6,480	8,880
1990	5.4	21,027.98	4.6	51,300	6,840	9,360
1991	3.7	21,811.60	3.7	53,400	7,080	9,720
1992	3.0	22,935.42	5.2	55,500	7,440	10,200
1993	2.6	23,132.67	.9	57,600	7,680	10,560
1994	2.8	23,753.53	2.7	60,600	8,040	11,160
1995	2.6	24,705.66	4.0	61,200	8,160	11,280
1996	2.9	25,913.90	4.9	62,700	8,280	12,500
1997	2.1	27,426.00	5.8	65,400	8,640	13,500
1998	1.3	28,861.44	5.2	68,400	9,120	14,500
1999	[f]2.5	30,469.84	5.6	72,600	9,600	15,500
2000	3.5	32,154.82	5.5	76,200	10,080	17,000
2001	2.6	32,921.92	2.4	80,400	10,680	25,000
2002	1.4	33,252.09	1.0	84,900	11,280	30,000
2003	2.1	34,064.95	2.4	87,000	11,520	30,720
2004	2.7	35,648.55	4.6	87,900	11,640	31,080
2005	4.1	36,952.94	3.7	90,000	12,000	31,800
2006	3.3	38,651.41	4.6	94,200	12,480	33,240
2007	2.3	40,405.48	4.5	97,500	12,960	34,440
2008	5.8	41,334.97	2.3	102,000	13,560	36,120
2009	.0	40,711.61	-1.5	106,800	14,160	37,680
2010	.0	41,673.83	2.4	106,800	14,160	37,680
2011	3.6	42,979.61	3.1	106,800	14,160	37,680
2012	1.7	44,321.67	3.1	110,100	14,640	38,880
2013	1.5	44,888.16	1.3	113,700	15,120	40,080
2014	1.7	46,481.52	3.5	117,000	15,480	41,400
2015	.0	48,098.63	3.5	118,500	15,720	41,880
2016	.3	48,642.15	1.1	118,500	15,720	41,880
2017	2.0	50,321.89	3.5	127,200	16,920	44,880
2018	2.8	52,145.80	3.6	128,400	17,040	45,360
2019	1.6	54,099.99	3.7	132,900	17,640	46,920
2020	1.3	55,628.60	2.8	137,700	18,240	48,600

Table V.C1.—Cost-of-Living Benefit Increases, Average Wage Index, Contribution and Benefit Bases, and Retirement Earnings Test Exempt Amounts, 1975-2031 (Cont.)

Calendar year	Cost-of-living benefit increase[a] (percent)	Average wage index (AWI)[b] Amount	Average wage index (AWI)[b] Increase (percent)	Contribution and benefit base[c]	Retirement earnings test exempt amount Under NRA[d]	Retirement earnings test exempt amount At NRA[e]
Intermediate:						
2021	[g]5.9	$58,743.07	5.6	[g]$142,800	[g]$18,960	[g]$50,520
2022	3.8	62,583.15	6.5	[g]147,000	[g]19,560	[g]51,960
2023	2.5	65,571.72	4.8	155,100	20,640	54,840
2024	2.4	68,371.79	4.3	165,300	21,960	58,440
2025	2.4	71,147.65	4.1	173,400	23,040	61,200
2026	2.4	73,980.60	4.0	180,600	24,000	63,840
2027	2.4	76,857.74	3.9	188,100	24,960	66,360
2028	2.4	79,761.29	3.8	195,600	25,920	69,000
2029	2.4	82,702.63	3.7	203,100	27,000	71,760
2030	2.4	85,713.03	3.6	210,600	27,960	74,400
2031	2.4	88,836.46	3.6	218,400	29,040	77,160
Low-cost:						
2021	[g]5.9	58,757.18	5.6	[g]142,800	[g]18,960	[g]50,520
2022	4.6	62,852.52	7.0	[g]147,000	[g]19,560	[g]51,960
2023	3.0	67,130.25	6.8	155,100	20,640	54,840
2024	3.0	70,999.01	5.8	166,200	22,080	58,680
2025	3.0	74,558.14	5.0	177,300	23,520	62,640
2026	3.0	78,330.86	5.1	187,500	24,840	66,240
2027	3.0	82,316.43	5.1	197,100	26,160	69,600
2028	3.0	86,451.88	5.0	207,000	27,480	73,080
2029	3.0	90,722.28	4.9	217,500	28,800	76,800
2030	3.0	95,162.12	4.9	228,300	30,360	80,640
2031	3.0	99,831.80	4.9	239,700	31,800	84,600
High-cost:						
2021	[g]5.9	58,728.91	5.6	[g]142,800	[g]18,960	[g]50,520
2022	3.1	61,441.05	4.6	[g]147,000	[g]19,560	[g]51,960
2023	1.1	62,461.55	1.7	155,100	20,640	54,840
2024	1.6	64,422.99	3.1	162,300	21,480	57,360
2025	1.8	66,330.90	3.0	165,000	21,840	58,320
2026	1.8	68,361.44	3.1	170,100	22,560	60,120
2027	1.8	70,254.36	2.8	175,200	23,280	61,920
2028	1.8	72,021.11	2.5	180,600	24,000	63,840
2029	1.8	73,775.14	2.4	185,700	24,600	65,520
2030	1.8	75,544.17	2.4	190,200	25,200	67,200
2031	1.8	77,352.07	2.4	195,000	25,920	68,880

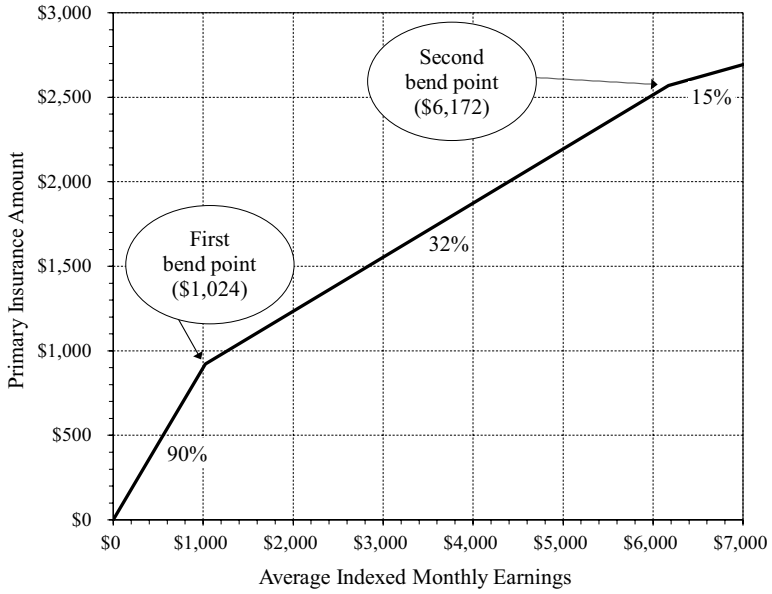
[a] Effective with benefits payable for June in each year 1975-82, and for December in each year after 1982.
[b] See table VI.G6 for projected dollar amounts of the AWI for years beyond the last year of this table.
[c] Public Law 95-216 specified amounts for 1978-81. Public Law 101-239 changed the indexing procedure and caused slightly higher bases after 1989.
[d] Normal retirement age. See table V.C3 for specific values.
[e] In 1955-82, the retirement earnings test did not apply at ages 72 and over. In 1983-99, the test did not apply at ages 70 and over. Beginning in 2000, the test does not apply beginning with the month of normal retirement age attainment. In the year of normal retirement age attainment, the higher exempt amount applies to earnings prior to the month of normal retirement age attainment. Public Law 95-216 specified amounts for 1978-82. Public Law 104-121 specified amounts for 1996-2002.
[f] Originally determined as 2.4 percent. Pursuant to Public Law 106-554, effectively 2.5 percent.
[g] Actual amount, as determined under automatic-adjustment provisions.

Table V.C2 shows values for other wage-indexed parameters. The table provides historical values from 1978, when indexing of the amount of earnings required for a quarter of coverage first began, through 2022, and also shows

projected values through 2031. These other wage-indexed program parameters are:

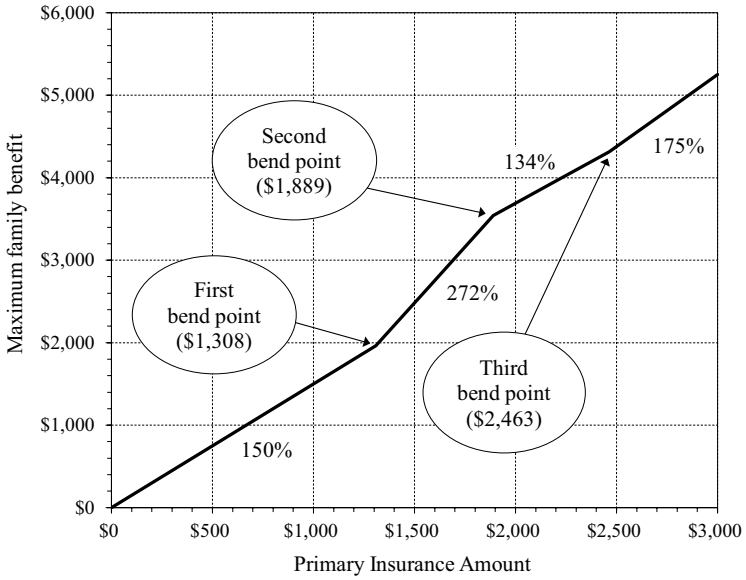
- *The bend points in the formula for computing the primary insurance amount (PIA) for workers who reach age 62, become disabled, or die in a given year.* As figure V.C1 illustrates, these two bend points define three ranges in a worker's average indexed monthly earnings (AIME). The formula for the worker's PIA multiplies a 90, 32, or 15 percent factor by the portion of the worker's AIME that falls within the three respective ranges, and then adds the resulting products together.

Figure V.C1.—Primary-Insurance-Amount Formula for Those Newly Eligible in 2022



- *The bend points in the formula for computing the maximum total amount of monthly benefits payable based on the earnings record of a retired or deceased worker (maximum family benefit).* As figure V.C2 illustrates, these three bend points define four ranges in a worker's PIA. The formula for the maximum family benefit multiplies a 150, 272, 134, or 175 percent factor by the portion of the worker's PIA that falls within the four respective ranges, and then adds the resulting products together.

Figure V.C2.—OASI Maximum-Family-Benefit Formula for Those Newly Eligible in 2022



- *The amount of earnings required in a year to earn a quarter of coverage (QC).* The number and timing of QCs earned determines an individual's insured status—the basic requirement for benefit eligibility under OASDI.
- *The old-law contribution and benefit base—the contribution and benefit base that would have been in effect without enactment of the 1977 amendments.* This old-law base is used in determining special-minimum benefits for certain workers who have many years of low earnings in covered employment. Since 1986, the calculation of OASDI benefits for certain workers who are eligible to receive pensions based on non-covered employment uses the old-law base. In addition, the Railroad Retirement program and the Employee Retirement Income Security Act of 1974 use the old-law base for certain purposes.

Table V.C2.—Values for Selected Wage-Indexed Program Parameters, Calendar Years 1978-2031

Calendar year	AIME bend points in PIA formula[a] First	AIME bend points in PIA formula[a] Second	PIA bend points in OASI maximum-family-benefit formula[b] First	PIA bend points in OASI maximum-family-benefit formula[b] Second	PIA bend points in OASI maximum-family-benefit formula[b] Third	Earnings required for a quarter of coverage	Old-law contribution and benefit base[c]
Historical data:							
1978	[d]	[d]	[d]	[d]	[d]	[e] $250	[e] $17,700
1979	[e] $180	[e] $1,085	[e] $230	[e] $332	[e] $433	260	18,900
1980	194	1,171	248	358	467	290	20,400
1981	211	1,274	270	390	508	310	22,200
1982	230	1,388	294	425	554	340	24,300
1983	254	1,528	324	468	610	370	26,700
1984	267	1,612	342	493	643	390	28,200
1985	280	1,691	358	517	675	410	29,700
1986	297	1,790	379	548	714	440	31,500
1987	310	1,866	396	571	745	460	32,700
1988	319	1,922	407	588	767	470	33,600
1989	339	2,044	433	626	816	500	35,700
1990	356	2,145	455	656	856	520	38,100
1991	370	2,230	473	682	890	540	39,600
1992	387	2,333	495	714	931	570	41,400
1993	401	2,420	513	740	966	590	42,900
1994	422	2,545	539	779	1,016	620	45,000
1995	426	2,567	544	785	1,024	630	45,300
1996	437	2,635	559	806	1,052	640	46,500
1997	455	2,741	581	839	1,094	670	48,600
1998	477	2,875	609	880	1,147	700	50,700
1999	505	3,043	645	931	1,214	740	53,700
2000	531	3,202	679	980	1,278	780	56,700
2001	561	3,381	717	1,034	1,349	830	59,700
2002	592	3,567	756	1,092	1,424	870	63,000
2003	606	3,653	774	1,118	1,458	890	64,500
2004	612	3,689	782	1,129	1,472	900	65,100
2005	627	3,779	801	1,156	1,508	920	66,900
2006	656	3,955	838	1,210	1,578	970	69,900
2007	680	4,100	869	1,255	1,636	1,000	72,600
2008	711	4,288	909	1,312	1,711	1,050	75,900
2009	744	4,483	950	1,372	1,789	1,090	79,200
2010	761	4,586	972	1,403	1,830	1,120	79,200
2011	749	4,517	957	1,382	1,803	1,120	79,200
2012	767	4,624	980	1,415	1,845	1,130	81,900
2013	791	4,768	1,011	1,459	1,903	1,160	84,300
2014	816	4,917	1,042	1,505	1,962	1,200	87,000
2015	826	4,980	1,056	1,524	1,987	1,220	88,200
2016	856	5,157	1,093	1,578	2,058	1,260	88,200
2017	885	5,336	1,131	1,633	2,130	1,300	94,500
2018	895	5,397	1,144	1,651	2,154	1,320	95,400
2019	926	5,583	1,184	1,708	2,228	1,360	98,700
2020	960	5,785	1,226	1,770	2,309	1,410	102,300
2021	996	6,002	1,272	1,837	2,395	1,470	106,200
2022	1,024	6,172	1,308	1,889	2,463	1,510	109,200
Intermediate:							
2023	1,081	6,517	1,382	1,994	2,601	1,590	115,200
2024	1,152	6,943	1,472	2,125	2,771	1,700	122,700
2025	1,207	7,275	1,542	2,226	2,903	1,780	128,700
2026	1,258	7,586	1,608	2,321	3,027	1,850	134,100
2027	1,310	7,894	1,673	2,415	3,150	1,930	139,500
2028	1,362	8,208	1,740	2,512	3,276	2,000	145,200
2029	1,415	8,527	1,808	2,609	3,403	2,080	150,900
2030	1,468	8,849	1,876	2,708	3,532	2,160	156,600
2031	1,522	9,176	1,945	2,808	3,662	2,240	162,300

Table V.C2.—Values for Selected Wage-Indexed Program Parameters, Calendar Years 1978-2031 (Cont.)

Calendar year	AIME bend points in PIA formula[a] First	AIME bend points in PIA formula[a] Second	PIA bend points in OASI maximum-family-benefit formula[b] First	PIA bend points in OASI maximum-family-benefit formula[b] Second	PIA bend points in OASI maximum-family-benefit formula[b] Third	Earnings required for a quarter of coverage	Old-law contribution and benefit base[c]
Low-cost:							
2023	$1,081	$6,519	$1,382	$1,995	$2,602	$1,590	$115,200
2024	1,157	6,973	1,478	2,134	2,783	1,700	123,300
2025	1,236	7,448	1,579	2,279	2,972	1,820	131,700
2026	1,307	7,877	1,670	2,410	3,144	1,920	139,200
2027	1,372	8,272	1,754	2,531	3,301	2,020	146,400
2028	1,442	8,691	1,842	2,659	3,468	2,120	153,600
2029	1,515	9,133	1,936	2,795	3,645	2,230	161,400
2030	1,591	9,592	2,033	2,935	3,828	2,340	169,500
2031	1,670	10,065	2,134	3,080	4,017	2,460	177,900
High-cost:							
2023	1,081	6,516	1,381	1,994	2,600	1,590	115,200
2024	1,131	6,817	1,445	2,086	2,720	1,660	120,600
2025	1,150	6,930	1,469	2,120	2,766	1,690	122,700
2026	1,186	7,148	1,515	2,187	2,852	1,750	126,300
2027	1,221	7,359	1,560	2,252	2,937	1,800	130,200
2028	1,258	7,584	1,608	2,321	3,027	1,850	134,100
2029	1,293	7,795	1,652	2,385	3,111	1,900	137,700
2030	1,326	7,991	1,694	2,445	3,189	1,950	141,300
2031	1,358	8,185	1,735	2,505	3,267	2,000	144,600

[a] The formula to compute a PIA is: (1) 90% of AIME below the first bend point, plus (2) 32% of AIME in excess of the first bend point but not in excess of the second, plus (3) 15% of AIME in excess of the second bend point. The bend points are determined based on the first year a beneficiary becomes eligible for benefits.

[b] The formula to compute an OASI family maximum is: (1) 150% of PIA below the first bend point, plus (2) 272% of PIA in excess of the first bend point but not in excess of the second, plus (3) 134% of PIA in excess of the second bend point but not in excess of the third, plus (4) 175% of PIA in excess of the third bend point. This formula also determines family maximums for disabled workers first eligible after 1978 and entitled before July 1980.

[c] Contribution and benefit base that would have been in effect without enactment of the Social Security Amendments of 1977. Public Law 101-239 changed the indexing procedure and caused slightly higher bases after 1989.

[d] No provision in law for this amount in this year.

[e] Amount specified by Social Security Amendments of 1977.

In addition to the economic factors that affect the determination of OASDI benefits, there are certain legislated changes that affect current and future benefit amounts. Two such changes are the scheduled increases in the normal retirement age and in the delayed retirement credits. Table V.C3 shows the scheduled changes in these parameters and the resulting effects on benefit levels expressed as a percentage of PIA.

Table V.C3.—Legislated Changes in Normal Retirement Age and Delayed Retirement Credits for Persons Attaining Age 62 in Each Year 1986 and Later

Year of birth	Year of attainment of age 62	Normal retirement age (NRA)	Credit for each year of delayed retirement after NRA (percent)	Benefit, as a percentage of PIA, beginning at age —				
				62	65	66	67	70
1924	1986	65	3	80	100	103	106	115
1925	1987	65	3 1/2	80	100	103 1/2	107	117 1/2
1926	1988	65	3 1/2	80	100	103 1/2	107	117 1/2
1927	1989	65	4	80	100	104	108	120
1928	1990	65	4	80	100	104	108	120
1929	1991	65	4 1/2	80	100	104 1/2	109	122 1/2
1930	1992	65	4 1/2	80	100	104 1/2	109	122 1/2
1931	1993	65	5	80	100	105	110	125
1932	1994	65	5	80	100	105	110	125
1933	1995	65	5 1/2	80	100	105 1/2	111	127 1/2
1934	1996	65	5 1/2	80	100	105 1/2	111	127 1/2
1935	1997	65	6	80	100	106	112	130
1936	1998	65	6	80	100	106	112	130
1937	1999	65	6 1/2	80	100	106 1/2	113	132 1/2
1938	2000	65, 2 mo	6 1/2	79 1/6	98 8/9	105 5/12	111 11/12	131 5/12
1939	2001	65, 4 mo	7	78 1/3	97 7/9	104 2/3	111 2/3	132 2/3
1940	2002	65, 6 mo	7	77 1/2	96 2/3	103 1/2	110 1/2	131 1/2
1941	2003	65, 8 mo	7 1/2	76 2/3	95 5/9	102 1/2	110	132 1/2
1942	2004	65, 10 mo	7 1/2	75 5/6	94 4/9	101 1/4	108 3/4	131 1/4
1943-54	2005-16	66	8	75	93 1/3	100	108	132
1955	2017	66, 2 mo	8	74 1/6	92 2/9	98 8/9	106 2/3	130 2/3
1956	2018	66, 4 mo	8	73 1/3	91 1/9	97 7/9	105 1/3	129 1/3
1957	2019	66, 6 mo	8	72 1/2	90	96 2/3	104	128
1958	2020	66, 8 mo	8	71 2/3	88 8/9	95 5/9	102 2/3	126 2/3
1959	2021	66, 10 mo	8	70 5/6	87 7/9	94 4/9	101 1/3	125 1/3
1960 & later	2022 & later	67	8	70	86 2/3	93 1/3	100	124

2. Covered Employment

Projections of the total U.S. civilian labor force and unemployment rate (see table V.B2) are based on Bureau of Labor Statistics definitions from the Current Population Survey (CPS). These projections represent the average weekly number of employed and unemployed persons, age 16 and over, in the U.S. in a calendar year. Covered employment for a calendar year is defined as the total number of persons who have any OASDI covered earnings (that is, earnings subject to the OASDI payroll tax) at any time during that year. For those age 16 and over, projected covered employment is the sum of age-sex groups, each reflecting the growth projected for the group's total U.S employment and average weeks worked per year.[1] For the short-range period, the age-sex-adjusted average weeks worked rises slightly as the age-sex-adjusted unemployment rate declines to its ultimate assumed value of 4.5 percent. After 2031, the average weeks worked for each age-sex group

[1] For those under age 16, projected covered employment is the sum of age-sex components, each of which is projected as a ratio to the Social Security area population.

is assumed to remain constant. The projection method also accounts for changes in non-OASDI-covered employment and the increase in coverage of Federal civilian employment as a result of the 1983 Social Security Amendments. It also reflects changes in the number and employment status of other-than-LPR immigrants residing within the Social Security coverage area, such as undocumented immigrants and foreign workers and students with temporary visas.

The covered-worker rate is the ratio of OASDI covered workers to the Social Security area population. For men age 16 and over, the projected age-adjusted covered-worker rates[1] for 2096 are 69.1, 69.3, and 69.5 percent for the low-cost, intermediate, and high-cost assumptions, respectively. For women age 16 and over, the projected age-adjusted covered-worker rates for 2096 are 66.8, 66.4, and 66.1 percent for the low-cost, intermediate, and high-cost assumptions, respectively. An important factor in the variation among the projected rates for the three alternatives is the portion of the men and women in the population that is projected to be other-than-LPR immigrants. For men, the intermediate projected rate for 2096 is lower than the 2020 age-adjusted rate of 70.7 percent primarily due to the projected increase in the portion of the Social Security area population that consists of other-than-LPR immigrants. For women, the intermediate projected rate for 2096 is higher than the 2020 age-adjusted rate of 63.7 percent because the projected increase in the age-adjusted labor force participation rate more than offsets the projected increase in the portion of the population that will be other-than-LPR immigrants.

3. Insured Population

Eligibility for worker benefits under the OASDI program requires some threshold level of work in covered employment. A worker satisfies this requirement by his or her accumulation of quarters of coverage (QCs). Prior to 1978, a worker earned one QC for each calendar quarter in which he or she earned at least $50. In 1978, when annual earnings reporting replaced quarterly reporting, the amount required to earn a QC (up to a maximum of four per year) was set at $250. As specified in the law, the Social Security Administration has adjusted this amount each year since then according to changes in the AWI. Its value in 2022 is $1,510.

There are three types of insured status that a worker can earn under the OASDI program. The number and recency of QCs earned determine each

[1] Age-adjusted covered-worker rates are adjusted to the 2011 age distribution of the Social Security area population.

status. A worker is fully insured when his or her total number of QCs is greater than or equal to the number of years elapsed after the year of attainment of age 21 (but not less than six). After a worker has accumulated 40 QCs, he or she remains permanently fully insured. A worker is disability insured if he or she is: (1) a fully insured worker who has accumulated 20 QCs during the 40-quarter period ending with the current quarter, (2) a fully insured worker aged 24-30 who has accumulated QCs during one-half of the quarters elapsed after the quarter of attainment of age 21 and up to and including the current quarter, or (3) a fully insured worker under age 24 who has accumulated six QCs during the 12-quarter period ending with the current quarter. A worker is currently insured when he or she has accumulated six QCs during the 13-quarter period ending with the current quarter. Periods of disability reduce the number of quarters required for insured status, but not below the minimum of six QCs.

There are many types of benefits payable to workers and their family members under the OASDI program. A worker must be fully insured to be eligible for a primary retirement benefit and for his or her spouse or children to be eligible for auxiliary retirement benefits. A deceased worker must have been either currently insured or fully insured at the time of death for his or her children (and their mother or father) to be eligible for benefits. If there are no eligible surviving children, the deceased worker must have been fully insured at the time of death for his or her surviving spouse to be eligible. A worker must be disability insured to be eligible for a primary disability benefit and for his or her spouse or children to be eligible for auxiliary disability benefits.

The Office of the Chief Actuary estimates the fully insured population, as a percentage of the Social Security area population, by single year of age and sex starting in 1969. The short-range model extrapolates the historical trend in these rates from data in the Continuous Work History Sample (CWHS). The model uses information on quarters of coverage earned due to employment covered by Social Security derived from tabulations of the CWHS. The model also uses historical administrative data on beneficiaries in force and estimated historical mortality rates. The model combines this information to estimate the proportion of individuals who were alive and fully insured as of the end of each historical year. Using projected mortality rates and covered workers, the model extrapolates these rates into the future and applies them to the historical and projected population to arrive at the fully insured population by age and sex through the end of the short-range period.

The long-range fully insured model uses 30,000 simulated work histories for each sex and birth cohort, representing everyone except the other-than-LPR

immigrant population.[1] For the other-than-LPR immigrant population, the model generates substantially lower percentages attaining fully insured status. The model constructs simulated work histories using past coverage rates, earnings distributions, and amounts required for crediting QCs, and develops them in a manner that replicates historical individual variations in work patterns. The probability of covered employment in any year is assumed to be higher for those who have worked more consistently in the recent past. Model parameters are selected so that simulated fully insured percentages are consistent with the fully insured percentages estimated by the short-range model for the recent historical period.

The Office of the Chief Actuary estimates the disability insured population, as a percentage of the fully insured population, by age and sex starting in 1969. The office bases historical values on a tabulation of the disability insured population from the CWHS and estimates of the fully insured population. The short-range model projects these percentages by using the relationship between the historical percentages and covered-worker rates. The long-range model projects these percentages by using the same simulated work histories used to project the fully insured percentages. The long-range model makes additional adjustments to the model simulations in order to bring the disability insured percentages in the historical and short-range periods into close agreement with those estimated from the CWHS and the short-range model.

The office does not project the currently insured population because the number of beneficiaries who are entitled to benefits based solely on currently insured status has been very small recently and is likely to remain small in the future.

Using these insured models, the percentage of the Social Security area population aged 62 and over that is fully insured is projected to change from its estimated level of 88.4 for December 31, 2019, to 86.6, 88.5, and 90.9 for December 31, 2100, under the low-cost, intermediate, and high-cost alternatives, respectively. Over the projection period, the percentages for both men and women change significantly. The percentage for men declines, reflecting, in part, increases in the percent of the population that is classified as other-than-LPR immigrants and is thus less likely to have earnings reported and credited to them. The percentage for women increases, reflecting the past substantial growth in the employment of younger cohorts of women. Under the intermediate assumptions, for example, the percentage for men

[1] Those granted legal work authorization through the 2012 Deferred Action for Childhood Arrivals program are included in the simulations.

decreases from 94.1 to 87.5, and the percentage for women increases from 83.6 to 89.4.

4. Old-Age and Survivors Insurance Beneficiaries

The Office of the Chief Actuary projects the number of OASI beneficiaries for each type of benefit separately by the sex of the worker on whose earnings the benefits are based and by the age of the beneficiary. For the long-range period, the office also projects the number of beneficiaries by marital status for several types of benefits. The office uses two separate models in making these projections. The short-range model makes projections during the first 10 years of the projection period and the long-range model makes projections thereafter.

The short-range model develops the number of retired-worker beneficiaries by applying award rates to the aged fully insured population, excluding those already receiving retired-worker, disabled-worker, aged-widow(er), or aged-spouse benefits, and by applying termination rates to the number of retired-worker beneficiaries.

The long-range model projects the number of retired-worker beneficiaries who were not previously converted from disabled-worker beneficiary status as a percentage of the exposed population.[1] For age 62, the model projects this percentage by using a linear regression based on the historical relationship between this percentage, the employment rate[2] at age 62, and the number of months from age 62 to normal retirement age. The percentage for ages 70 and over is nearly 100 because delayed retirement credits cannot be earned after age 70. The long-range model projects the percentage for each age 63 through 69 based on historical experience with an adjustment for changes in the portion of the primary insurance amount that is payable at each age of entitlement. The model adjusts these percentages for ages 62 through 69 to reflect changes in the normal retirement age.

The long-range model calculates the number of retired-worker beneficiaries previously converted from disabled-worker beneficiary status using an extension of disabled-worker death rates by age, sex, and duration.

The Office of the Chief Actuary estimates the number of aged-spouse beneficiaries, excluding those who are also receiving a retired-worker benefit, from the population projected by age and sex. Benefits of aged-spouse beneficia-

[1] The exposed population is the fully insured population age 62 and over, excluding persons entitled to or converted from disabled-worker benefits and fully insured persons entitled only to widow(er) benefits.

[2] The employment rate is the ratio of U.S. civilian employment to the civilian noninstitutional population.

ries depend on the earnings records of their husbands or wives, who are referred to as "earners." The short-range model projects insured aged-spouse beneficiaries in conjunction with the retired-worker beneficiaries. This model projects uninsured aged-spouse beneficiaries by applying award rates to the aged uninsured male or female population and by applying termination rates to the population already receiving such benefits.

The long-range model estimates aged-spouse beneficiaries separately for those married and divorced. The model projects the number of married aged-spouse beneficiaries, by age and sex, by applying a series of factors to the number of spouses, aged 62 and over, in the population. These factors are the probabilities that the spouse and the earner meet all of the conditions of eligibility—that is, the probabilities that: (1) the earner is 62 or over, (2) the earner is insured, (3) the earner is receiving benefits, (4) the spouse is not receiving a benefit for the care of an entitled child, (5) the spouse is either not insured or is insured but not receiving benefits, and (6) the spouse is not eligible to receive a significant government pension based on earnings from noncovered employment. To calculate the estimated number of aged-spouse beneficiaries, the model applies a projected prevalence rate to the resulting number of spouses. Due to the Bipartisan Budget Act of 2015, for those turning age 62 in 2016 and later, deemed filing now applies to all retired workers and spouses even after initial entitlement, regardless of age. Thus, spouses who are insured are no longer eligible to delay their retired-worker benefit while receiving an aged-spouse benefit.

The long-range model estimates the number of divorced aged-spouse beneficiaries, by age and sex, by applying the same factors to the number of divorced persons aged 62 and over in the population, with three differences. First, the model applies a factor to reflect the probability that the earner (former spouse) is still alive. If the former spouse is not alive, the person may be entitled to a divorced widow(er) benefit. Second, the model applies a factor to reflect the probability that the marriage to the former spouse lasted at least 10 years. Third, the model does not apply factor (3) in the previous paragraph because, effective January 1985, a divorced person is generally no longer required to wait for the former spouse to receive benefits.

The Office of the Chief Actuary bases the projected numbers of children under age 18, and students aged 18 and 19, who are eligible for benefits as children of retired-worker beneficiaries, on the projected number of children in the population. The short-range model develops the number of entitled children by applying award rates to the number of children in the population who have two living parents and by applying termination rates to the number of children already receiving benefits.

The long-range model projects separately the number of entitled children by sex of the earner parent. For each age under 18, the model multiplies the projected number of children with a parent aged 62 and over by the ratio of the number of retired workers aged 62 to 71 to the number of members of the population aged 62 to 71. For student beneficiaries, the model multiplies the number of children aged 18 and 19 in the population by the probabilities that: (1) the parent is alive, aged 62 or over, insured, and receiving a retired-worker benefit; and (2) the child is attending high school.

The Office of the Chief Actuary projects the number of disabled children, aged 18 and over, of retired-worker beneficiaries from the adult population. The short-range model applies award rates to the population and applies termination rates to the number of disabled children already receiving benefits. The long-range model projects the number of disabled children in a manner similar to that used for student children except for a factor that reflects the probability of being disabled before age 22.

The short-range model develops the number of spouses of retired workers, who are entitled to spouse benefits because they are caring for a child who is under age 16 or disabled, by applying award rates to the number of awards to children of retired workers and by applying termination rates to the number of young spouses with a child in their care who are already receiving benefits. The long-range model projects the number of young-spouse beneficiaries with a child in their care as a proportion of the number of child beneficiaries of retired workers, including projected changes in average family size.

The Office of the Chief Actuary projects the number of aged-widow(er) beneficiaries, excluding those who are also receiving a retired-worker benefit, from the population by age and sex. The short-range model projects fully insured aged-widow(er) beneficiaries in conjunction with the retired-worker beneficiaries. The model projects the number of uninsured aged-widow(er) beneficiaries by applying award rates to the aged uninsured male or female population and by applying termination rates to the population already receiving such benefits. The long-range model projects uninsured aged-widow(er) beneficiaries by marital status. The model multiplies the number of widow(er)s in the population aged 60 and over by the probabilities that: (1) the deceased earner is fully insured at death, (2) the widow(er) is not receiving a benefit for the care of an entitled child, (3) the widow(er) is not fully insured, and (4) the widow(er) benefits are not withheld because of receipt of a significant government pension based on earnings in noncovered employment. In addition, the model applies the same factors to the number of divorced persons aged 60 and over in the population and includes addi-

tional factors representing the probability that the person's former earner spouse has died and that the marriage lasted at least 10 years. The model projects the number of insured aged-widow(er) beneficiaries who are ages 60 through 70 in a manner similar to that for uninsured aged-widow(er) beneficiaries. In addition, the model assumes that some insured widow(er)s who had not applied for their retired-worker benefits will receive widow(er) benefits. The model projects insured aged-widow(er) beneficiaries over age 70 by applying termination rates to the population that started receiving such benefits prior to age 70.

The short-range model develops the number of disabled-widow(er) beneficiaries by applying award rates to the uninsured male or female population and by applying termination rates to the population already receiving a disabled-widow(er) benefit. The long-range model projects the number for each cohort by age from 50 to normal retirement age as percentages of the widowed and divorced populations, adjusted for the insured status of the deceased spouse, the prevalence of disability, and the probability that the disabled spouse is not receiving another type of benefit.

The Office of the Chief Actuary bases the projected number of children under age 18, and students aged 18 and 19, who are entitled to benefits as survivors of deceased workers, on the number of children in the population whose mothers or fathers are deceased. The short-range model develops the number of entitled children by applying award rates to the number of orphaned children and by applying termination rates to the number of children already receiving benefits.

The long-range model projects the number of surviving-child beneficiaries in a manner similar to that for student beneficiaries of retired workers, except that the model replaces the probability that the parent is aged 62 or over with the probability that the parent is deceased.

The Office of the Chief Actuary projects the number of surviving-disabled-child beneficiaries, aged 18 and over, from the adult population. The short-range model applies award rates to the population and applies termination rates to the number of surviving-disabled-child beneficiaries already receiving benefits. The long-range model projects the number of surviving-disabled-child beneficiaries in a manner similar to that for surviving-student-child beneficiaries, except for including an additional factor to reflect the probability of being disabled before age 22.

The short-range model develops the numbers of entitled surviving-mother and surviving-father beneficiaries by applying award rates to the number of awards to surviving-child beneficiaries, in cases where the children are either

under age 16 or disabled, and by applying termination rates to the number of surviving-mother and surviving-father beneficiaries already receiving benefits. The long-range model estimates the numbers of surviving-mother and surviving-father beneficiaries, assuming they are not remarried, from the number of surviving-child beneficiaries.

The Office of the Chief Actuary projects the number of surviving-parent beneficiaries based on the historical pattern of the number of such beneficiaries.

Table V.C4 shows the projected number of beneficiaries under the OASI program by type of benefit. The retired-worker beneficiary counts include those persons who receive a residual auxiliary benefit in addition to their retired-worker benefit. The office makes estimates of the number and amount of residual payments separately for spouses and widow(er)s.

Table V.C4.—OASI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1945-2100
[In thousands]

	Retired workers and auxiliaries			Survivors				
Calendar year	Worker[a]	Spouse	Child	Widow-widower	Mother-father	Child	Parent	Total
Historical data:								
1945	518	159	13	94	121	377	6	1,288
1950	1,771	508	46	314	169	653	15	3,477
1955	4,474	1,192	122	701	292	1,154	25	7,961
1960	8,061	2,269	268	1,544	401	1,577	36	14,157
1965	11,101	2,614	461	2,371	472	2,074	35	19,128
1970	13,349	2,668	546	3,227	523	2,688	29	23,030
1975	16,589	2,867	643	3,888	582	2,919	21	27,509
1980	19,564	3,018	639	4,415	563	2,610	15	30,823
1985	22,435	3,069	456	4,862	372	1,918	10	33,122
1990	24,841	3,104	421	5,098	304	1,777	6	35,551
1995	26,679	3,027	441	5,213	275	1,884	4	37,522
2000	28,505	2,798	459	4,901	203	1,878	3	38,747
2005	30,461	2,524	488	4,569	178	1,903	2	40,126
2010	34,593	2,316	580	4,285	159	1,913	2	43,847
2011	35,600	2,291	594	4,239	158	1,907	2	44,791
2012	36,720	2,280	612	4,193	154	1,907	1	45,868
2013	37,893	2,285	625	4,139	150	1,899	1	46,992
2014	39,009	2,303	635	4,092	143	1,892	1	48,075
2015	40,089	2,335	648	4,050	140	1,893	1	49,155
2016	41,233	2,370	661	4,004	133	1,893	1	50,296
2017	42,447	2,375	675	3,961	128	1,904	1	51,491
2018	43,721	2,391	690	3,908	121	1,911	1	52,743
2019	45,094	2,430	701	3,878	117	1,916	1	54,137
2020	46,330	2,323	704	3,823	115	1,936	1	55,231
2021	47,293	2,165	687	3,773	114	1,976	1	56,009
Intermediate:								
2022	48,604	2,009	712	3,728	112	2,005	1	57,171
2025	52,821	1,768	763	3,682	108	2,061	1	61,204
2030	59,571	1,661	855	3,626	99	2,098	1	67,910
2035	63,979	1,606	946	3,405	112	2,136	1	72,185
2040	66,331	1,464	1,025	3,150	128	2,186	1	74,284

Table V.C4.—OASI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1945-2100 (Cont.)
[In thousands]

	Retired workers and auxiliaries			Survivors				
Calendar year	Worker[a]	Spouse	Child	Widow-widower	Mother-father	Child	Parent	Total
Intermediate (Cont.):								
2045	67,460	1,351	1,068	2,989	129	2,214	1	75,212
2050	69,155	1,295	1,115	2,863	126	2,200	1	76,755
2055	71,607	1,276	1,164	2,766	122	2,157	1	79,092
2060	75,017	1,271	1,215	2,685	117	2,088	1	82,393
2065	78,172	1,289	1,227	2,646	113	2,030	1	85,479
2070	81,273	1,319	1,243	2,633	111	2,009	1	88,589
2075	84,359	1,341	1,273	2,618	111	2,013	1	91,716
2080	86,359	1,351	1,294	2,577	110	2,014	1	93,705
2085	87,320	1,353	1,305	2,520	107	1,995	1	94,602
2090	87,738	1,373	1,310	2,480	105	1,966	1	94,972
2095	89,252	1,410	1,344	2,457	102	1,939	1	96,505
2100	91,997	1,446	1,382	2,454	100	1,917	1	99,296
Low-cost:								
2022	48,582	2,009	714	3,725	112	2,010	1	57,154
2025	52,693	1,770	770	3,676	110	2,085	1	61,106
2030	59,091	1,672	878	3,611	104	2,183	1	67,539
2035	62,634	1,601	980	3,446	111	2,348	1	71,121
2040	64,125	1,455	1,083	3,216	130	2,530	1	72,540
2045	64,436	1,326	1,141	3,073	133	2,655	1	72,765
2050	65,378	1,256	1,203	2,962	134	2,714	1	73,648
2055	67,207	1,221	1,270	2,872	133	2,731	1	75,434
2060	69,987	1,195	1,344	2,791	133	2,726	1	78,176
2065	72,509	1,186	1,371	2,746	135	2,754	1	80,703
2070	74,921	1,188	1,404	2,729	140	2,845	1	83,228
2075	77,227	1,181	1,460	2,709	146	2,971	1	85,695
2080	78,487	1,161	1,501	2,669	151	3,077	1	87,047
2085	78,818	1,139	1,525	2,631	155	3,145	1	87,414
2090	79,283	1,155	1,545	2,640	157	3,198	1	87,978
2095	81,829	1,194	1,625	2,687	160	3,260	1	90,757
2100	86,000	1,235	1,706	2,757	165	3,341	1	95,205
High-cost:								
2022	48,630	2,009	711	3,730	112	2,001	1	57,195
2025	52,978	1,767	759	3,690	107	2,038	1	61,339
2030	60,183	1,654	835	3,650	93	2,008	1	68,423
2035	65,705	1,645	905	3,345	106	1,891	1	73,599
2040	69,275	1,512	952	3,053	116	1,796	1	76,705
2045	71,647	1,417	979	2,859	113	1,732	1	78,747
2050	74,522	1,386	1,008	2,707	106	1,661	1	81,391
2055	77,957	1,397	1,034	2,589	97	1,578	1	84,653
2060	82,171	1,415	1,050	2,491	87	1,475	1	88,689
2065	86,059	1,451	1,034	2,444	78	1,375	1	92,443
2070	89,970	1,495	1,023	2,419	72	1,298	1	96,278
2075	93,814	1,531	1,017	2,399	66	1,243	1	100,071
2080	96,526	1,557	1,010	2,349	62	1,198	1	102,702
2085	97,956	1,558	1,002	2,259	57	1,150	1	103,983
2090	97,875	1,563	984	2,166	52	1,099	1	103,740
2095	97,398	1,577	973	2,073	48	1,049	1	103,119
2100	97,390	1,610	969	2,021	44	1,002	1	103,037

[a] Retired-worker beneficiaries include persons who also receive a residual benefit consisting of the excess of an auxiliary benefit over their retired-worker benefit.

Notes:
1. The number of beneficiaries does not include uninsured individuals who receive benefits under section 228 of the Social Security Act. Transfers from the General Fund of the Treasury reimburse the OASI Trust Fund for the cost of most of these individuals.
2. Components may not sum to totals because of rounding.

5. Disability Insurance Beneficiaries

The DI Trust Fund pays for benefits to disabled workers who: (1) satisfy the disability insured requirements, (2) are unable to engage in any substantial gainful activity due to a medically determinable physical or mental impairment severe enough to satisfy the requirements of the program, and (3) have not yet attained normal retirement age. Spouses and children of such disabled workers may also receive DI benefits provided they satisfy certain criteria, primarily age and earnings requirements.

The Office of the Chief Actuary projects the number of disabled-worker beneficiaries in current-payment status (disability prevalence) for each future year. The projections start with the number in current-payment status as of December 2021. Projections of the number of new beneficiaries awarded benefits each year (disability incidence) and the number of beneficiaries leaving the disability rolls each year then determine the number in current-payment status in later years. Beneficiaries leave the rolls due to death and recovery (disability terminations) and due to conversion from disabled-worker to retired-worker beneficiary status at normal retirement age, after which the OASI Trust Fund pays for benefits. The remainder of this section describes the concepts of disability incidence, termination, and prevalence.

a. Disability Incidence

The disability incidence rate is the ratio of the number of new beneficiaries awarded benefits each year to the number of individuals who meet insured requirements but are not yet receiving benefits (the disability-exposed population[1]). The Office of the Chief Actuary projects the number of newly awarded beneficiaries for each future year by multiplying assumed age-sex-specific disability incidence rates and the projected disability-exposed population by age and sex.

Figure V.C3 illustrates the projected incidence rates under the three alternatives along with historical rates. Incidence rates have varied substantially during the historical period since 1970 due to a variety of demographic and economic factors, along with changes in legislation and program administration. The solid lines in figure V.C3 show the age-sex-adjusted incidence rate consistent with the age-sex distribution of the disability-exposed population for 2000. This adjustment allows a meaningful comparison of incidence rates over time by focusing on the likelihood of being awarded disabled worker

[1] The disability-exposed population excludes those receiving benefits, while the disability insured population includes them. Section V.C.3 of this report describes the projection of the disability insured population.

benefits, excluding the effects of a changing distribution of the population toward ages where disability is more or less likely.

The dashed lines in figure V.C3 represent the gross (unadjusted) incidence rates. The changing age-sex distribution of the exposed population over time influences these unadjusted rates. The gross incidence rate fell below the age-sex-adjusted rate between 1975 and 2000 as the baby-boom generation increased the size of the younger working-age population, where disability incidence is lower than in older populations. After 1990, the gross rate generally increased relative to the age-sex-adjusted rate as the baby-boom generation moved into an age range where disability incidence peaks. The projected gross incidence rate generally declines relative to the age-sex-adjusted rate as the baby-boom generation moves above the normal retirement age and the lower-birth-rate cohorts of the 1970s enter prime disability ages (50 to normal retirement age). As these smaller cohorts age beyond normal retirement age, by about 2050, the gross incidence rate returns to a higher relative level under the intermediate assumptions. Thereafter, the gross rate remains higher than the age-sex-adjusted rate, and reflects the persistently higher average age of the working-age population, which is largely due to lower birth rates since 1965, and to the increase in the normal retirement age.

For the first 10 years of the projection period (through 2031), incidence rates reflect several factors following on the experience since the recession of 2007-09. At the beginning of the period of high unemployment that began in 2007, disability incidence rates were well above the general trend level, with rates reaching a peak in 2010. Over the period through 2019, incidence rates subsided as the economy recovered, and have persisted at levels well below those expected over the long-term. A portion of the elevation of disability incidence rates experienced during the recession that began in 2007 and the lowering of incidence rates experienced during the recovery were likely due to many individuals applying for disability benefits earlier than they would have otherwise. However, the continuing decline in disability incidence since 2010 far exceeds the effect of individuals having filed earlier due to the 2007-09 recession.

For 2021, the actual incidence rate (3.0 per thousand) was below the level projected in last year's report (4.1 per thousand). In this year's report, incidence rates under the intermediate alternative are projected to rise more slowly early in the projection period than in last year's report, consistent with the low levels experienced recently and the lower assumed ultimate incidence rate. Incidence rates are projected to rise to a temporary peak level for 2027 as some of the reduced levels of applications in the pandemic period are realized in the next few years. After 2027, incidence rates gradually

decline through the rest of the short-range period to the ultimate assumed level of incidence.

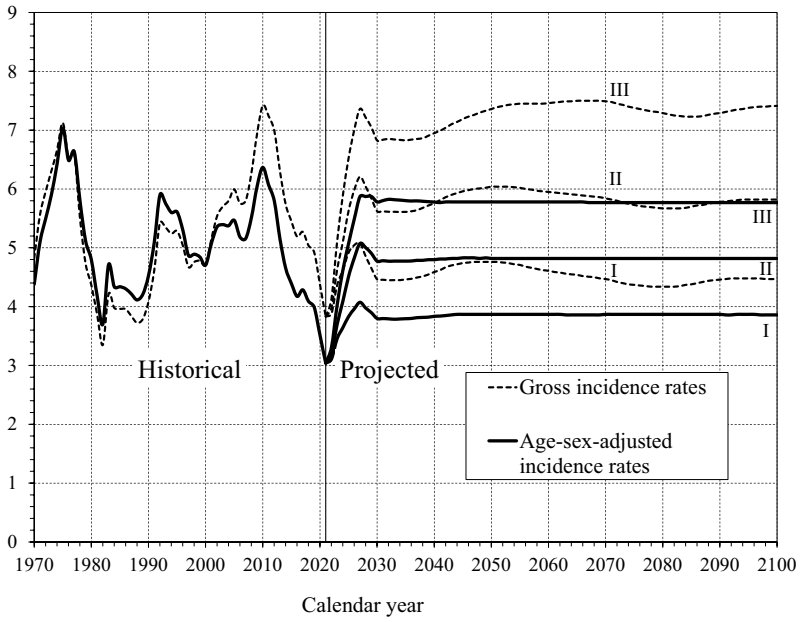
This projected pattern of incidence over the next several years is based on the expectation that disability applications will increase to pre-pandemic levels as the COVID-19 pandemic recedes and the economy fully recovers from the 2020 recession. In 2031, at the end of the short-range period, age-sex-specific incidence rates are assumed to reach the ultimate rates assumed for the long-range projections. These ultimate age-sex-specific disability incidence rates were selected based on careful analysis of historical levels and patterns and expected future conditions, including the impact of scheduled increases in the normal retirement age.[1] The ultimate incidence rates represent the expected average rates of incidence for the future.

For the intermediate alternative, the Trustees assume that the ultimate age-sex-adjusted incidence rate (adjusted to the disability-exposed population for the year 2000) will be 4.8 awards per thousand exposed, which is 0.2 per thousand lower than was assumed in last year's report. Figure V.C3 illustrates that the age-sex-adjusted incidence rate averaged 5.0 per thousand over the historical period 1970 through 2021, but has dropped substantially below that level since 2013. The rates seen in recent years are not consistent with an assumption of a full rise back to longer-term past historical averages, and, as a result, the Trustees reduced the ultimate disability incidence rate for this report from 5.0 to 4.8 per thousand exposed.

The Trustees assume that the ultimate age-sex-adjusted incidence rates for the low-cost and high-cost alternatives will be 3.9 and 5.8 awards per thousand exposed, or about 20 percent lower and higher, respectively, than the ultimate incidence rate for the intermediate alternative. These ultimate low-cost and high-cost incidence rates are lower than those in last year's report by roughly 0.1 and 0.2 awards per thousand exposed, respectively.

[1] Projected incidence rates are adjusted upward to account for additional workers who are expected to file for disability benefits (rather than retirement benefits) in response to reductions in retirement benefits as the normal retirement age rises.

Figure V.C3.—DI Disability Incidence Rates, 1970-2100
[Awards per thousand disability-exposed]



b. Disability Termination

Beneficiaries stop receiving disability benefits when they die, experience an improvement in their medically-determinable impairment such that they are deemed able to engage in substantial gainful activity, or return to substantial work. Disabled-worker beneficiaries who return to substantial work for an extended period are deemed to have recovered, and their benefits are then terminated. The termination rate is the ratio of the number of terminations for these reasons to the average number of disabled-worker beneficiaries during the year.

The Office of the Chief Actuary projects termination rates by age, sex, and reason for termination. In addition, the office projects termination rates by duration of entitlement to disabled-worker benefits in the long-range period (post-2031).

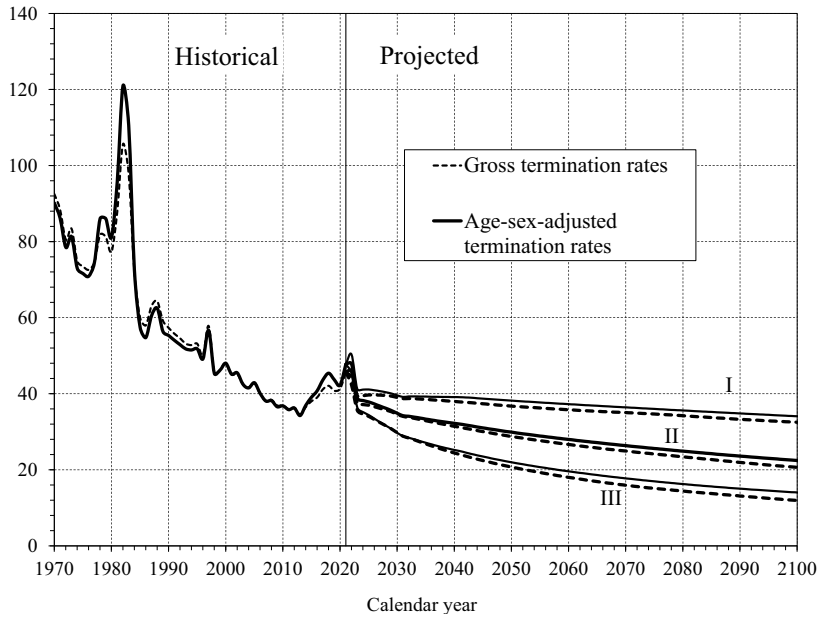
In the short-range period (through 2031), the projected age-sex-adjusted death rate (adjusted to the 2000 disabled-worker beneficiary population) under the intermediate assumptions declines from the temporarily elevated rate of 30.0 deaths per thousand beneficiaries for 2021 to about 23.8 per thousand for 2031. These rates are assumed to remain elevated through 2023

due to the COVID-19 pandemic, and then return to follow the underlying declining trend in general population mortality. The projected age-sex-adjusted recovery rate (medical improvement and return to substantial work) under the intermediate assumptions decreases from the relatively high level of 17.7 per thousand beneficiaries for 2021 to 10.4 per thousand beneficiaries for 2031. The recovery rate has been high in recent years due to an ongoing administrative effort to eliminate a backlog of medical continuing disability reviews. The recovery rate is expected to increase temporarily through 2022 as these reviews are completed and the backlog is eliminated over the next several years. Thereafter, the rate decreases as the backlog is reduced. Under the low-cost and high-cost assumptions, total age-sex-adjusted termination rates due to death and recovery are roughly 10 to 20 percent higher or lower, respectively, than under the intermediate assumptions.

For the long-range period (post-2031), the Office of the Chief Actuary projects death and recovery rates by age, sex, and duration of entitlement relative to the average level of rates experienced over the base period 2011 through 2015. The assumed ultimate age-sex-adjusted recovery rate for disabled workers is about 10.4 per thousand beneficiaries. The assumed ultimate age-sex-adjusted recovery rates for the low-cost and high-cost alternatives are about 12.5 and 8.3 recoveries per thousand beneficiaries, respectively. Death rates by age and sex change throughout the long-range period at the same rate as death rates in the general population. The age-sex-adjusted death rate decreases from 30.0 per thousand beneficiaries in 2021 to 21.9, 12.5, and 6.2 per thousand disabled-worker beneficiaries for 2096 under the low-cost, intermediate, and high-cost assumptions, respectively.

Figure V.C4 illustrates gross and age-sex-adjusted total termination rates (including both recoveries and deaths) for disabled-worker beneficiaries for the historical period since 1970, and for the projection period through 2100. As with incidence rates, the age-sex-adjusted termination rate illustrates the real change in the tendency to terminate benefits. Changes in the age-sex distribution of the beneficiary population influence the gross termination rate. A shift in the disabled-worker beneficiary population to older ages, as occurred over the past 20 years when the baby-boom generation moved into pre-retirement ages, increases gross death termination rates relative to the age-sex-adjusted rates.

Figure V.C4.—DI Disability Termination Rates, 1970-2100
[Terminations per thousand disabled-worker beneficiaries]



c. Comparison of Incidence, Termination, and Conversion

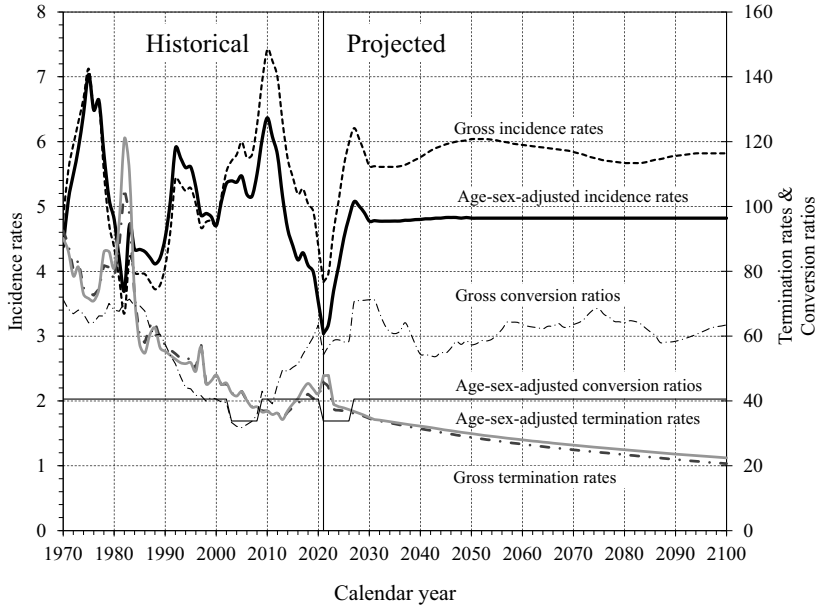
Incidence and termination rates are the foundation for projecting the number of disabled-worker beneficiaries in current-payment status. At normal retirement age, all disabled-worker beneficiaries convert to retired-worker status and leave the DI rolls.

Figure V.C5 compares the historical and projected (intermediate) levels of incidence, termination, and conversion on both a gross basis and an age-sex-adjusted basis. Incidence rates have varied widely, and the Trustees expect the age-sex adjusted rates under the intermediate assumptions to remain near the middle of the high and low extremes experienced since 1970. Termination rates have declined and the Trustees expect them to continue to decline, largely because of declining death rates.

Conversions are a transfer of beneficiaries at normal retirement age from the DI program to the OASI program. Therefore, the disability "conversion" rate is 100 percent for disabled-worker beneficiaries reaching normal retirement age in a given year and zero at all other ages. After conversion, recovery from the disabling condition is no longer relevant for benefit eligibility. The conversion ratio is the number of conversions in a given year (that is, benefi-

ciaries who reach normal retirement age) divided by the average number of disabled-worker beneficiaries at all ages in that year. The ratio is constant on an age-sex-adjusted basis, except for the two periods during which normal retirement age increases under current law. On a gross basis, however, the conversion ratio rises and falls with the changing proportion of all disabled-worker beneficiaries who attain normal retirement age in a given year. The gross conversion ratio generally increases from 2005 to 2030 due to aging of the beneficiary population.

Figure V.C5.—Comparison of DI Disability Incidence Rates, Termination Rates and Conversion Ratios Under Intermediate Assumptions, 1970-2100
[Awards per thousand disability-exposed;
terminations and conversions per thousand disabled-worker beneficiaries]



d. DI Beneficiaries and Disability Prevalence Rates

The Office of the Chief Actuary makes detailed projections of disabled-worker awards, terminations, and conversions and combines these to project the number of disabled workers receiving benefits over the next 75 years. Table V.C5 presents the projected numbers of disabled workers in current-payment status. The number of disabled workers in current-payment status grows from 7.9 million at the end of 2021, to 11.0 million, 12.6 million, and 12.7 million at the end of 2100, under the low-cost, intermediate, and high-cost assumptions, respectively. Of course, much of this growth results from

the growth and aging of the population described earlier in this chapter. Table V.C5 also presents projected numbers of auxiliary beneficiaries and disability prevalence rates on both a gross basis and an age-sex-adjusted basis.

Table V.C5.—DI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1960-2100

[Beneficiaries in thousands; prevalence rates per thousand persons insured for disability benefits]

Calendar year	Disabled-worker beneficiaries	Auxiliary beneficiaries		Total beneficiaries	Disability prevalence rates	
		Spouse	Child		Gross	Age-sex-adjusted[a]
Historical data:						
1960	455	77	155	687		
1965	988	193	558	1,739		
1970	1,493	283	889	2,665	20	18
1975	2,488	453	1,411	4,351	29	28
1980	2,856	462	1,359	4,677	28	31
1985	2,653	306	945	3,904	24	26
1990	3,007	266	989	4,261	25	28
1995	4,179	264	1,409	5,852	33	35
2000	5,036	165	1,466	6,667	36	36
2005	6,519	157	1,633	8,309	45	40
2010	8,204	161	1,820	10,185	55	44
2011	8,576	164	1,874	10,614	58	45
2012	8,827	163	1,900	10,890	59	46
2013	8,941	157	1,889	10,987	60	46
2014	8,955	150	1,828	10,932	59	46
2015	8,909	143	1,756	10,808	59	45
2016	8,809	136	1,667	10,612	58	44
2017	8,695	127	1,590	10,412	57	43
2018	8,537	119	1,507	10,164	55	41
2019	8,378	114	1,434	9,927	54	40
2020	8,151	105	1,364	9,620	52	39
2021	7,877	97	1,245	9,219	50	36
Intermediate:						
2022	7,663	96	1,201	8,960	48	35
2025	7,729	99	1,219	9,048	48	34
2030	8,004	95	1,371	9,469	49	36
2035	8,295	94	1,475	9,863	50	38
2040	8,786	97	1,635	10,518	52	39
2045	9,522	108	1,810	11,439	55	40
2050	10,030	111	1,929	12,070	58	41
2055	10,411	114	1,996	12,521	59	42
2060	10,501	111	2,012	12,624	59	42
2065	10,670	114	2,018	12,802	59	42
2070	10,824	118	2,054	12,995	59	42
2075	10,788	117	2,127	13,032	58	42
2080	10,884	118	2,217	13,219	57	43
2085	11,139	120	2,293	13,552	57	43
2090	11,740	128	2,350	14,218	58	43
2095	12,270	132	2,396	14,799	59	43
2100	12,626	134	2,446	15,206	60	43

Table V.C5.—DI Beneficiaries With Benefits in Current-Payment Status at the End of Calendar Years 1960-2100 (Cont.)

[Beneficiaries in thousands; prevalence rates per thousand persons insured for disability benefits]

Calendar year	Disabled-worker beneficiaries	Auxiliary beneficiaries		Total beneficiaries	Disability prevalence rates	
		Spouse	Child		Gross	Age-sex-adjusted[a]
Low-cost:						
2022	7,635	96	1,198	8,929	48	34
2025	7,460	99	1,175	8,734	46	32
2030	6,984	93	1,221	8,299	43	31
2035	6,839	76	1,267	8,182	40	30
2040	6,987	74	1,403	8,463	41	31
2045	7,446	79	1,551	9,076	42	31
2050	7,775	79	1,648	9,502	43	31
2055	8,051	80	1,703	9,835	43	32
2060	8,127	77	1,726	9,930	42	32
2065	8,291	78	1,759	10,128	42	32
2070	8,462	81	1,834	10,377	41	32
2075	8,543	80	1,947	10,571	41	32
2080	8,777	81	2,067	10,925	40	32
2085	9,228	84	2,167	11,479	40	32
2090	9,974	92	2,251	12,317	41	32
2095	10,552	96	2,329	12,978	42	32
2100	10,962	98	2,422	13,482	42	33
High-cost:						
2022	7,697	96	1,205	8,998	49	35
2025	8,081	100	1,282	9,463	51	36
2030	8,955	96	1,502	10,553	56	41
2035	9,839	114	1,630	11,583	60	45
2040	10,699	124	1,745	12,569	64	47
2045	11,728	143	1,902	13,773	70	50
2050	12,408	150	2,017	14,575	74	51
2055	12,894	156	2,080	15,130	78	52
2060	12,950	151	2,073	15,174	79	53
2065	13,075	151	2,027	15,253	80	53
2070	13,103	156	1,983	15,242	81	53
2075	12,806	152	1,969	14,927	81	53
2080	12,515	151	1,984	14,651	80	54
2085	12,223	146	2,004	14,373	79	54
2090	12,281	149	2,008	14,439	80	54
2095	12,527	154	1,995	14,676	81	54
2100	12,655	156	1,973	14,784	82	54

[a] Adjusted to the age-sex distribution of the disability insured population for the year 2000.

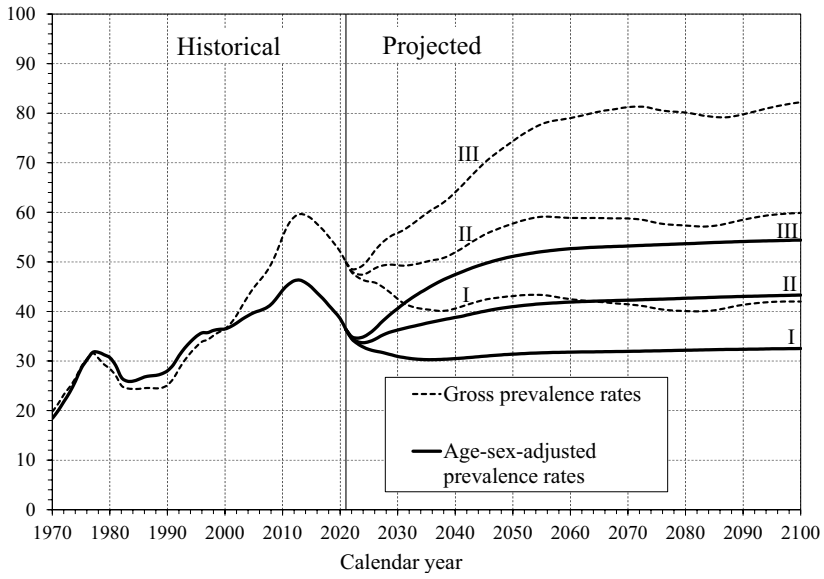
Note: Components may not sum to totals because of rounding.

The disability prevalence rate is the ratio of the number of disabled-worker beneficiaries in current-payment status to the number of persons insured for disability benefits. Figure V.C6 illustrates the historical and projected disability prevalence rates on both a gross basis and on an age-sex-adjusted basis (adjusted to the age-sex distribution of the disability insured population for the year 2000).

Changes in prevalence rates are a direct result of changes in incidence rates and termination rates. Figure V.C5 depicts patterns for incidence and termi-

nation rates, which are helpful for understanding the trend in prevalence rates. Annual incidence and termination rates are not directly comparable or combinable because their denominators differ.

Figure V.C6.—DI Disability Prevalence Rates, 1970-2100
[Rate per thousand persons insured for disability benefits]



Age-sex-adjusted prevalence rates have increased primarily because: (1) termination rates, in particular death termination rates, have declined; (2) incidence rates at younger ages have increased relative to rates at older ages (new beneficiaries at younger ages have more potential years on the disability rolls); (3) incidence rates have increased substantially for women to parity with men; and (4) the maturation of the DI program (disabled worker benefits became available to those over age 50 at the start of the program in 1957 and to younger workers in 1960, and disability insured status requirements were eased for those under age 31 in 1968). Gross prevalence rates have increased more than age-sex-adjusted prevalence rates since the baby-boom generation began to reach ages 45 through normal retirement age, a time of life when disability incidence rates are relatively high. The Office of the Chief Actuary projects both gross and age-sex adjusted prevalence rates to grow at a slower pace based on assumed stabilization in these four factors: (1) the age distribution of the general population, (2) the age distribution of the disability insured population, (3) incidence rates by age and sex, and

(4) DI program age and insured requirements. As these factors gradually stabilize, the declining death termination rate continues to have a small influence toward higher disability prevalence rates.

As mentioned above in the discussion of incidence and termination rates, the age-sex-adjusted prevalence rate isolates the changing trend in the underlying likelihood of receiving benefits for the insured population, without reflecting changes in the age distribution of the population. As with incidence rates, gross disability prevalence rates declined relative to the age-sex-adjusted rate when the baby-boom generation reached working age between 1970 and 1990; this trend reflects the lower disability prevalence rates associated with younger ages. Conversely, the gross rate of disability prevalence has increased relative to the age-sex-adjusted rate after 1990 due to the aging of the baby-boom generation into ages with higher disability prevalence rates.

Under the intermediate assumptions, the projected age-sex-adjusted disability prevalence rate grows from 36.3 per thousand disability insured workers at the end of 2021 to 43.3 per thousand at the end of 2100. The projected age-sex-adjusted disability prevalence rate at the end of 2100 is 32.5 per thousand under the low-cost assumptions and 54.4 per thousand under the high-cost assumptions.

Table V.C5 presents projections of the numbers of auxiliary beneficiaries paid from the DI Trust Fund. As indicated at the beginning of this subsection, auxiliary beneficiaries are qualifying spouses and children of disabled workers. A spouse must either be at least age 62 or have an eligible child beneficiary in his or her care who is either under age 16 or disabled prior to age 22. A child must be: (1) under age 18, (2) age 18 or 19 and still a student in high school, or (3) age 18 or older and disabled prior to age 22.

The projection of the number of auxiliary beneficiaries relies on the projected number of disabled-worker beneficiaries. In the short-range period (2022 through 2031), the Office of the Chief Actuary projects incidence and termination rates for each category of auxiliary beneficiary. After 2031, the office projects child beneficiaries at ages 18 and under in relation to the projected number of children in the population using the probability that either of their parents is a disabled-worker beneficiary. The office projects the remaining categories of children and spouses in a similar manner.

6. Covered and Taxable Earnings, Taxable Payroll, and Payroll Tax Contributions

Covered earnings include both covered wages and covered self-employment net earnings. The Office of the Chief Actuary projects covered wages for component sectors of the economy (i.e., private, State and local government, Federal civilian, and military) based on the projected overall growth of sectoral and total wages in the U.S. economy. The projections of covered wages also reflect changes in covered employment due to a relative increase in non-covered undocumented immigrants and to the mandatory coverage of new hires in the Federal civilian sector. The office projects covered self-employment net earnings based on the growth in net proprietors' income in the U.S. economy.

Taxable earnings are the portion of covered earnings subject to the Social Security payroll tax. Taxable wages for an employee are total covered wages from all wage employment up to the contribution and benefit base. Taxable wages for an employer are the sum of all covered wages paid to each employee up to the base. Employees with multiple jobs whose total wages exceed the base are eligible for a refund of excess employee taxes withheld; employers are not eligible for a refund on this basis. For self-employed workers with no taxable wages, taxable earnings are the amount of covered self-employment net earnings up to the base. For self-employed workers with taxable wages less than the base, covered self-employment net earnings are taxable up to the difference between the base and their taxable wages. For projection purposes, the Office of the Chief Actuary computes taxable earnings based on a proportion of covered earnings that is at or below the base.

The OASDI taxable payroll (see table VI.G6) for a year is computed as the amount of earnings which, when multiplied by the combined OASDI employee-employer payroll tax rate for that year, yields the total amount of payroll taxes due from wages paid and self-employment net earnings for the year. The Trustees use taxable payroll to determine income rates, cost rates, and actuarial balances. Taxable payroll is derived by adjusting total taxable earnings to account for categories of earnings that are taxed at rates other than the combined employee-employer rate and to take into account amounts credited as wages that were not included in normally reported wages. For 1951 and later, taxable earnings are reduced by one-half of the amount of wages paid to employees with multiple jobs that exceed the contribution and benefit base. For 1983 through 2001, deemed wage credits for military service after 1956 are added to taxable earnings. The self-employment tax rates for 1951 through 1983 were less than the combined employee-employer

rates; therefore, the self-employment component of taxable payroll for those years is reduced by multiplying the ratio of the self-employment rate to the combined employee-employer rate times the taxable self-employment net earnings. Finally, for 1966 through 1979, employers were exempt from paying their share of payroll tax on their employees' tips and, for 1980 through 1987, employers paid tax on only part of their employees' tips. For those years, the taxable payroll is reduced by half of the amount of tips for which the employer owed no payroll tax.

The ratio of taxable payroll to covered earnings (the taxable ratio) fell from 88.6 percent for 1984 to 82.6 percent for 2000, mostly due to much larger increases in wage levels for very high earners than for all other earners. From 2000 to 2010, the taxable ratio varied with the business cycle, rising during economic downturns and falling during recoveries. Specifically, the taxable ratio rose to 85.7 percent for 2002, declined to 82.4 percent for 2007, rose to 85.2 percent for 2009, and averaged 83.0 percent for the period 2010 to 2019. The ratio fell to 82.4 percent for 2020 from the previous year's 83.1 percent. Unlike previous economic downturns, the pandemic-induced recession led to a much greater decrease in wage levels for earners at the low end of the earnings distribution than for those at the high end. This resulted in a relatively higher proportion of total wages being above the contribution and benefit base than has typically been the case in other economic downturns.

The effect of the pandemic-induced recession on the taxable ratio is projected to continue through 2022. By 2022, the taxable ratio declines to 80.5, 80.4, and 80.9 percent for the low-cost, intermediate, and high-cost alternatives, respectively. After 2022, the taxable ratios for each alternative gradually converge to the levels assumed for the end of the short-range period.

For this report, the Trustees assume a level for the taxable ratio at the end of the short-range period (2031) of 84.0 percent for the low-cost assumptions, 82.5 percent for the intermediate assumptions, and 81.0 percent for the high-cost assumptions.[1] These are the same assumptions that the Trustees used for the end of the short-range period (2030) for the 2021 report.

The Office of the Chief Actuary projects payroll tax contributions using the patterns of tax collection required by Federal laws and regulations. The office determines payroll tax liabilities by multiplying the scheduled tax rates for each year by the amount of taxable wages and self-employment net earn-

[1] The taxable ratio drifts down slightly after 2031, to 84.0, 82.3, and 80.6 percent for 2096 for the low-cost, intermediate, and high-cost assumptions, respectively, as self-employment income becomes an increasing share of total earnings.

ings for that year. The office then splits these liabilities into amounts by collection period. For wages, Federal law requires that employers withhold OASDI and HI payroll taxes and Federal individual income taxes from employees' pay. As an employer's accumulation of such taxes (including the employer share of payroll taxes) meets certain thresholds, which the Department of the Treasury determines, the employer must deposit these taxes with the U.S. Treasury by a specific day, depending on the amount of money involved.[1] For projection purposes, the office splits the payroll tax contributions related to wages into amounts paid in the same quarter as incurred and in the following quarter. Self-employed workers must make estimated tax payments on their earnings four times during the year and make up any underestimate on their individual income tax returns. The projection splits the self-employed tax liabilities by collection quarter to reflect this pattern.

The projected tax contributions also reflect the method used to ensure that money transferred to the trust funds is adjusted, over time, to equal the actual liability owed. Because payers generally make tax payments without identifying the separate OASDI contribution amounts, Treasury makes daily transfers of money from the General Fund to the trust funds on an initial estimated basis. The Social Security Administration periodically certifies the amounts of wages and self-employment net earnings on which tax contributions are owed for each year, at which time Treasury determines adjustments to appropriations to reconcile tax liabilities with deposits in the trust funds. This process also includes periodic transfers from the trust funds to the General Fund for contributions on wages in excess of the contribution and benefit base.

Table V.C6 shows the payroll tax contribution rates applicable under current law in each calendar year and the allocation of these rates between the OASI and DI Trust Funds.[2] It also shows the contribution and benefit base for each year through 2022.

[1] Generally, the higher the amount of liability, the sooner the taxes must be paid. For smaller employers, payment is due by the middle of the month following when the liability was incurred. Medium-size employers have three banking days in which to make their deposits. Larger employers must make payment on the next business day after paying their employees.

[2] Table VI.G1 shows the payroll tax contribution rates for the Hospital Insurance (HI) program.

Table V.C6.—Contribution and Benefit Base and Payroll Tax Contribution Rates

Calendar years	Contribution and benefit base	Payroll tax contribution rates (percent)					
		Employees and employers, combined[a]			Self-employed[b]		
		OASDI	OASI	DI	OASDI	OASI	DI
1937-49	$3,000	2.00	2.00	—	—	—	—
1950	3,000	3.00	3.00	—	—	—	—
1951-53	3,600	3.00	3.00	—	2.2500	2.2500	—
1954	3,600	4.00	4.00	—	3.0000	3.0000	—
1955-56	4,200	4.00	4.00	—	3.0000	3.0000	—
1957-58	4,200	4.50	4.00	0.50	3.3750	3.0000	0.3750
1959	4,800	5.00	4.50	.50	3.7500	3.3750	.3750
1960-61	4,800	6.00	5.50	.50	4.5000	4.1250	.3750
1962	4,800	6.25	5.75	.50	4.7000	4.3250	.3750
1963-65	4,800	7.25	6.75	.50	5.4000	5.0250	.3750
1966	6,600	7.70	7.00	.70	5.8000	5.2750	.5250
1967	6,600	7.80	7.10	.70	5.9000	5.3750	.5250
1968	7,800	7.60	6.65	.95	5.8000	5.0875	.7125
1969	7,800	8.40	7.45	.95	6.3000	5.5875	.7125
1970	7,800	8.40	7.30	1.10	6.3000	5.4750	.8250
1971	7,800	9.20	8.10	1.10	6.9000	6.0750	.8250
1972	9,000	9.20	8.10	1.10	6.9000	6.0750	.8250
1973	10,800	9.70	8.60	1.10	7.0000	6.2050	.7950
1974	13,200	9.90	8.75	1.15	7.0000	6.1850	.8150
1975	14,100	9.90	8.75	1.15	7.0000	6.1850	.8150
1976	15,300	9.90	8.75	1.15	7.0000	6.1850	.8150
1977	16,500	9.90	8.75	1.15	7.0000	6.1850	.8150
1978	17,700	10.10	8.55	1.55	7.1000	6.0100	1.0900
1979	22,900	10.16	8.66	1.50	7.0500	6.0100	1.0400
1980	25,900	10.16	9.04	1.12	7.0500	6.2725	.7775
1981	29,700	10.70	9.40	1.30	8.0000	7.0250	.9750
1982	32,400	10.80	9.15	1.65	8.0500	6.8125	1.2375
1983	35,700	10.80	9.55	1.25	8.0500	7.1125	.9375
1984[c]	37,800	11.40	10.40	1.00	11.4000	10.4000	1.0000
1985[c]	39,600	11.40	10.40	1.00	11.4000	10.4000	1.0000
1986[c]	42,000	11.40	10.40	1.00	11.4000	10.4000	1.0000
1987[c]	43,800	11.40	10.40	1.00	11.4000	10.4000	1.0000
1988[c]	45,000	12.12	11.06	1.06	12.1200	11.0600	1.0600
1989[c]	48,000	12.12	11.06	1.06	12.1200	11.0600	1.0600
1990	51,300	12.40	11.20	1.20	12.4000	11.2000	1.2000
1991	53,400	12.40	11.20	1.20	12.4000	11.2000	1.2000
1992	55,500	12.40	11.20	1.20	12.4000	11.2000	1.2000
1993	57,600	12.40	11.20	1.20	12.4000	11.2000	1.2000
1994	60,600	12.40	10.52	1.88	12.4000	10.5200	1.8800
1995	61,200	12.40	10.52	1.88	12.4000	10.5200	1.8800
1996	62,700	12.40	10.52	1.88	12.4000	10.5200	1.8800
1997	65,400	12.40	10.70	1.70	12.4000	10.7000	1.7000
1998	68,400	12.40	10.70	1.70	12.4000	10.7000	1.7000
1999	72,600	12.40	10.70	1.70	12.4000	10.7000	1.7000
2000	76,200	12.40	10.60	1.80	12.4000	10.6000	1.8000
2001	80,400	12.40	10.60	1.80	12.4000	10.6000	1.8000
2002	84,900	12.40	10.60	1.80	12.4000	10.6000	1.8000
2003	87,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2004	87,900	12.40	10.60	1.80	12.4000	10.6000	1.8000
2005	90,000	12.40	10.60	1.80	12.4000	10.6000	1.8000

Table V.C6.—Contribution and Benefit Base and Payroll Tax Contribution Rates (Cont.)

Calendar years	Contribution and benefit base	Payroll tax contribution rates (percent)					
		Employees and employers, combined[a]			Self-employed[b]		
		OASDI	OASI	DI	OASDI	OASI	DI
2006	$94,200	12.40	10.60	1.80	12.4000	10.6000	1.8000
2007	97,500	12.40	10.60	1.80	12.4000	10.6000	1.8000
2008	102,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2009	106,800	12.40	10.60	1.80	12.4000	10.6000	1.8000
2010[d]	106,800	12.40	10.60	1.80	12.4000	10.6000	1.8000
2011[d]	106,800	10.40	8.89	1.51	10.4000	8.8900	1.5100
2012[d]	110,100	10.40	8.89	1.51	10.4000	8.8900	1.5100
2013	113,700	12.40	10.60	1.80	12.4000	10.6000	1.8000
2014	117,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2015	118,500	12.40	10.60	1.80	12.4000	10.6000	1.8000
2016	118,500	12.40	10.03	2.37	12.4000	10.0300	2.3700
2017	127,200	12.40	10.03	2.37	12.4000	10.0300	2.3700
2018	128,400	12.40	10.03	2.37	12.4000	10.0300	2.3700
2019	132,900	12.40	10.60	1.80	12.4000	10.6000	1.8000
2020	137,700	12.40	10.60	1.80	12.4000	10.6000	1.8000
2021	142,800	12.40	10.60	1.80	12.4000	10.6000	1.8000
2022	147,000	12.40	10.60	1.80	12.4000	10.6000	1.8000
2023 and later	[e]	12.40	10.60	1.80	12.4000	10.6000	1.8000

[a] Except as noted below, the combined employee/employer rate is divided equally between employees and employers.
[b] Beginning in 1990, self-employed persons receive a deduction, for purposes of computing their net earnings, equal to half of the combined OASDI and HI contributions that would be payable without regard to the contribution and benefit base. The OASDI contribution rate then applies to net earnings after this deduction, but subject to the OASDI base.
[c] In 1984 only, employees received an immediate credit of 0.3 percent of taxable wages against their OASDI payroll tax contributions. The self-employed received similar credits of 2.7 percent, 2.3 percent, and 2.0 percent against their combined OASDI and Hospital Insurance (HI) contributions on net earnings from self-employment in 1984, 1985, and 1986-89, respectively. The General Fund of the Treasury reimbursed the trust funds for these credits.
[d] Public Law 111-147 exempted most employers from paying the employer share of OASDI payroll tax on wages paid during the period March 19, 2010 through December 31, 2010 to certain qualified individuals hired after February 3, 2010. Public Law 111-312 reduced the OASDI payroll tax rate for 2011 by 2 percentage points for employees and for self-employed workers. Public Law 112-96 extended the 2011 rate reduction through 2012. These laws require that the General Fund of the Treasury reimburse the OASI and DI Trust Funds for these temporary reductions in 2010 through 2012 payroll tax revenue, in order to "replicate to the extent possible" revenue that would have been received if the combined employee/employer payroll tax rates had remained at 12.4 percent for OASDI (10.6 percent for OASI and 1.8 percent for DI).
[e] Subject to automatic adjustment based on increases in average wages.

7. Income From Taxation of Benefits

Under current law, the OASI and DI Trust Funds are credited with income tax revenue from the taxation of up to the first 50 percent of taxpayers' OASI and DI benefit payments. (The HI Trust Fund receives the remainder of the income tax revenue from the taxation of up to 85 percent of taxpayers' OASI and DI benefit payments.) Benefits are partially subject to federal income tax for beneficiaries with income (defined for this purpose as adjusted gross income excluding Social Security benefits, plus half of their Social Security benefits and all of their non-taxable interest income) in excess of specified

threshold amounts. The threshold amounts are $25,000 for single filers, $32,000 for joint filers, and $0 for those married individuals filing separately.

For the short-range period, the Office of the Chief Actuary estimates the income to the OASI and DI Trust Funds from taxation of benefits by applying the following two factors (projected by the Office of Tax Analysis, Department of the Treasury) to total OASI and DI scheduled benefits: (1) the percentage of taxpayers' scheduled benefits (limited to 50 percent) that is taxable and (2) the average marginal tax rate applicable to those benefits. Up to 85 percent of benefits may be subject to federal income tax, with any tax on more than 50 percent of a taxpayer's benefits credited to the Medicare Hospital Insurance Trust Fund.

For the long-range period, the office estimates the income to the trust funds from taxation of benefits by applying projected ratios of taxation of OASI and DI benefits to total OASI and DI scheduled benefits. These tax ratios rely on estimates from the Office of Tax Analysis in the Department of the Treasury. The Office of the Chief Actuary's estimates reflect the following assumptions: (1) The income thresholds used for benefit taxation are specified in the Internal Revenue Code to be constant in the future, and have never been changed, while income and benefit levels continue to rise. Accordingly, projected ratios of income from taxation of benefits to the amount of benefits increase gradually. (2) A permanent level shift upward in the ratios is projected for 2026 and beyond due to the expiration of the personal income tax provisions in Public Law 115-97, the Tax Cuts and Jobs Act of 2017. (3) Because indexation of income tax brackets is not specified in the Social Security Act, and because periodic changes have been made in the past to avoid indefinite compression of the income tax brackets relative to income levels (bracket creep), the Trustees assume that such periodic changes will occur in the future. As a result, after the tenth year of the projection period, income tax brackets are assumed to rise with average wages, rather than with the C-CPI-U as specified under current law. Thus, the income tax brackets are projected to roughly maintain their levels relative to the income distribution.

8. Average Benefits

Projections of average benefits for each benefit type reflect recent historical averages, projected average primary insurance amounts (PIAs), and projected ratios of average benefits to average PIAs. Calculations of average PIAs are based on projected distributions of beneficiaries by duration from year of initial entitlement, average PIAs at initial entitlement, and increases in PIAs after initial entitlement. Projected increases in average PIAs after ini-

tial entitlement depend on automatic benefit increases, recomputations to reflect additional covered earnings, and differences in mortality by level of lifetime earnings. Calculations of future average PIAs at initial entitlement are based on projected earnings histories, which in turn reflect a combination of the actual earnings histories associated with a sample of 2018 initial entitlements and more recent actual earnings levels by age and sex for covered workers.

For retired-worker, aged-spouse, and aged-widow(er) benefits, the percentage of the PIA that is payable depends on the age at initial entitlement to benefits. Projected ratios of average benefits to average PIAs for these types of benefits are based on projections of age distributions at initial entitlement.

9. Scheduled Benefits

For each type of benefit, scheduled benefits are the product of the number of beneficiaries and the corresponding average monthly benefit. The short-range model calculates scheduled benefits on a quarterly basis. The long-range model calculates all scheduled benefits on an annual basis, using the number of beneficiaries at the beginning and end of the year. Adjustments to these annual scheduled benefits include retroactive payments to newly awarded beneficiaries and other amounts not reflected in the regular monthly scheduled benefits.

Scheduled lump-sum death benefits are estimated as the product of: (1) the number of lump-sum death payments projected on the basis of the assumed death rates, the projected fully insured population, and the estimated percentage of the fully insured population that will qualify for lump-sum death payments; and (2) the amount of the lump-sum death payment, which is $255 (unindexed since 1973).

10. Illustrative Scheduled Benefit Amounts

Table V.C7 shows, under the intermediate assumptions, future benefit amounts payable upon retirement at the normal retirement age and at age 65, for various hypothetical workers attaining age 65 in 2022 and subsequent years. The illustrative benefit amounts in table V.C7 are presented in CPI-indexed 2022 dollars—that is, adjusted to 2022 levels by the CPI indexing series shown in table VI.G6. As a point of comparison, table V.C7 also shows the national average wage index (AWI) for 2022 and subsequent years in CPI-indexed 2022 dollars.

The normal retirement age was 65 for individuals who reached age 62 before 2000. It increased to age 66 during the period 2000 through 2005, at a rate of 2 months per year as workers attained age 62. Under current law, the normal

retirement age increases to age 67 during the period 2017 through 2022, also by 2 months per year as workers attain age 62. The illustrative benefit amounts shown in table V.C7 for retirees at age 65 are lower than the amounts shown for retirees at normal retirement age because the statute requires an actuarial reduction for monthly benefits taken before normal retirement age to reflect the expected additional years benefits will be collected. For example, those who collect benefits starting in 2027 at age 65 will receive benefits for two more years than if they instead claim benefits at the normal retirement age (age 67) unless they die between the ages of 65 and 67.

Table V.C7 shows five different pre-retirement earnings patterns. Four of these patterns assume the earnings history of workers with scaled-earnings patterns[1] and reflect very low, low, medium, and high career-average levels of pre-retirement earnings starting at age 21. The fifth pattern assumes the earnings history of a steady maximum earner starting at age 22. The four scaled-earnings patterns derive from earnings experienced by insured workers during calendar years 1999 through 2018. These earnings levels differ by age. The career-average level of earnings for each scaled case targets a percent of the AWI.

For the scaled medium earner, the career-average earnings level is about equal to the AWI (estimated to be $62,583 for 2022). For the scaled very low, low, and high earners, the career-average earnings level, wage-indexed to the year before starting benefits, is about 25 percent, 45 percent, and 160 percent of the AWI, respectively (estimated to be $15,646, $28,162, and $100,133, respectively, for 2022). The steady maximum earner has earnings at or above the contribution and benefit base ($147,000 for 2022) for each year starting at age 22 through the year prior to retirement.

Table V.C7.—Annual Scheduled Benefit Amounts for Retired Workers With Various Pre-Retirement Earnings Patterns Based on Intermediate Assumptions, Calendar Years 2022-2100

Year attain age 65[a]	Age at retirement	Scaled very low earnings[b]	Scaled low earnings[c]	Scaled medium earnings[d]	Scaled high earnings[e]	Steady maximum earnings[f]	National Average Wage Index in 2022 dollars[g]
		Benefits in 2022 dollars[h] with retirement at normal retirement age					
2022	66:6	$11,781	$15,429	$25,465	$33,685	$41,206	$62,583
2025	67:0	11,851	15,539	25,680	33,878	41,680	66,308
2030	67:0	13,231	17,332	28,599	37,816	46,549	70,950
2035	67:0	14,155	18,538	30,578	40,450	49,825	75,381
2040	67:0	15,035	19,685	32,490	42,973	52,902	79,937

[1] Actuarial Note 2022.3 has more details on scaled-earnings patterns. See www.ssa.gov/OACT/NOTES/ran3/.

Table V.C7.—Annual Scheduled Benefit Amounts for Retired Workers With Various Pre-Retirement Earnings Patterns Based on Intermediate Assumptions, Calendar Years 2022-2100 (Cont.)

Year attain age 65[a]	Age at retirement	Scaled very low earnings[b]	Scaled low earnings[c]	Scaled medium earnings[d]	Scaled high earnings[e]	Steady maximum earnings[f]	National Average Wage Index in 2022 dollars[g]
2045	67:0	$15,948	$20,876	$34,443	$45,563	$56,131	$84,434
2050	67:0	16,841	22,050	36,375	48,129	59,234	89,058
2055	67:0	17,764	23,262	38,372	50,764	62,385	94,081
2060	67:0	18,769	24,575	40,544	53,633	65,860	99,505
2065	67:0	19,853	25,995	42,881	56,724	69,633	105,304
2070	67:0	21,011	27,506	45,378	60,030	73,701	111,411
2075	67:0	22,230	29,106	48,012	63,514	77,980	117,829
2080	67:0	23,508	30,780	50,774	67,169	82,471	124,514
2085	67:0	24,843	32,526	53,652	70,980	87,152	131,500
2090	67:0	26,237	34,351	56,666	74,963	92,042	138,963
2095	67:0	27,729	36,304	59,886	79,224	97,265	147,006
2100	67:0	29,334	38,407	63,354	83,810	102,895	155,515
		Benefits in 2022 dollars[h] with retirement at age 65					
2022	65:0	10,328	13,519	22,306	29,517	36,030	62,583
2025	65:0	10,253	13,425	22,166	29,293	35,792	66,308
2030	65:0	11,456	15,000	24,743	32,745	40,051	70,950
2035	65:0	12,261	16,053	26,467	35,033	42,892	75,381
2040	65:0	13,025	17,046	28,116	37,217	45,547	79,937
2045	65:0	13,808	18,076	29,819	39,464	48,334	84,434
2050	65:0	14,592	19,095	31,495	41,684	51,018	89,058
2055	65:0	15,387	20,145	33,222	43,971	53,735	94,081
2060	65:0	16,260	21,279	35,097	46,451	56,727	99,505
2065	65:0	17,194	22,510	37,121	49,130	59,974	105,304
2070	65:0	18,197	23,820	39,284	51,996	63,478	111,411
2075	65:0	19,253	25,203	41,563	55,011	67,167	117,829
2080	65:0	20,363	26,654	43,958	58,179	71,037	124,514
2085	65:0	21,518	28,167	46,450	61,479	75,071	131,500
2090	65:0	22,727	29,748	49,056	64,928	79,283	138,963
2095	65:0	24,018	31,438	51,845	68,615	83,782	147,006
2100	65:0	25,408	33,259	54,846	72,589	88,629	155,515

[a] Attains age 65 on January 1 of the year.

[b] Career-average earnings at about 25 percent of the AWI.

[c] Career-average earnings at about 45 percent of the AWI.

[d] Career-average earnings at about 100 percent of the AWI. Such a worker would have career-average earnings at approximately the 56th percentile of all new retired-worker beneficiaries.

[e] Career-average earnings at about 160 percent of the AWI.

[f] Earnings for each year at or above the contribution and benefit base.

[g] Average Wage Index from table VI.G6, adjusted to be in 2022 dollars by using the CPI indexing series from table VI.G6.

[h] Annual amounts are the total for the 12-month period starting with the month of retirement, adjusted to be in 2022 dollars by using the CPI indexing series from table VI.G6.

Note: Benefits shown at age 65 reflect adjustments for early retirement. For early retirement as early as age 62, the benefit amount is reduced 5/9 of one percent for each month before normal retirement age, up to 36 months. If the number of months exceeds 36, then the benefit is further reduced 5/12 of one percent per month. For example, if the number of reduction months is 60 (the maximum number for retirement at 62 when normal retirement age is 67), then the benefit is reduced by 30 percent. *Delayed retirement credit* is generally given for retirement after the normal retirement age. The delayed retirement credit is 2/3 of one percent per month for persons born in 1943 and later. No credit is given for delaying benefits after attaining age 70. See table V.C3 for additional details, including adjustments applying to other birth years.

11. Administrative Expenses

The projection of administrative expenses through the short-range period is based on historical experience and the projected growth in average wages. The Office of Budget of the Social Security Administration provides estimates for the first several years of the projection. For years after the short-range period, projected administrative expenses reflect increases in the number of beneficiaries in current-payment status, and increases in the average wage. However, the increases in average wage are partially offset by assumed administrative productivity gains.

12. Railroad Retirement Financial Interchange

Railroad workers are covered under a separate multi-tiered benefit plan, with a first tier of coverage similar to OASDI coverage. An annual financial interchange between the Railroad Retirement fund and the OASI and DI Trust Funds is made to resolve the difference between: (1) the amount of OASDI benefits that would be paid to railroad workers and their families if railroad employment had been covered under the OASDI program, plus administrative expenses associated with these benefits; and (2) the amount of OASDI payroll tax and income tax that would be received with allowances for interest from railroad workers.

The Office of the Chief Actuary's projection of future amounts for the financial interchange with the Railroad Retirement fund reflects trends similar to those used in estimating the cost of OASDI benefits. The annual short-range net cost for the OASI and DI Trust Funds is about $5 to $6 billion and the long-range summarized net cost for the OASI and DI Trust Funds is 0.05 percent of taxable payroll.

VI. APPENDICES

A. HISTORY OF OASI AND DI TRUST FUND OPERATIONS

The Federal Old-Age and Survivors Insurance (OASI) Trust Fund was established on January 1, 1940 as a separate account in the United States Treasury. The Federal Disability Insurance (DI) Trust Fund, another separate account in the United States Treasury, was established on August 1, 1956. These funds conduct the financial operations of the OASI and DI programs. The Board of Trustees is responsible for overseeing the financial operations of these funds. The following paragraphs describe the various components of trust fund income and cost. Following this description, tables VI.A1 and VI.A2 present the historical operations of the separate trust funds since their inception, and table VI.A3 presents the operations of the hypothetical combined trust funds[1] during the period when they have co-existed.

The primary income of these two funds comes from appropriations under permanent authority on the basis of payroll tax contributions. Federal law requires that all employees who work in OASDI covered employment, and their employers, make payroll tax contributions on their wages up to a specified annual maximum amount (the contribution and benefit base). Employees and their employers must also make payroll tax contributions on monthly cash tips if such tips are at least $20. Self-employed persons must make payroll tax contributions on their covered net earnings from self-employment subject to the annual contribution and benefit base. The Federal Government pays amounts equivalent to the combined employer and employee contributions that would be paid on deemed wage credits attributable to military service performed between 1957 and 2001, if such wage credits were covered wages. Treasury initially deposits payroll tax contributions to the trust funds each day on an estimated basis. Subsequently, Treasury makes adjustments based on the certified amount of wages and self-employment earnings in the records of the Social Security Administration.

Income also includes various reimbursements from the General Fund of the Treasury, such as: (1) the cost of noncontributory wage credits for military service before 1957, and periodic adjustments to previous determinations of this cost; (2) the cost in 1971 through 1982 of deemed wage credits for military service performed after 1956; (3) the cost of benefits to certain uninsured persons who attained age 72 before 1968; (4) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984 through 1989 by Public Law 98-21; (5) the cost in 2009 through 2017 of excluding certain self-employment earnings from SECA taxes under Public

[1] The OASI and DI Trust Funds are distinct legal entities which operate independently. To illustrate the actuarial status of the program as a whole, the fund operations are often combined on a hypothetical basis.

Law 110-246; and (6) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

Beginning in 1984, Federal law subjected up to 50 percent of an individual's or couple's OASDI benefits to Federal income taxation under certain circumstances. Effective for taxable years beginning after 1993, the law increased the maximum percentage from 50 percent to 85 percent. Treasury credits the proceeds from this taxation of up to 50 percent of benefits to the OASI and DI Trust Funds in advance, on an estimated basis, at the beginning of each calendar quarter, with no reimbursement to the General Fund for interest costs attributable to the advance transfers.[1] Treasury makes subsequent adjustments based on the actual amounts shown on annual income tax records. Each of the OASI and DI Trust Funds receives the income taxes paid on the benefits from that trust fund.[2]

Another source of income to the trust funds is interest received on investments held by the trust funds. On a daily basis, Treasury invests trust fund income in interest-bearing obligations of the U.S. Government. These investments include the special public-debt obligations described in the next paragraph. The Social Security Act also authorizes the trust funds to hold obligations guaranteed as to both principal and interest by the United States. The act therefore permits the trust funds to hold certain Federally sponsored agency obligations and marketable obligations.[3] The trust funds may acquire any of these obligations on original issue at the issue price or by purchase of outstanding obligations at their market price.

The Social Security Act authorizes the issuance of special public-debt obligations for purchase exclusively by the trust funds. The act provides that the interest rate for special obligations newly issued in any month is the average market yield, as of the last business day of the prior month, on all of the outstanding marketable U.S. obligations that are due or callable more than 4 years in the future. This rate is rounded to the nearest one-eighth of one percent. Beginning January 1999, in calculating the average market yield rate for this purpose, the Treasury incorporates the yield to the call date when a callable bond's market price is above par.

Although the Social Security Act does not authorize the purchase or sale of special issue securities in the open market, Treasury redeems special issue securities prior to maturity at par value when needed to meet current operat-

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[1] The HI Trust Fund receives the additional tax revenue resulting from the increase to 85 percent.

[2] A special provision applies to benefits paid to nonresident aliens. Effective for taxable years beginning after 1994, Public Law 103-465 subjects benefits to a flat-rate tax, usually 25.5 percent, before they are paid. Therefore, this tax remains in the trust funds. From 1984 to 1994, the flat-rate tax was usually 15 percent.

[3] The Social Security Act requires the trust funds to acquire special-issue obligations unless the Managing Trustee determines that the purchase of marketable obligations is in the public interest. The purchase of marketable obligations has been quite limited and has not occurred since 1980.

ing expenses. As a result, changes in market yield rates after issuance of special issue securities do not cause fluctuations in the value of these securities. As is true for marketable Treasury securities held by the public, the full faith and credit of the U.S. Government backs all of the investments held by the trust funds.

Annual cost for the OASI and DI Trust Funds primarily consists of: (1) OASDI benefit payments[1], net of any reimbursements from the General Fund of the Treasury for unnegotiated benefit checks; and (2) expenses incurred by the Social Security Administration and the Department of the Treasury in administering the OASDI program and the provisions of the Internal Revenue Code relating to the collection of contributions. Such administrative expenses include, among other items, the cost of (1) payroll; (2) construction, rental, lease, or purchase of office buildings and related facilities for the Social Security Administration; and (3) information technology systems. The Social Security Act prohibits payments from the OASI and DI Trust Funds for any purpose not related to the payment of benefits or administrative costs for the OASDI program.

Annual cost also includes: (1) the costs of vocational rehabilitation services furnished to disabled persons receiving cash benefits because of their disabilities, where such services contributed to their successful rehabilitation; and (2) net costs of the provisions of the Railroad Retirement Act that provide for a system of coordination and financial interchange between the Railroad Retirement program and the Social Security program. Under the financial interchange provisions, the Railroad Retirement program's Social Security Equivalent Benefit Account and the trust funds interchange amounts on an annual basis so that each trust fund is in the same position it would have been had railroad employment always been covered under Social Security.

The statements of the operations of the trust funds in this report do not include the net worth of facilities and other fixed capital assets because the value of fixed capital assets is not available in the form of a financial asset redeemable for the payment of benefits or administrative costs. As a result of this unavailability, the actuarial status of the trust funds does not take these assets into account.

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[1] Periodically, benefit payments which were scheduled to be paid on January 3 were actually paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. The most recent such accelerated payment affected benefits scheduled to be paid on January 3, 2021. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year without regard to the accelerated payments described above.

Table VI.A1.— Operations of the OASI Trust Fund, Calendar Years 1937-2021
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		
	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a,e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
1937[g]	$0.8	$0.8	—	—	[h]	[h]	[h]	—	—	$0.8	$0.8	—
1938[g]	.4	.4	—	—	[h]	[h]	[h]	—	—	.4	1.1	7,660
1939[g]	.6	.6	—	—	[h]	[h]	[h]	—	—	.6	1.7	8,086
1940	.4	.3	—	—	[h]	$0.1	[h]	[h]	—	.3	2.0	2,781
1941	.8	.8	—	—	$0.1	.1	$0.1	[h]	—	.7	2.8	1,782
1942	1.1	1.0	—	—	.1	.2	.1	[h]	—	.9	3.7	1,737
1943	1.3	1.2	—	—	.1	.2	.2	[h]	—	1.1	4.8	1,891
1944	1.4	1.3	—	—	.1	.2	.2	[h]	—	1.2	6.0	2,025
1945	1.4	1.3	—	—	.1	.3	.3	[h]	—	1.1	7.1	1,975
1946	1.4	1.3	—	—	.2	.4	.4	[h]	—	1.0	8.1	1,704
1947	1.7	1.6	[h]	—	.2	.5	.5	[h]	—	1.2	9.4	1,592
1948	2.0	1.7	[h]	—	.3	.6	.6	$0.1	—	1.4	10.7	1,542
1949	1.8	1.7	[h]	—	.1	.7	.7	.1	—	1.1	11.8	1,487
1950	2.9	2.7	[h]	—	.3	1.0	1.0	.1	—	1.9	13.7	1,156
1951	3.8	3.4	[h]	—	.4	2.0	1.9	.1	—	1.8	15.5	698
1952	4.2	3.8	—	—	.4	2.3	2.2	.1	—	1.9	17.4	681
1953	4.4	3.9	—	—	.4	3.1	3.0	.1	—	1.3	18.7	564
1954	5.6	5.2	—	—	.4	3.7	3.7	.1	[h]	1.9	20.6	500
1955	6.2	5.7	—	—	.5	5.1	5.0	.1	[h]	1.1	21.7	405
1956	6.7	6.2	—	—	.5	5.8	5.7	.1	[h]	.9	22.5	371
1957	7.4	6.8	—	—	.6	7.5	7.3	.2	[h]	-.1	22.4	300
1958	8.1	7.6	—	—	.6	8.6	8.3	.2	$0.1	-.5	21.9	259
1959	8.6	8.1	—	—	.5	10.3	9.8	.2	.3	-1.7	20.1	212
1960	11.4	10.9	—	—	.5	11.2	10.7	.2	.3	.2	20.3	180
1961	11.8	11.3	—	—	.5	12.4	11.9	.2	.3	-.6	19.7	163
1962	12.6	12.1	—	—	.5	14.0	13.4	.3	.4	-1.4	18.3	141
1963	15.1	14.5	—	—	.5	14.9	14.2	.3	.4	.1	18.5	123
1964	16.3	15.7	—	—	.6	15.6	14.9	.3	.4	.6	19.1	118
1965	16.6	16.0	—	—	.6	17.5	16.7	.3	.4	-.9	18.2	109
1966	21.3	20.6	$0.1	—	.6	19.0	18.3	.3	.4	2.3	20.6	96
1967	24.0	23.1	.1	—	.8	20.4	19.5	.4	.5	3.7	24.2	101
1968	25.0	23.7	.4	—	.9	23.6	22.6	.5	.4	1.5	25.7	103
1969	29.6	27.9	.4	—	1.2	25.2	24.2	.5	.5	4.4	30.1	102
1970	32.2	30.3	.4	—	1.5	29.8	28.8	.5	.6	2.4	32.5	101
1971	35.9	33.7	.5	—	1.7	34.5	33.4	.5	.6	1.3	33.8	94
1972	40.1	37.8	.5	—	1.8	38.5	37.1	.7	.7	1.5	35.3	88
1973	48.3	46.0	.4	—	1.9	47.2	45.7	.6	.8	1.2	36.5	75
1974	54.7	52.1	.4	—	2.2	53.4	51.6	.9	.9	1.3	37.8	68
1975	59.6	56.8	.4	—	2.4	60.4	58.5	.9	1.0	-.8	37.0	63
1976	66.3	63.4	.6	—	2.3	67.9	65.7	1.0	1.2	-1.6	35.4	54
1977	72.4	69.6	.6	—	2.2	75.3	73.1	1.0	1.2	-2.9	32.5	47
1978	78.1	75.5	.6	—	2.0	83.1	80.4	1.1	1.6	-5.0	27.5	39
1979	90.3	87.9	.6	—	1.8	93.1	90.6	1.1	1.4	-2.9	24.7	30
1980	105.8	103.5	.5	—	1.8	107.7	105.1	1.2	1.4	-1.8	22.8	23
1981	125.4	122.6	.7	—	2.1	126.7	123.8	1.3	1.6	-1.3	21.5	18
1982	125.2	123.7	.7	—	.8	142.1	138.8	1.5	1.8	[i].6	22.1	15
1983	150.6	138.3	5.5	—	6.7	153.0	149.2	1.5	2.3	-2.4	19.7	14
1984	169.3	159.5	4.7	$2.8	2.3	161.9	157.8	1.6	2.4	7.4	27.1	[j]20
1985	184.2	175.1	4.0	3.2	1.9	171.2	167.2	1.6	2.3	[i]8.7	35.8	[j]24
1986	197.4	189.1	1.8	3.4	3.1	181.0	176.8	1.6	2.6	[i]3.2	39.1	[j]28
1987	210.7	201.1	1.7	3.3	4.7	187.7	183.6	1.5	2.6	23.1	62.1	[j]30
1988	240.8	227.7	2.1	3.4	7.6	200.0	195.5	1.8	2.8	40.7	102.9	[j]41
1989	264.7	248.1	2.1	2.4	12.0	212.5	208.0	1.7	2.8	52.2	155.1	[j]59

Table VI.A1.— Operations of the OASI Trust Fund, Calendar Years 1937-2021 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		
	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
1990	$286.7	$266.1	-$0.7	$4.8	$16.4	$227.5	$223.0	$1.6	$3.0	$59.1	$214.2	[j]78
1991	299.3	272.5	.1	5.9	20.8	245.6	240.5	1.8	3.4	53.7	267.8	87
1992	311.2	281.1	-.1	5.9	24.3	259.9	254.9	1.8	3.1	51.3	319.1	103
1993	323.3	290.9	[h]	5.3	27.0	273.1	267.8	2.0	3.4	50.2	369.3	117
1994	328.3	293.3	[h]	5.0	29.9	284.1	279.1	1.6	3.4	44.1	413.5	130
1995	342.8	304.7	-.2	5.5	32.8	297.8	291.6	2.1	4.1	45.0	458.5	139
1996	363.7	321.6	[h]	6.5	35.7	308.2	302.9	1.8	3.6	55.5	514.0	149
1997	397.2	349.9	[h]	7.4	39.8	322.1	316.3	2.1	3.7	75.1	589.1	160
1998	424.8	371.2	[h]	9.1	44.5	332.3	326.8	1.9	3.7	92.5	681.6	177
1999	457.0	396.4	[h]	10.9	49.8	339.9	334.4	1.8	3.7	117.2	798.8	201
2000	490.5	421.4	[h]	11.6	57.5	358.3	352.7	2.1	3.5	132.2	931.0	223
2001	518.1	441.5	[h]	11.9	64.7	377.5	372.3	2.0	3.3	140.6	1,071.5	247
2002	539.7	455.2	.4	12.9	71.2	393.7	388.1	2.1	3.5	146.0	1,217.5	272
2003	543.8	456.1	[h]	12.5	75.2	406.0	399.8	2.6	3.6	137.8	1,355.3	300
2004	566.3	472.8	[h]	14.6	79.0	421.0	415.0	2.4	3.6	145.3	1,500.6	322
2005	604.3	506.9	-.3	13.8	84.0	441.9	435.4	3.0	3.6	162.4	1,663.0	340
2006	642.2	534.8	[h]	15.6	91.8	461.0	454.5	3.0	3.5	181.3	1,844.3	361
2007	675.0	560.9	[h]	17.2	97.0	495.7	489.1	3.1	3.6	179.3	2,023.6	372
2008	695.5	574.6	[h]	15.6	105.3	516.2	509.3	3.2	3.6	179.3	2,202.9	392
2009	698.2	570.4	[h]	19.9	107.9	564.3	557.2	3.4	3.7	133.9	2,336.8	390
2010	677.1	544.8	2.0	22.1	108.2	584.9	577.4	3.5	3.9	92.2	2,429.0	400
2011	698.8	482.4	87.8	22.2	106.5	603.8	596.2	3.5	4.1	95.0	2,524.1	402
2012	731.1	503.9	97.7	26.7	102.8	645.5	637.9	3.4	4.1	85.6	2,609.7	391
2013	743.8	620.8	4.2	20.7	98.1	679.5	672.1	3.4	3.9	64.3	2,674.0	384
2014	769.4	646.2	.4	28.0	94.8	714.2	706.8	3.1	4.3	55.2	2,729.2	374
2015	801.6	679.5	.3	30.6	91.2	750.5	742.9	3.4	4.3	51.0	2,780.3	364
2016	797.5	678.8	.1	31.6	87.0	776.4	768.6	3.5	4.3	21.1	2,801.3	358
2017	825.6	706.5	[h]	35.9	83.2	806.7	798.7	3.7	4.3	19.0	2,820.3	347
2018	831.0	715.9	[h]	34.5	80.7	853.5	844.9	3.8	4.8	-22.4	2,797.9	330
2019	917.9	805.1	[h]	34.9	77.9	911.4	902.8	3.7	4.9	6.5	2,804.3	307

Table VI.A1.— Operations of the OASI Trust Fund, Calendar Years 1937-2021 (Cont.)
[Dollar amounts in billions]

	Income					Cost				Asset Reserves[a]		
Calendar year	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
2020 . .	$968.3	$856.0	[h]	$39.0	$73.3	$961.0	$952.4	$3.7	$4.8	$7.4	$2,811.7	292
2021 . .	942.9	838.2	[h]	37.2	67.5	1,001.9	993.1	4.0	4.8	-59.1	2,752.6	281

[a] Beginning in 1979, benefit payments scheduled to be paid on January 3 of a given year were paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. For comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year without regard to the accelerated payments described above.

[b] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $30.4 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[c] Includes net reimbursements from the General Fund of the Treasury to the OASI Trust Fund for: (1) the cost of noncontributory wage credits for military service before 1957; (2) the cost in 1971-82 of deemed wage credits for military service performed after 1956; (3) the cost of benefits to certain uninsured persons who attained age 72 before 1968; (4) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (5) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (6) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[d] Net interest includes net profits or losses on marketable investments. Beginning in 1967, the trust fund pays administrative expenses on an estimated basis, with a final adjustment including interest made in the following fiscal year. Net interest includes the amounts of these interest adjustments. The 1970 report describes the accounting for administrative expenses for years prior to 1967. Beginning in October 1973, figures include relatively small amounts of gifts to the fund. Net interest for 1983-86 reflects payments for interest on amounts owed under the interfund borrowing provisions. During 1983-90, net interest reflects interest reimbursements paid from the trust fund to the General Fund on advance tax transfers.

[e] Beginning in 1966, includes payments for vocational rehabilitation services furnished to disabled persons receiving benefits because of their disabilities. Beginning in 1983, net benefit amounts include reimbursements paid from the General Fund to the trust fund for unnegotiated benefit checks. Excluding the portion attributable to vocational rehabilitation services and unnegotiated benefit checks, amounts are the same as benefits scheduled under law at that time for all historical years.

[f] The "Trust fund ratio" column represents asset reserves at the beginning of a year as a percentage of cost during the year. The table shows no ratio for 1937 because no reserves existed at the beginning of the year.

[g] Operations prior to 1940 are for the Old-Age Reserve Account established by the original Social Security Act. The 1939 Amendments transferred the asset reserves of the Account to the OASI Trust Fund effective January 1, 1940.

[h] Between -$50 million and $50 million.

[i] Reflects interfund borrowing of $17.5 billion by the OASI Trust Fund from the DI and HI Trust Funds in 1982 and the subsequent repayment of those loans in 1985 ($4.4 billion) and 1986 ($13.2 billion).

[j] Reserves used for the trust fund ratio calculation include January advance tax transfers.

Note: Components may not sum to totals because of rounding.

Table VI.A2.— Operations of the DI Trust Fund, Calendar Years 1957-2021
[Dollar amounts in billions]

	Income					Cost				Asset Reserves[a]		
Calendar year	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
1957 . .	$0.7	$0.7	—	—	[g]	$0.1	$0.1	[g]	—	$0.6	$0.6	—
1958 . .	1.0	1.0	—	—	[g]	.3	.2	[g]	—	.7	1.4	249
1959 . .	.9	.9	—	—	[g]	.5	.5	[g]	[g]	.4	1.8	284
1960 . .	1.1	1.0	—	—	$0.1	.6	.6	[g]	[g]	.5	2.3	304
1961 . .	1.1	1.0	—	—	.1	1.0	.9	$0.1	[g]	.1	2.4	239
1962 . .	1.1	1.0	—	—	.1	1.2	1.1	.1	[g]	-.1	2.4	206
1963 . .	1.2	1.1	—	—	.1	1.3	1.2	.1	[g]	-.1	2.2	183
1964 . .	1.2	1.2	—	—	.1	1.4	1.3	.1	[g]	-.2	2.0	159
1965 . .	1.2	1.2	—	—	.1	1.7	1.6	.1	[g]	-.4	1.6	121
1966 . .	2.1	2.0	[g]	—	.1	1.9	1.8	.1	[g]	.1	1.7	82
1967 . .	2.4	2.3	[g]	—	.1	2.1	1.9	.1	[g]	.3	2.0	83
1968 . .	3.5	3.3	[g]	—	.1	2.5	2.3	.1	[g]	1.0	3.0	83
1969 . .	3.8	3.6	[g]	—	.2	2.7	2.6	.1	[g]	1.1	4.1	111
1970 . .	4.8	4.5	[g]	—	.3	3.3	3.1	.2	[g]	1.5	5.6	126
1971 . .	5.0	4.6	$0.1	—	.4	4.0	3.8	.2	[g]	1.0	6.6	140
1972 . .	5.6	5.1	.1	—	.4	4.8	4.5	.2	[g]	.8	7.5	140
1973 . .	6.4	5.9	.1	—	.5	6.0	5.8	.2	[g]	.5	7.9	125
1974 . .	7.4	6.8	.1	—	.5	7.2	7.0	.2	[g]	.2	8.1	110
1975 . .	8.0	7.4	.1	—	.5	8.8	8.5	.3	[g]	-.8	7.4	92
1976 . .	8.8	8.2	.1	—	.4	10.4	10.1	.3	[g]	-1.6	5.7	71
1977 . .	9.6	9.1	.1	—	.3	11.9	11.5	.4	[g]	-2.4	3.4	48
1978 . .	13.8	13.4	.1	—	.3	13.0	12.6	.3	[g]	.9	4.2	26
1979 . .	15.6	15.1	.1	—	.4	14.2	13.8	.4	[g]	1.4	5.6	30
1980 . .	13.9	13.3	.1	—	.5	15.9	15.5	.4	[g]	-2.0	3.6	35
1981 . .	17.1	16.7	.2	—	.2	17.7	17.2	.4	[g]	-.6	3.0	21
1982 . .	22.7	22.0	.2	—	.5	18.0	17.4	.6	[g]	[h] -.4	2.7	17
1983 . .	20.7	18.0	1.1	—	1.6	18.2	17.5	.6	[g]	2.5	5.2	15
1984 . .	17.3	15.5	.4	$0.2	1.2	18.5	17.9	.6	[g]	-1.2	4.0	[i]35
1985 . .	19.3	17.0	1.2	.2	.9	19.5	18.8	.6	[g]	[h]2.4	6.3	[i]27
1986 . .	19.4	18.2	.2	.2	.8	20.5	19.9	.6	$0.1	[h]1.5	7.8	[i]38
1987 . .	20.3	19.5	.2	[g]	.6	21.4	20.5	.8	.1	-1.1	6.7	[i]44
1988 . .	22.7	21.8	.2	.1	.6	22.5	21.7	.7	.1	.2	6.9	[i]38
1989 . .	24.8	23.8	.2	.1	.7	23.8	22.9	.8	.1	1.0	7.9	[i]38
1990 . .	28.8	28.4	-.6	.1	.9	25.6	24.8	.7	.1	3.2	11.1	[i]40
1991 . .	30.4	29.1	[g]	.2	1.1	28.6	27.7	.8	.1	1.8	12.9	39
1992 . .	31.4	30.1	[g]	.2	1.1	32.0	31.1	.8	.1	-.6	12.3	40
1993 . .	32.3	31.2	[g]	.3	.8	35.7	34.6	1.0	.1	-3.4	9.0	35
1994 . .	52.8	51.4	[g]	.3	1.2	38.9	37.7	1.0	.1	14.0	22.9	23
1995 . .	56.7	54.4	-.2	.3	2.2	42.1	40.9	1.1	.1	14.6	37.6	55
1996 . .	60.7	57.3	[g]	.4	3.0	45.4	44.2	1.2	[g]	15.4	52.9	83
1997 . .	60.5	56.0	[g]	.5	4.0	47.0	45.7	1.3	.1	13.5	66.4	113
1998 . .	64.4	59.0	[g]	.6	4.8	49.9	48.2	1.6	.2	14.4	80.8	133
1999 . .	69.5	63.2	[g]	.7	5.7	53.0	51.4	1.5	.1	16.5	97.3	152
2000 . .	77.9	71.1	-.8	.7	6.9	56.8	55.0	1.6	.2	21.1	118.5	171
2001 . .	83.9	74.9	[g]	.8	8.2	61.4	59.6	1.7	[g]	22.5	141.0	193
2002 . .	87.4	77.3	[g]	.9	9.2	67.9	65.7	2.0	.2	19.5	160.5	208
2003 . .	88.1	77.4	[g]	.9	9.7	73.1	70.9	2.0	.2	15.0	175.4	219
2004 . .	91.4	80.3	[g]	1.1	10.0	80.6	78.2	2.2	.2	10.8	186.2	218
2005 . .	97.4	86.1	[g]	1.1	10.3	88.0	85.4	2.3	.3	9.4	195.6	212
2006 . .	102.6	90.8	[g]	1.2	10.6	94.5	91.7	2.3	.4	8.2	203.8	207
2007 . .	109.9	95.2	[g]	1.4	13.2	98.8	95.9	2.5	.4	11.1	214.9	206
2008 . .	109.8	97.6	[g]	1.3	11.0	109.0	106.0	2.5	.4	.9	215.8	197
2009 . .	109.3	96.9	[g]	2.0	10.5	121.5	118.3	2.7	.4	-12.2	203.5	178

Table VI.A2.— Operations of the DI Trust Fund, Calendar Years 1957-2021 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		
	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
2010 . .	$104.0	$92.5	$0.4	$1.9	$9.3	$127.7	$124.2	$3.0	$0.5	-$23.6	$179.9	159
2011 . .	106.3	81.9	14.9	1.6	7.9	132.3	128.9	2.9	.5	-26.1	153.9	136
2012 . .	109.1	85.6	16.5	.6	6.4	140.3	136.9	2.9	.5	-31.2	122.7	110
2013 . .	111.2	105.4	.7	.4	4.7	143.4	140.1	2.8	.6	-32.2	90.4	86
2014 . .	114.9	109.7	.1	1.7	3.4	145.1	141.7	2.9	.4	-30.2	60.2	62
2015 . .	118.6	115.4	[g]	1.1	2.1	146.6	143.4	2.8	.4	-28.0	32.3	41
2016 . .	160.0	157.4	[g]	1.2	1.4	145.9	142.8	2.8	.4	14.1	46.3	22
2017 . .	171.0	167.1	[g]	2.0	1.9	145.8	142.8	2.8	.2	25.1	71.5	32
2018 . .	172.3	169.2	[g]	.5	2.6	146.8	143.7	2.9	.2	25.6	97.1	49
2019 . .	143.9	139.4	[g]	1.6	2.9	147.9	145.1	2.7	.1	-4.0	93.1	66
2020 . .	149.7	145.3	[g]	1.7	2.8	146.3	143.6	2.6	.1	3.5	96.6	64
2021 . .	145.5	142.4	[g]	.5	2.6	142.6	140.1	2.5	.1	2.8	99.4	68

[a] Beginning in 1979, benefit payments scheduled to be paid on January 3 of a given year were paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. For comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year without regard to the accelerated payments described above.

[b] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $5.2 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[c] Includes net reimbursements from the General Fund of the Treasury to the DI Trust Fund for: (1) the cost of noncontributory wage credits for military service before 1957; (2) the cost in 1971-82 of deemed wage credits for military service performed after 1956; (3) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (4) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (5) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[d] Net interest includes net profits or losses on marketable investments. Beginning in 1967, the trust fund pays administrative expenses on an estimated basis, with a final adjustment including interest made in the following fiscal year. Net interest includes the amounts of these interest adjustments. The 1970 report describes the accounting for administrative expenses for years prior to 1967. Beginning in July 1974, figures include relatively small amounts of gifts to the fund. Net interest for 1983-86 reflects payments for interest on amounts owed under the interfund borrowing provisions. During 1983-90, net interest reflects interest reimbursements paid from the trust fund to the General Fund on advance tax transfers.

[e] Beginning in 1966, includes payments for vocational rehabilitation services furnished to disabled persons receiving benefits because of their disabilities. Beginning in 1983, net benefit amounts include reimbursements paid from the General Fund to the trust fund for unnegotiated benefit checks. Excluding the portion attributable to vocational rehabilitation services and unnegotiated benefit checks, amounts are the same as benefits scheduled under law at that time for all historical years.

[f] The "Trust fund ratio" column represents asset reserves at the beginning of a year as a percentage of cost during the year. The table shows no ratio for 1957 because no reserves existed at the beginning of the year.

[g] Between -$50 million and $50 million.

[h] Reflects interfund borrowing by the OASI Trust Fund from the DI Trust Fund in 1982 of $5.1 billion and the subsequent repayment of that loan in 1985 ($2.5 billion) and 1986 ($2.5 billion).

[i] Reserves used for the trust fund ratio calculation include January advance tax transfers.

Note: Components may not sum to totals because of rounding.

Table VI.A3.— Operations of the Combined OASI and DI Trust Funds, Calendar Years 1957-2021
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		
	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
1957	$8.1	$7.5	—	—	$0.6	$7.6	$7.4	$0.2	[g]	$0.5	$23.0	298
1958	9.1	8.5	—	—	.6	8.9	8.6	.2	$0.1	.2	23.2	259
1959	9.5	8.9	—	—	.6	10.8	10.3	.2	.3	-1.3	22.0	215
1960	12.4	11.9	—	—	.6	11.8	11.2	.2	.3	.6	22.6	186
1961	12.9	12.3	—	—	.6	13.4	12.7	.3	.3	-.5	22.2	169
1962	13.7	13.1	—	—	.6	15.2	14.5	.3	.4	-1.5	20.7	146
1963	16.2	15.6	—	—	.6	16.2	15.4	.3	.4	[g]	20.7	128
1964	17.5	16.8	—	—	.6	17.0	16.2	.4	.4	.5	21.2	122
1965	17.9	17.2	—	—	.7	19.2	18.3	.4	.5	-1.3	19.8	110
1966	23.4	22.6	$0.1	—	.7	20.9	20.1	.4	.5	2.5	22.3	95
1967	26.4	25.4	.1	—	.9	22.5	21.4	.5	.5	3.9	26.3	99
1968	28.5	27.0	.4	—	1.0	26.0	25.0	.6	.5	2.5	28.7	101
1969	33.3	31.5	.5	—	1.3	27.9	26.8	.6	.5	5.5	34.2	103
1970	37.0	34.7	.5	—	1.8	33.1	31.9	.6	.6	3.9	38.1	103
1971	40.9	38.3	.5	—	2.0	38.5	37.2	.7	.6	2.4	40.4	99
1972	45.6	42.9	.5	—	2.2	43.3	41.6	.9	.7	2.3	42.8	93
1973	54.8	51.9	.5	—	2.4	53.1	51.5	.8	.8	1.6	44.4	80
1974	62.1	58.9	.5	—	2.7	60.6	58.6	1.1	.9	1.5	45.9	73
1975	67.6	64.3	.5	—	2.9	69.2	67.0	1.2	1.0	-1.5	44.3	66
1976	75.0	71.6	.7	—	2.7	78.2	75.8	1.2	1.2	-3.2	41.1	57
1977	82.0	78.7	.7	—	2.5	87.3	84.7	1.4	1.2	-5.3	35.9	47
1978	91.9	88.9	.8	—	2.3	96.0	93.0	1.4	1.6	-4.1	31.7	37
1979	105.9	103.0	.7	—	2.2	107.3	104.4	1.5	1.5	-1.5	30.3	30
1980	119.7	116.7	.7	—	2.3	123.5	120.6	1.5	1.4	-3.8	26.5	25
1981	142.4	139.4	.8	—	2.2	144.4	141.0	1.7	1.6	-1.9	24.5	18
1982	147.9	145.7	.9	—	1.4	160.1	156.2	2.1	1.8	[h] .2	24.8	15
1983	171.3	156.3	6.7	—	8.3	171.2	166.7	2.2	2.3	.1	24.9	14
1984	186.6	175.0	5.2	$3.0	3.4	180.4	175.7	2.3	2.4	6.2	31.1	[i]21
1985	203.5	192.1	5.2	3.4	2.7	190.6	186.1	2.2	2.4	[h]11.1	42.2	[i]24
1986	216.8	207.4	1.9	3.7	3.9	201.5	196.7	2.2	2.7	[h] 4.7	46.9	[i]29
1987	231.0	220.6	1.9	3.2	5.3	209.1	204.1	2.4	2.6	21.9	68.8	[i]31
1988	263.5	249.5	2.3	3.4	8.2	222.5	217.1	2.5	2.9	41.0	109.8	[i]41
1989	289.4	271.9	2.3	2.5	12.7	236.2	230.9	2.4	2.9	53.2	163.0	[i]57
1990	315.4	294.5	-1.3	5.0	17.2	253.1	247.8	2.3	3.0	62.3	225.3	[i]75
1991	329.7	301.6	.1	6.1	21.9	274.2	268.2	2.6	3.5	55.5	280.7	82
1992	342.6	311.3	-.1	6.1	25.4	291.9	286.0	2.7	3.2	50.7	331.5	96
1993	355.6	322.0	.1	5.6	27.9	308.8	302.4	3.0	3.4	46.8	378.3	107
1994	381.1	344.7	[g]	5.3	31.1	323.0	316.8	2.7	3.5	58.1	436.4	117
1995	399.5	359.1	-.4	5.8	35.0	339.8	332.6	3.1	4.1	59.7	496.1	128
1996	424.5	378.9	[g]	6.8	38.7	353.6	347.0	3.0	3.6	70.9	567.0	140
1997	457.7	406.0	[g]	7.9	43.8	369.1	362.0	3.4	3.7	88.6	655.5	154
1998	489.2	430.2	[g]	9.7	49.3	382.3	375.0	3.5	3.8	106.9	762.5	171
1999	526.6	459.6	[g]	11.6	55.5	392.9	385.8	3.3	3.8	133.7	896.1	194
2000	568.4	492.5	-.8	12.3	64.5	415.1	407.6	3.8	3.7	153.3	1,049.4	216
2001	602.0	516.4	[g]	12.7	72.9	438.9	431.9	3.7	3.3	163.1	1,212.5	239
2002	627.1	532.5	.4	13.8	80.4	461.7	453.8	4.2	3.6	165.4	1,378.0	263
2003	631.9	533.5	[g]	13.4	84.9	479.1	470.8	4.6	3.7	152.8	1,530.8	288
2004	657.7	553.0	[g]	15.7	89.0	501.6	493.3	4.5	3.8	156.1	1,686.8	305
2005	701.8	592.9	-.3	14.9	94.3	529.9	520.7	5.3	3.9	171.8	1,858.7	318
2006	744.9	625.6	[g]	16.9	102.4	555.4	546.2	5.3	3.8	189.5	2,048.1	335
2007	784.9	656.1	[g]	18.6	110.2	594.5	584.9	5.5	4.0	190.4	2,238.5	345
2008	805.3	672.1	[g]	16.9	116.3	625.1	615.3	5.7	4.0	180.2	2,418.7	358
2009	807.5	667.3	[g]	21.9	118.3	685.8	675.5	6.2	4.1	121.7	2,540.3	353

Table VI.A3.— Operations of the Combined OASI and DI Trust Funds, Calendar Years 1957-2021 (Cont.)
[Dollar amounts in billions]

Calendar year	Income					Cost				Asset Reserves[a]		
	Total	Net payroll tax contributions[b]	GF reimbursements[c]	Taxation of benefits[b]	Net interest[d]	Total[a]	Benefit payments[a e]	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[f]
2010 . .	$781.1	$637.3	$2.4	$23.9	$117.5	$712.5	$701.6	$6.5	$4.4	$68.6	$2,609.0	357
2011 . .	805.1	564.2	102.7	23.8	114.4	736.1	725.1	6.4	4.6	69.0	2,677.9	354
2012 . .	840.2	589.5	114.3	27.3	109.1	785.8	774.8	6.3	4.7	54.4	2,732.3	341
2013 . .	855.0	726.2	4.9	21.1	102.8	822.9	812.3	6.2	4.5	32.1	2,764.4	332
2014 . .	884.3	756.0	.5	29.6	98.2	859.2	848.5	6.1	4.7	25.0	2,789.5	322
2015 . .	920.2	794.9	.3	31.6	93.3	897.1	886.3	6.2	4.7	23.0	2,812.5	311
2016 . .	957.5	836.2	.1	32.8	88.4	922.3	911.4	6.2	4.7	35.2	2,847.7	305
2017 . .	996.6	873.6	[g]	37.9	85.1	952.5	941.5	6.5	4.5	44.1	2,891.8	299
2018 . .	1,003.4	885.1	[g]	35.0	83.3	1,000.2	988.6	6.7	4.9	3.1	2,894.9	289
2019 . .	1,061.8	944.5	[g]	36.5	80.8	1,059.3	1,047.9	6.4	4.9	2.5	2,897.4	273
2020 . .	1,118.1	1,001.3	[g]	40.7	76.1	1,107.2	1,095.9	6.3	5.0	10.9	2,908.3	262
2021 . .	1,088.3	980.6	[g]	37.6	70.1	1,144.6	1,133.2	6.5	4.9	-56.3	2,852.0	254

[a] Beginning in 1979, benefit payments scheduled to be paid on January 3 of a given year were paid on December 31 of the preceding year as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Such advance payments have occurred about every 7 years, first for benefits scheduled for January 3, 1982. For comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year without regard to the accelerated payments described above.

[b] Includes adjustments for prior calendar years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $35.5 billion was made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.

[c] Includes net reimbursements from the General Fund of the Treasury to the OASI and DI Trust Funds for: (1) the cost of noncontributory wage credits for military service before 1957; (2) the cost in 1971-82 of deemed wage credits for military service performed after 1956; (3) the cost of benefits to certain uninsured persons who attained age 72 before 1968; (4) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (5) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (6) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

[d] Net interest includes net profits or losses on marketable investments. Beginning in 1967, the trust funds pay administrative expenses on an estimated basis, with a final adjustment including interest made in the following fiscal year. Net interest includes the amounts of these interest adjustments. The 1970 report describes the accounting for administrative expenses for years prior to 1967. Beginning in October 1973, figures include relatively small amounts of gifts to the funds. Net interest for 1983-86 reflects payments for interest on amounts owed under the interfund borrowing provisions. During 1983-90, net interest reflects interest reimbursements paid from the trust funds to the General Fund on advance tax transfers.

[e] Beginning in 1966, includes payments for vocational rehabilitation services furnished to disabled persons receiving benefits because of their disabilities. Beginning in 1983, net benefit amounts include reimbursements paid from the General Fund to the trust funds for unnegotiated benefit checks. Excluding the portion attributable to vocational rehabilitation services and unnegotiated benefit checks, amounts are the same as benefits scheduled under law at that time for all historical years.

[f] The "Trust fund ratio" column represents asset reserves at the beginning of a year as a percentage of cost during the year.

[g] Between -$50 million and $50 million.

[h] Reflects interfund borrowing by the OASI Trust Fund from the HI Trust Fund in 1982 of $12.4 billion and the subsequent repayment of that loan in 1985 ($1.8 billion) and 1986 ($10.6 billion).

[i] Reserves used for the trust fund ratio calculation include January advance tax transfers.

Note: Components may not sum to totals because of rounding.

Tables VI.A4 and VI.A5 show the total asset reserves of the OASI Trust Fund and the DI Trust Fund, respectively, at the end of calendar years 2020 and 2021. The tables show the invested asset reserves by interest rate and year of maturity. Bonds issued to the trust funds in 2021 had an interest rate of 1.500 percent, compared with an interest rate of 0.750 percent for bonds issued in 2020.

Table VI.A4.—OASI Trust Fund Asset Reserves, End of Calendar Years 2020 and 2021

[In thousands]

	December 31, 2020	December 31, 2021
Obligations sold only to the trust funds (special issue securities):		
Certificates of indebtedness:		
0.875 percent, 2021	$31,409,192	—
1.500 percent, 2022	—	$53,944,023
Bonds:		
0.750 percent, 2022	14,931,408	—
0.750 percent, 2023-25	44,794,224	44,794,224
0.750 percent, 2026-33	119,451,256	119,451,256
1.375 percent, 2022	6,693,020	—
1.375 percent, 2023-25	20,079,060	20,079,060
1.375 percent, 2026	6,693,019	6,693,019
1.375 percent, 2027	173,240,401	173,240,401
1.500 percent, 2023-25	—	38,088,537
1.500 percent, 2026-32	—	88,873,260
1.500 percent, 2033	—	12,696,179
1.750 percent, 2022	4,908,185	—
1.750 percent, 2023-25	14,724,555	14,724,555
1.750 percent, 2026-27	9,816,372	9,816,372
1.750 percent, 2028	178,148,587	178,148,587
1.875 percent, 2022	2,320,956	—
1.875 percent, 2023-27	11,604,780	11,604,780
1.875 percent, 2028-30	6,962,865	6,962,865
1.875 percent, 2031	188,111,583	188,111,583
2.000 percent, 2022	3,655,628	—
2.000 percent, 2023-25	10,966,884	10,966,884
2.000 percent, 2026-29	14,622,516	14,622,516
2.000 percent, 2030	185,790,628	185,790,628
2.250 percent, 2022	5,582,927	—
2.250 percent, 2023-25	16,748,781	16,748,781
2.250 percent, 2026-27	11,165,852	11,165,852
2.250 percent, 2028	5,582,927	5,582,927
2.250 percent, 2029	183,731,514	183,731,514
2.250 percent, 2030-31	3,193,030	3,193,030
2.250 percent, 2032	189,708,097	189,708,097
2.250 percent, 2033	12,818,538	12,818,538
2.250 percent, 2034	177,899,339	177,899,339
2.500 percent, 2022	5,971,787	—
2.500 percent, 2023-25	17,915,361	17,915,361
2.500 percent, 2026	166,547,382	166,547,382
2.875 percent, 2022	7,264,432	—
2.875 percent, 2023-24	14,528,864	14,528,864
2.875 percent, 2025	160,575,595	160,575,595
2.875 percent, 2032	1	1
2.875 percent, 2033	176,889,560	176,889,560
3.250 percent, 2022	10,628,270	—
3.250 percent, 2023	10,628,270	10,628,270
3.250 percent, 2024	153,311,163	153,311,163
4.000 percent, 2022	12,075,192	—
4.000 percent, 2023	142,682,893	142,682,893
5.000 percent, 2021	10,010,036	—
5.000 percent, 2022	130,607,701	130,152,459
5.125 percent, 2021	118,153,469	—
Total investments	2,793,146,100	2,752,688,355
Undisbursed balances[a]	18,569,550	-52,566
Total asset reserves	2,811,715,650	2,752,635,789

[a] A negative amount for a given year represents a situation where actual program cost exceeded the amount of invested securities of the OASI Trust Fund that were redeemed to cover such cost. In this situation, future redemption of additional invested securities will be required to pay for this shortfall. For 2020 and other calendar years where January 3 of the following year is a Sunday, a positive amount is shown on a liability basis for benefits scheduled to be paid on January 3 of the following year that were, by law, actually paid on the preceding December 31.

Note: Amounts of special issue securities are at par value. The trust fund purchases and redeems special issue securities at par value. The table groups equal amounts that mature in two or more years at a given interest rate.

Table VI.A5.—DI Trust Fund Asset Reserves, End of Calendar Years 2020 and 2021
[In thousands]

	December 31, 2020	December 31, 2021
Obligations sold only to the trust funds (special issue securities):		
Certificates of indebtedness:		
0.875 percent, 2021	$110,721	—
1.500 percent, 2022	—	$7,651,929
1.625 percent, 2022	—	352,540
Bonds:		
0.750 percent, 2024-26	1,438,419	1,438,419
0.750 percent, 2027-29	1,438,422	1,438,422
0.750 percent, 2030-34	2,397,365	2,397,365
0.750 percent, 2035	5,348,270	5,348,270
1.500 percent, 2024-29	—	845,268
1.500 percent, 2030-35	—	845,274
1.500 percent, 2036	—	5,489,148
1.875 percent, 2022	595,277	—
2.250 percent, 2024-25	2,489,358	2,489,358
2.250 percent, 2026	1,244,680	1,244,680
2.250 percent, 2027-32	7,468,074	7,468,074
2.250 percent, 2033-34	9,737,594	9,737,594
2.875 percent, 2024-25	7,248,238	7,248,238
2.875 percent, 2026-32	25,368,826	25,368,826
4.000 percent, 2023	14,675,554	14,675,554
5.000 percent, 2022	11,142,596	5,398,822
Total investments	90,703,394	99,437,781
Undisbursed balances[a]	5,866,965	-43,640
Total asset reserves	96,570,359	99,394,141

[a] A negative amount for a given year represents a situation where actual program cost exceeded the amount of invested securities of the DI Trust Fund that were redeemed to cover such cost. In this situation, future redemption of additional invested securities will be required to pay for this shortfall. For 2020 and other calendar years where January 3 of the following year is a Sunday, a positive amount is shown on a liability basis for benefits scheduled to be paid on January 3 of the following year that were, by law, actually paid on the preceding December 31.

Note: Amounts of special issue securities are at par value. The trust fund purchases and redeems special issue securities at par value. The table groups equal amounts that mature in two or more years at a given interest rate.

B. HISTORY OF ACTUARIAL STATUS ESTIMATES

This appendix chronicles the history of the long-range OASDI actuarial balance and the year of combined OASI and DI Trust Fund reserve depletion since 1982 under the intermediate assumptions. The actuarial balance is the principal summary measure of actuarial status for the long-range period as a whole. The year of trust fund reserve depletion is also critical, as it indicates the year by which legislative action would be needed in order to maintain timely payment of scheduled benefits.

The 1983 report was the last report for which the actuarial balance was positive. The two basic components of actuarial balance are the summarized income rate and the summarized cost rate, both of which are expressed as percentages of taxable payroll over the period. Section IV.B.4 defines the summarized income rate, summarized cost rate, and actuarial balance in detail. For any given period, the actuarial balance includes the difference between the present value of non-interest income for the period and the present value of the cost for the period, each divided by the present value of taxable payroll for all years in the period. The computation of the actuarial balance also includes:

- In the reports for 1988 and later, the amount of the trust fund asset reserves on hand at the beginning of the valuation period; and
- In the reports for 1991 and later, the present value of a target trust fund asset reserve equal to 100 percent of the annual cost to be reached and maintained at the end of the valuation period.

Reports of 1973-87 used the average-cost method, a simpler method which approximates the results of the present-value approach for computing the actuarial balance. Under the average-cost method, the sum of the annual cost rates over the 75-year projection period was divided by the total number of years, 75, to obtain the average cost rate per year. A similar computation produced the average income rate. The actuarial balance was the difference between the average income rate and the average cost rate.

When the 1973 report introduced the average-cost method, the financing of the program was more nearly on a pay-as-you-go basis over the long-range. Also, the long-range demographic and economic assumptions in that report produced an annual rate of growth in total taxable payroll which was about the same as the annual rate at which the trust funds earned interest. In either circumstance (i.e., pay-as-you-go financing, where the annual income rate is the same as the annual cost rate, or an annual rate of growth in total taxable payroll equal to the annual interest rate), the average-cost method produces

the same result as the present-value method. However, by 1988, neither of these circumstances still existed.

After the 1977 and 1983 Social Security Amendments, projections indicated substantial increases in the trust fund reserves continuing well into the 21st century. These laws changed the program's financing from essentially pay-as-you-go to partial advance funding through the 75-year period. Also, for the reports from 1973 through 1987, long-range fertility rates and average real wage growth assumptions were gradually reduced, resulting in an annual rate of growth in taxable payroll that was significantly lower than the assumed interest rate by 1987. As a result of the difference between this rate of growth and the assumed interest rate, the results of the average-cost method and the present-value method began to diverge in the reports for 1973 through 1987, and by 1988 they were quite different. While the average-cost method reflected most of the effects of assumed interest rates, it no longer reflected all interest effects. The present-value method, by contrast, accurately reflects the implications of assumed interest rates. As a result, the 1988 report reintroduced the present-value method of calculating the actuarial balance.

A positive actuarial balance indicates that estimated income (plus starting reserves, beginning with the 1988 report) is more than sufficient to meet estimated trust fund obligations (plus the ending target fund, beginning with the 1991 report) for the period as a whole. Even with a positive actuarial balance, it is possible for reserves to become temporarily depleted within the long-range period. An actuarial balance of zero indicates that the estimated income (plus starting reserves, beginning with the 1988 report) exactly matches estimated trust fund obligations (plus the ending target fund, beginning with the 1991 report) for the period as a whole. A negative actuarial balance indicates that estimated income (plus starting reserves, beginning with the 1988 report) is insufficient to meet estimated trust fund obligations (plus the ending target fund, beginning with the 1991 report) for the entire period.

Table VI.B1 contains the long-range OASDI actuarial balances, summarized income rates, and summarized cost rates for the 1982 report through the current report. The reports presented these values on the basis of the intermediate assumptions, which recent reports refer to as alternative II and reports from 1982 to 1990 referred to as alternative II-B.

Table VI.B1.—Long-Range OASDI Actuarial Balances and Trust Fund Reserve Depletion Dates as Shown in the Trustees Reports for 1982-2022 under Intermediate Assumptions[a]

[As a percentage of taxable payroll]

Year of report	Summarized income rate	Summarized cost rate	Actuarial balance[b]	Change from previous year[c]	Year of combined trust fund reserve depletion
1982	12.27	14.09	-1.82	[d]	1983
1983	12.87	12.84	+.02	+1.84	solvent
1984	12.90	12.95	-.06	-.08	solvent
1985	12.94	13.35	-.41	-.35	2049
1986	12.96	13.40	-.44	-.03	2051
1987	12.89	13.51	-.62	-.18	2051
1988	12.94	13.52	-.58	+.04	2048
1989	13.02	13.72	-.70	-.13	2046
1990	13.04	13.95	-.91	-.21	2043
1991	13.11	14.19	-1.08	-.17	2041
1992	13.16	14.63	-1.46	-.38	2036
1993	13.21	14.67	-1.46	[d]	2036
1994	13.24	15.37	-2.13	-.66	2029
1995	13.27	15.44	-2.17	-.04	2030
1996	13.33	15.52	-2.19	-.02	2029
1997	13.37	15.60	-2.23	-.03	2029
1998	13.45	15.64	-2.19	+.04	2032
1999	13.49	15.56	-2.07	+.12	2034
2000	13.51	15.40	-1.89	+.17	2037
2001	13.58	15.44	-1.86	+.03	2038
2002	13.72	15.59	-1.87	-.01	2041
2003	13.78	15.70	-1.92	-.04	2042
2004	13.84	15.73	-1.89	+.03	2042
2005	13.87	15.79	-1.92	-.04	2041
2006	13.88	15.90	-2.02	-.09	2040
2007	13.92	15.87	-1.95	+.06	2041
2008	13.94	15.63	-1.70	+.26	2041
2009	14.02	16.02	-2.00	-.30	2037
2010	14.01	15.93	-1.92	+.08	2037
2011	14.02	16.25	-2.22	-.30	2036
2012	14.02	16.69	-2.67	-.44	2033
2013	13.88	16.60	-2.72	-.05	2033
2014	13.89	16.77	-2.88	-.16	2033
2015	13.86	16.55	-2.68	+.20	2034
2016	13.84	16.50	-2.66	+.02	2034
2017	13.84	16.67	-2.83	-.17	2034
2018	13.84	16.69	-2.84	-.02	2034
2019	13.81	16.60	-2.78	+.06	2035
2020	13.85	17.06	-3.21	-.43	2035
2021	13.78	17.31	-3.54	-.32	2034
2022	13.78	17.20	-3.42	+.12	2035

[a] This table shows the actuarial balance and year of trust fund reserve depletion based on the intermediate assumptions, which the 1982-90 reports referred to as alternative II-B and the 1991 and later reports refer to as alternative II.

[b] The definition and method of calculating the actuarial balance were changed in 1988 and 1991. See text for details.

[c] A detailed year-by-year breakdown of the reasons for the changes in the actuarial balance since the 1983 Trustees Report may be found in Actuarial Note 2022.8 at www.ssa.gov/OACT/NOTES/ran8/.

[d] Between -0.005 and 0.005 percent of taxable payroll.

Note: Components may not sum to totals because of rounding.

For several of the years included in the table, significant legislative changes or definitional changes affected the actuarial balance. The Social Security Amendments of 1983 account for the largest single change shown in the table: the actuarial balance of -1.82 for the 1982 report improved to +0.02 for the 1983 report. In 1985, the actuarial balance changed largely because of an adjustment made to the method for estimating the age distribution of immigrants.

Rebenchmarking of the National Income and Product Accounts and changes in demographic assumptions contributed to the change in the actuarial balance for 1987. Various changes in assumptions and methods for the 1988 report had roughly offsetting effects on the actuarial balance. In 1989 and 1990, changes in economic assumptions accounted for most of the changes in the actuarial balance.

In 1991, the effect of legislation, changes in economic assumptions, and the introduction of the cost of reaching and maintaining an ending target trust fund level combined to produce the change in the actuarial balance. In 1992, changes in disability assumptions and the method for projecting average benefit levels accounted for most of the change in the actuarial balance. In 1993, numerous small changes in assumptions and methods had offsetting effects on the actuarial balance. In 1994, changes in the real wage assumptions, disability rates, and the earnings sample used for projecting average benefit levels accounted for most of the change in the actuarial balance. In 1995, numerous small changes had largely offsetting effects on the actuarial balance, including a substantial reallocation of the payroll tax rate, which reduced the OASI actuarial balance, but increased the DI actuarial balance.

In 1996, a change in the method of projecting dually-entitled beneficiaries produced a large increase in the actuarial balance, which almost totally offset decreases produced by changes in the valuation period and in the demographic and economic assumptions. Various changes in assumptions and methods for the 1997 report had roughly offsetting effects on the actuarial balance. In 1998, increases caused by changes in the economic assumptions, although partially offset by decreases produced by changes in the valuation period and in the demographic assumptions, accounted for most of the changes in the actuarial balance. In 1999, increases caused by changes in the economic assumptions (related to improvements in the CPI by the Bureau of Labor Statistics) accounted for most of the changes in the actuarial balance. For the 2000 report, changes in economic assumptions and methodology caused increases in the actuarial balance, although reductions in the balance caused by the change in valuation period and changes in demographic assumptions partially offset these increases.

For the 2001 report, increases caused by changes in the demographic starting values, although partially offset by a decrease produced by the change in the valuation period, accounted for most of the changes in the actuarial balance. For the 2002 report, changes in the valuation period and the demographic assumptions—both decreases in the actuarial balance—were offset by changes in the economic assumptions, while an increase due to disability assumptions was slightly more than offset by a decrease due to changes in the projection methods and data. For the 2003 report, an increase due to the change in program assumptions was more than offset by decreases due to the change in valuation period and changes in demographic assumptions. In the 2004 report, increases due to changing the method of projecting benefit levels for higher earners more than offset decreases in the actuarial balance arising from the change in the valuation period and the net effect of other changes in programmatic data and methods. For the 2005 report, an increase due to changing the method of projecting future average benefit levels was more than offset by decreases due to changes in the valuation period, updated starting values for the economic assumptions, and other methodological changes.

In 2006, decreases in the actuarial balance due to the change in the valuation period, a reduction in the ultimate annual real interest rate, and improvements in calculating mortality for disabled workers, were greater in aggregate than increases in the actuarial balance due to changes in demographic starting values and the ultimate total fertility rate, as well as other programmatic data and method changes. For the 2007 report, increases in the actuarial balance arising from revised disability incidence rate assumptions, improvements in average benefit level projections, and changes in near-term economic projections, more than offset decreases in the balance due to the valuation period change and updated historical mortality data. For the 2008 report, the large increase in the actuarial balance was primarily due to changes in immigration projection methods and assumptions. These changes more than offset the decreases in the actuarial balance due to the change in the valuation period and the lower starting and ultimate mortality rates. In 2009, changes in starting values and near-term economic assumptions due to the economic recession, faster ultimate rates of decline in death rates for ages 65-84, and the change in the valuation period accounted for most of the large decrease in the actuarial balance. Legislative changes, in particular the estimated effects of the Patient Protection and Affordable Care Act and the Health Care and Education Reconciliation Act of 2010, were the main reason for the increase in the actuarial balance for the 2010 report. The change in the valuation period partially offset this increase; there were also changes in

several assumptions, methods, and recent data which had largely offsetting effects.

For the 2011 report, changes in mortality projections, due to new starting values and revised methods, were the most significant of several factors contributing to the increase in the deficit. In 2012, changes in economic assumptions and starting values accounted for about half of the decrease in actuarial balance. Other factors worsening the actuarial balance were the change in valuation period, changes to starting demographic values, changes to ultimate disability incidence assumptions, and methodology changes and data updates. For the 2013 report, the change in valuation period accounted for the entire net change in the actuarial balance. The effects of substantially lower death rates for 2009 than previously projected and the American Taxpayer Relief Act of 2012 (which lowered the Federal marginal income tax rates) were offset by updates of program-specific data and methodology improvements. In 2014, changes in economic data and assumptions accounted for the majority of the net change in the actuarial balance. Other factors worsening the actuarial balance were the change in the valuation period and various methodology improvements and data updates. For the 2015 report, methodological improvements and updates of programmatic data accounted for the majority of the net increase in the actuarial balance. Also increasing the actuarial balance were a lower assumed ultimate average wage differential and changes in near-term economic assumptions. These increases were offset somewhat by the change in the valuation period and updates to historical and near-term projected birth rates.

For the 2016 report, the actuarial balance increased primarily due to the effects of the Bipartisan Budget Act of 2015 and improvements made to immigration methods. The most notable immigration change was a revision to the method for projecting emigration of the never-authorized population to reflect lower rates of emigration for those who have resided here longer. These increases in the actuarial balance were largely offset by the effects of changes in ultimate economic assumptions, including a lower real interest rate and a lower annual increase in the rate of price inflation. In 2017, the change in the valuation period and various methodology improvements accounted for most of the net reduction in the actuarial balance. Other economic factors also contributed to worsening the actuarial balance, including a lower real wage differential assumption and an assumed weaker recovery from the recent recession. These reductions were offset somewhat by lower estimated disability incidence rates over the short-range period. For the 2018 report, incorporating the effects of lower-than-expected birth rates, lower near-term fertility assumptions, and the change in the valuation period

decreased the actuarial balance. Offsetting these factors to a large degree were the effects of higher-than-expected death rates and several methods improvements, most notably an update to the sample used to project average benefit levels for newly-entitled worker beneficiaries. For the 2019 report, the actuarial balance increased primarily due to higher-than-expected death rates and lower near-term and ultimate disability incidence rate assumptions. Partially offsetting these factors were the effects of a lower ultimate real interest rate assumption and the change in the valuation period. For the 2020 report, the actuarial balance decreased primarily due to the following factors. First, the repeal of the Affordable Care Act's excise tax on employer-sponsored group health insurance premiums reduced projected earnings as a share of employee compensation, having a significant negative financial effect on the trust funds. In addition, lower assumed values for the ultimate total fertility rate, the ultimate rate of price inflation, and the ultimate real interest rate, as compared to the rates assumed for the 2019 report, decreased the actuarial balance.

In 2021, the actuarial balance decreased due to the change in the valuation period and three main additional factors. First, economic assumptions were updated to reflect experience during and following the COVID-19 pandemic. In particular, the levels of productivity and potential GDP were assumed to be roughly 1 percent lower beginning with the second quarter of 2020. Second, the data and methodology used for projecting average benefit levels were updated and improved. Third, data and estimates provided by the Office of Tax Analysis at the Department of the Treasury indicated lower near-term and ultimate levels of taxation of benefits.

Section IV.B.6 describes changes affecting the actuarial balance shown for the 2022 report.

C. FISCAL YEAR HISTORICAL AND PROJECTED TRUST FUND OPERATIONS THROUGH 2031

Tables VI.C1, VI.C2, and VI.C3 contain details of the fiscal year 2021 operations of the OASI, DI, and the combined OASI and DI Trust Funds, respectively. The fiscal year for the U.S. Government is the 12-month period ending September 30. Fiscal year 2021 is the most recent fiscal year for which complete information is available. The descriptions of the values in these tables are similar to the corresponding descriptions and values in the calendar year operations tables in section III.A. Please see that section for a description of the various items of income and cost.

Table VI.C1.—Operations of the OASI Trust Fund, Fiscal Year 2021
[In millions]

Total asset reserves, September 30, 2020		$2,811,181
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$837,537	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund	-6,413	
Net payroll tax contributions[a]		831,124
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L.s 111-312, 112-78, and 112-96[a]	2	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		2
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	242	
All other, not subject to withholding[a]	34,081	
Total income from taxation of benefits[a]		34,323
Investment income and interest adjustments:		
Interest on investments	70,535	
Interest adjustments[c]	1	
Total investment income and interest adjustments		70,536
Gifts		[b]
Total income		935,985
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[d]	982,706	
Reimbursement from the General Fund for unnegotiated checks	-48	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	14	
Net benefit payments[d]		982,673
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		4,792
Administrative expenses:		
Costs incurred by:		
Social Security Administration	3,390	
Department of the Treasury	524	
Offsetting miscellaneous receipts	-7	
Miscellaneous reimbursements from the General Fund [e]	-4	
Net administrative expenses		3,902
Total cost		991,367
Net increase in asset reserves		-55,383
Total invested assets	2,755,785	
Undisbursed balances[f]	14	
Total asset reserves, September 30, 2021		2,755,799

[a] Includes adjustments for prior years. In June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $30,380 million was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI program.
[f] A positive balance represents a situation where the invested securities of the OASI Trust Fund that were redeemed to make cash payments exceeded actual program cash payments. In this situation, this excess amount will be used to partially offset future redemption of additional invested securities.

Note: Components may not sum to totals because of rounding.

Table VI.C2.—Operations of the DI Trust Fund, Fiscal Year 2021
[In millions]

Total asset reserves, September 30, 2020		$97,063
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$142,280	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund	-1,085	
Net payroll tax contributions[a]		141,195
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L.s 111-312, 112-78, and 112-96[a]	[b]	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		[b]
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	4	
All other, not subject to withholding[a]	475	
Total income from taxation of benefits[a]		479
Investment income and interest adjustments:		
Interest on investments	2,716	
Interest adjustments[c]	2	
Total investment income and interest adjustments		2,719
Gifts		—
Total income		144,392
Cost:		
Benefit payments:		
Monthly benefits[d]	140,676	
Reimbursement from the General Fund for unnegotiated checks	-26	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	92	
Net benefit payments[d]		140,742
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		107
Administrative expenses:		
Costs incurred by:		
Social Security Administration	2,439	
Department of the Treasury	93	
Demonstration projects	12	
Miscellaneous reimbursements from the General Fund[e]	-1	
Net administrative expenses		2,543
Total cost		143,393
Net increase in asset reserves		999
Total invested assets	98,032	
Undisbursed balances[f]	30	
Total asset reserves, September 30, 2021		98,063

[a] Includes adjustments for prior years. In June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $5,155 million was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust fund and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust fund.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the DI program.
[f] A positive balance represents a situation where the invested securities of the OASI Trust Fund that were redeemed to make cash payments exceeded actual program cash payments. In this situation, this excess amount will be used to partially offset future redemption of additional invested securities.

Note: Components may not sum to totals because of rounding.

Table VI.C3.—Operations of the Combined OASI and DI Trust Funds, Fiscal Year 2021
[In millions]

Total asset reserves, September 30, 2020		$2,908,245
Income:		
Net payroll tax contributions:		
Payroll tax contributions[a]	$979,817	
Payments from the General Fund of the Treasury for payroll tax contributions subject to refund	-7,499	
Net payroll tax contributions[a]		972,318
Reimbursements from the General Fund:		
Reduction in payroll tax contributions due to P.L.s 111-312, 112-78, and 112-96[a]	2	
Payroll tax credits due to P.L. 98-21[a]	[b]	
Net General Fund reimbursements[a]		2
Income based on taxation of benefit payments:		
Withheld from benefit payments to nonresident aliens	245	
All other, not subject to withholding[a]	34,556	
Total income from taxation of benefits[a]		34,801
Investment income and interest adjustments:		
Interest on investments	73,252	
Interest adjustments[c]	3	
Total investment income and interest adjustments		73,255
Gifts		[b]
Total income		1,080,377
Cost:		
Benefit payments:		
Monthly benefits and lump-sum death payments[d]	1,123,382	
Reimbursement from the General Fund for unnegotiated checks	-73	
Payment for costs of vocational rehabilitation services for disabled beneficiaries	107	
Net benefit payments[d]		1,123,415
Financial interchange with the Railroad Retirement "Social Security Equivalent Benefit Account"		4,900
Administrative expenses:		
Costs incurred by:		
Social Security Administration	5,829	
Department of the Treasury	617	
Offsetting miscellaneous receipts	-7	
Demonstration projects	12	
Miscellaneous reimbursements from the General Fund[e]	-5	
Net administrative expenses		6,445
Total cost		1,134,760
Net increase in asset reserves		-54,383
Total invested assets	2,853,817	
Undisbursed balances[f]	45	
Total asset reserves, September 30, 2021		2,853,862

[a] Includes adjustments for prior years. In June 2021, unusually large negative adjustments to payroll tax contributions in the amount of $35,536 million were made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.
[b] Between -$0.5 and $0.5 million.
[c] Includes: (1) interest on adjustments in the allocation of administrative expenses between the trust funds and the General Fund account for the Supplemental Security Income program, (2) interest arising from the revised allocation of administrative expenses among the trust funds, and (3) interest on certain reimbursements to the trust funds.
[d] Includes net reductions for the recovery of overpayments.
[e] Reimbursements for costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI and DI programs.
[f] A positive balance represents a situation where the invested securities of the OASI Trust Fund that were redeemed to make cash payments exceeded actual program cash payments. In this situation, this excess amount will be used to partially offset future redemption of additional invested securities.

Note: Components may not sum to totals because of rounding.

Tables VI.C4, VI.C5, and VI.C6 show estimates of the operations and status of the OASI, DI, and the hypothetical combined OASI and DI Trust Funds, respectively, during fiscal years 2017 through 2031.

Table VI.C4.—Operations of the OASI Trust Fund, Fiscal Years 2017-2031
[Dollar amounts in billions]

	Income					Cost				Asset Reserves		
Fiscal year	Total	Net payroll tax contributions[a]	GF reimbursements[b]	Taxation of benefits[a c]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[d]
Historical data:												
2017. .	$822.4	$702.1	[e]	$35.4	$84.9	$799.0	$791.1	$3.6	$4.3	$23.5	$2,820.1	350
2018. .	822.4	706.1	[e]	34.7	81.6	841.5	833.0	3.7	4.8	-19.0	2,801.1	335
2019. .	900.1	785.6	[e]	34.9	79.6	896.8	888.1	3.9	4.9	3.2	2,804.3	312
2020. .	955.6	841.7	[e]	37.9	76.0	948.7	940.2	3.7	4.8	6.9	2,811.2	296
2021. .	936.0	831.1	[e]	34.3	70.5	991.4	982.7	3.9	4.8	-55.4	2,755.8	284
Intermediate:												
2022. .	1,033.4	922.0	[e]	46.7	64.7	1,072.5	1,063.4	3.9	5.3	-39.1	2,716.7	257
2023. .	1,088.9	980.7	[e]	48.8	59.4	1,158.2	1,148.7	4.1	5.4	-69.3	2,647.4	235
2024. .	1,133.9	1,024.3	[e]	53.2	56.4	1,236.1	1,226.1	4.3	5.8	-102.2	2,545.1	214
2025. .	1,182.8	1,071.3	[e]	58.0	53.5	1,313.1	1,302.8	4.4	5.8	-130.2	2,414.9	194
2026. .	1,243.2	1,121.1	[e]	69.6	52.5	1,394.1	1,383.6	4.6	5.9	-150.9	2,264.0	173
2027. .	1,298.2	1,167.1	[e]	77.9	53.3	1,478.0	1,467.4	4.7	5.9	-179.8	2,084.2	153
2028. .	1,362.4	1,225.2	[e]	84.5	52.7	1,568.2	1,557.4	4.8	6.0	-205.9	1,878.3	133
2029. .	1,414.9	1,273.5	[e]	91.5	50.0	1,661.6	1,650.6	5.0	6.0	-246.7	1,631.7	113
2030. .	1,471.4	1,326.1	[e]	99.2	46.1	1,757.8	1,746.5	5.1	6.1	-286.4	1,345.3	93
2031. .	1,526.5	1,378.6	[e]	107.4	40.4	1,856.2	1,844.8	5.2	6.2	-329.7	1,015.6	72
Low-cost:												
2022. .	1,036.0	924.5	[e]	46.7	64.8	1,072.1	1,062.9	3.9	5.3	-36.0	2,719.8	257
2023. .	1,117.9	1,007.3	[e]	49.0	61.6	1,163.2	1,153.7	4.1	5.4	-45.3	2,674.5	234
2024. .	1,181.6	1,067.5	[e]	53.7	60.4	1,247.2	1,237.2	4.3	5.7	-65.7	2,608.8	214
2025. .	1,253.2	1,133.2	[e]	58.8	61.2	1,330.8	1,320.6	4.5	5.8	-77.6	2,531.2	196
2026. .	1,340.0	1,206.1	[e]	70.8	63.0	1,419.5	1,408.8	4.7	5.9	-79.5	2,451.6	178
2027. .	1,422.5	1,275.8	[e]	79.7	67.0	1,511.7	1,500.8	4.9	6.0	-89.2	2,362.5	162
2028. .	1,517.4	1,360.0	[e]	86.8	70.6	1,611.0	1,599.9	5.1	6.0	-93.7	2,268.8	147
2029. .	1,602.9	1,435.7	[e]	94.4	72.8	1,714.7	1,703.2	5.3	6.1	-111.9	2,156.9	132
2030. .	1,696.0	1,518.4	[e]	102.8	74.8	1,822.6	1,810.8	5.6	6.2	-126.6	2,030.3	118
2031. .	1,791.1	1,603.3	[e]	111.9	75.9	1,934.5	1,922.4	5.8	6.3	-143.4	1,887.0	105
High-cost:												
2022. .	1,023.7	912.4	[e]	46.7	64.5	1,073.1	1,063.9	3.9	5.3	-49.4	2,706.4	257
2023. .	1,014.8	908.8	[e]	48.7	57.4	1,154.4	1,144.8	4.1	5.4	-139.6	2,566.8	234
2024. .	1,052.0	948.1	[e]	52.5	51.4	1,218.7	1,208.6	4.3	5.8	-166.7	2,400.0	211
2025. .	1,085.4	981.4	[e]	56.7	47.3	1,284.1	1,274.0	4.3	5.8	-198.7	2,201.3	187
2026. .	1,126.2	1,016.1	[e]	67.7	42.4	1,356.5	1,346.2	4.4	5.9	-230.3	1,971.0	162
2027. .	1,160.5	1,045.1	[e]	75.4	40.0	1,431.7	1,421.3	4.5	5.8	-271.1	1,699.9	138
2028. .	1,197.7	1,080.7	[e]	81.5	35.5	1,512.4	1,502.0	4.5	5.9	-314.7	1,385.2	112
2029. .	1,222.6	1,106.3	[e]	87.8	28.5	1,595.3	1,584.8	4.6	5.9	-372.7	1,012.5	87
2030. .	1,249.5	1,134.3	[e]	94.8	20.4	1,679.7	1,669.1	4.7	5.9	-430.2	582.2	60
2031. .	1,274.7	1,160.9	[e]	102.1	11.7	1,765.0	1,754.3	4.7	6.0	-490.3	92.0	33

[a] Includes adjustments for prior years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $30.4 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.
[b] Includes reimbursements from the General Fund of the Treasury to the OASI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (2) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (3) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.
[c] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in law.
[d] The "Trust fund ratio" column represents asset reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year.
[e] Between -$50 million and $50 million.

Note: Components may not sum to totals because of rounding.

Table VI.C5.—Operations of the DI Trust Fund, Fiscal Years 2017-2031
[Dollar amounts in billions]

Fiscal year	Income					Cost				Asset Reserves		
	Total	Net payroll tax contributions[a]	GF reimbursements[b]	Taxation of benefits[a,c]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[d]
Historical data:												
2017	$169.5	$165.9	[e]	$2.0	$1.6	$145.8	$142.9	$2.7	$0.2	$23.7	$69.4	31
2018	170.3	167.0	[e]	1.0	2.2	146.6	143.6	2.8	.2	23.7	93.1	47
2019	151.0	146.8	[e]	1.2	2.9	147.7	144.9	2.8	.1	3.3	96.4	63
2020	147.4	142.9	[e]	1.7	2.8	146.7	144.1	2.5	.1	0.7	97.1	66
2021	144.4	141.2	[e]	.5	2.7	143.4	140.7	2.5	.1	1.0	98.1	68
Intermediate:												
2022	160.7	156.6	[e]	1.5	2.6	145.1	142.2	2.8	.1	15.7	113.7	68
2023	170.7	166.5	[e]	1.6	2.6	150.8	147.8	3.0	.1	19.9	133.6	75
2024	178.6	173.9	[e]	1.7	3.0	157.2	154.0	3.1	.1	21.5	155.1	85
2025	187.5	181.9	[e]	1.9	3.7	166.0	162.7	3.3	.1	21.5	176.5	93
2026	197.2	190.4	[e]	2.2	4.6	175.4	171.8	3.4	.1	21.8	198.4	101
2027	206.3	198.2	[e]	2.5	5.6	185.0	181.3	3.6	.1	21.3	219.6	107
2028	217.4	208.1	[e]	2.7	6.7	192.9	188.9	3.8	.1	24.6	244.2	114
2029	227.1	216.3	[e]	2.8	8.0	199.2	195.0	4.0	.2	28.0	272.2	123
2030	237.8	225.2	[e]	3.0	9.6	205.0	200.6	4.2	.2	32.8	305.0	133
2031	248.7	234.1	[e]	3.2	11.5	211.8	207.3	4.4	.2	36.9	341.9	144
Low-cost:												
2022	161.2	157.0	[e]	1.5	2.6	144.5	141.6	2.8	.1	16.7	114.8	68
2023	175.6	171.0	[e]	1.6	3.0	149.8	146.7	3.0	.1	25.8	140.6	77
2024	187.0	181.3	[e]	1.7	4.0	155.0	151.9	3.1	.1	31.9	172.5	91
2025	199.7	192.4	[e]	1.8	5.5	162.1	158.7	3.3	.1	37.7	210.2	106
2026	214.5	204.8	[e]	2.1	7.5	169.1	165.6	3.5	.1	45.3	255.5	124
2027	229.1	216.6	[e]	2.4	10.1	175.9	172.1	3.7	.1	53.2	308.7	145
2028	246.8	230.9	[e]	2.5	13.3	180.8	176.8	3.9	.1	66.0	374.7	171
2029	263.9	243.8	[e]	2.6	17.5	184.5	180.2	4.2	.1	79.4	454.1	203
2030	283.2	257.8	[e]	2.7	22.6	187.9	183.3	4.4	.2	95.3	549.4	242
2031	303.9	272.3	[e]	2.9	28.8	192.4	187.6	4.7	.2	111.5	660.9	286
High-cost:												
2022	159.1	155.0	[e]	1.6	2.6	145.8	143.0	2.8	.1	13.3	111.4	67
2023	158.2	154.3	[e]	1.6	2.3	152.8	149.8	3.0	.1	5.4	116.7	73
2024	164.9	161.0	[e]	1.7	2.1	160.5	157.4	3.1	.1	4.3	121.1	73
2025	170.8	166.7	[e]	1.9	2.3	171.1	167.7	3.2	.1	-.2	120.8	71
2026	177.2	172.5	[e]	2.3	2.3	182.4	178.9	3.4	.1	-5.2	115.6	66
2027	182.4	177.5	[e]	2.6	2.3	194.2	190.6	3.6	.1	-11.9	103.7	60
2028	188.4	183.5	[e]	2.8	2.1	203.5	199.6	3.7	.1	-15.1	88.7	51
2029	192.6	187.9	[e]	3.0	1.8	210.6	206.6	3.8	.2	-18.0	70.7	42
2030	197.2	192.6	[e]	3.2	1.4	217.0	212.8	4.0	.2	-19.8	50.8	33
2031	201.4	197.1	[e]	3.4	.9	224.2	219.9	4.1	.2	-22.9	27.9	23

[a] Includes adjustments for prior years. For example, in June 2021, an unusually large negative adjustment to payroll tax contributions in the amount of $5.2 billion was made because payroll tax revenue credited to the trust fund in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.
[b] Includes reimbursements from the General Fund of the Treasury to the DI Trust Fund for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (2) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (3) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.
[c] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in law.
[d] The "Trust fund ratio" column represents asset reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year.
[e] Between -$50 million and $50 million.

Note: Components may not sum to totals because of rounding.

Table VI.C6.—Operations of the Combined OASI and DI Trust Funds, Fiscal Years 2017-2031
[Dollar amounts in billions]

Fiscal year	Income					Cost				Asset Reserves		
	Total	Net payroll tax contributions[a]	GF reimbursements[b]	Taxation of benefits[ac]	Net interest	Total	Scheduled benefits	Administrative costs	RRB interchange	Net increase during year	Amount at end of year	Trust fund ratio[d]
Historical data:												
2017. .	$991.9	$868.0	[e]	$37.4	$86.5	$944.7	$934.0	$6.2	$4.5	$47.2	$2,889.5	301
2018. .	992.7	873.2	[e]	35.7	83.8	988.0	976.7	6.4	4.9	4.7	2,894.2	292
2019. .	1,051.1	932.4	[e]	36.1	82.5	1,044.5	1,033.0	6.6	4.9	6.5	2,900.7	277
2020. .	1,103.0	984.6	[e]	39.6	78.8	1,095.4	1,084.3	6.2	5.0	7.5	2,908.2	265
2021. .	1,080.4	972.3	[e]	34.8	73.3	1,134.8	1,123.4	6.4	4.9	-54.4	2,853.9	256
Intermediate:												
2022. .	1,194.2	1,078.6	[e]	48.3	67.3	1,217.6	1,205.6	6.6	5.4	-23.4	2,830.4	234
2023. .	1,259.6	1,147.2	[e]	50.4	62.0	1,309.0	1,296.5	7.1	5.5	-49.4	2,781.0	216
2024. .	1,312.5	1,198.2	[e]	54.9	59.4	1,393.3	1,380.1	7.4	5.8	-80.8	2,700.2	200
2025. .	1,370.3	1,253.2	[e]	59.9	57.2	1,479.1	1,465.5	7.7	5.9	-108.8	2,591.4	183
2026. .	1,440.4	1,311.4	[e]	71.8	57.1	1,569.5	1,555.4	8.0	6.0	-129.1	2,462.3	165
2027. .	1,504.5	1,365.2	[e]	80.4	58.9	1,663.0	1,648.6	8.3	6.0	-158.5	2,303.8	148
2028. .	1,579.8	1,433.3	[e]	87.2	59.4	1,761.1	1,746.3	8.7	6.1	-181.3	2,122.6	131
2029. .	1,642.1	1,489.8	[e]	94.3	58.0	1,860.8	1,845.6	9.0	6.2	-218.7	1,903.9	114
2030. .	1,709.2	1,551.3	[e]	102.2	55.8	1,962.7	1,947.2	9.3	6.3	-253.5	1,650.3	97
2031. .	1,775.2	1,612.7	[e]	110.6	51.9	2,068.0	2,052.1	9.6	6.4	-292.8	1,357.5	80
Low-cost:												
2022. .	1,197.2	1,081.6	[e]	48.2	67.4	1,216.5	1,204.6	6.6	5.4	-19.3	2,834.6	235
2023. .	1,293.5	1,178.3	[e]	50.6	64.6	1,313.0	1,300.4	7.1	5.4	-19.5	2,815.0	216
2024. .	1,368.5	1,248.7	[e]	55.4	64.4	1,402.3	1,389.1	7.4	5.8	-33.7	2,781.3	201
2025. .	1,453.0	1,325.6	[e]	60.6	66.7	1,492.9	1,479.3	7.8	5.9	-39.9	2,741.4	186
2026. .	1,554.4	1,410.9	[e]	73.0	70.5	1,588.6	1,574.4	8.2	6.0	-34.2	2,707.2	173
2027. .	1,651.6	1,492.4	[e]	82.0	77.1	1,687.6	1,672.9	8.6	6.1	-36.0	2,671.2	160
2028. .	1,764.1	1,591.0	[e]	89.3	83.9	1,791.8	1,776.6	9.1	6.2	-27.7	2,643.5	149
2029. .	1,866.7	1,679.5	[e]	97.0	90.3	1,899.2	1,883.4	9.5	6.3	-32.4	2,611.0	139
2030. .	1,979.3	1,776.3	[e]	105.6	97.4	2,010.5	1,994.2	10.0	6.4	-31.3	2,579.8	130
2031. .	2,095.1	1,875.6	[e]	114.8	104.7	2,126.9	2,110.0	10.4	6.5	-31.9	2,547.9	121
High-cost:												
2022. .	1,182.8	1,067.3	[e]	48.3	67.1	1,218.9	1,206.9	6.6	5.4	-36.1	2,817.8	234
2023. .	1,173.0	1,063.1	[e]	50.3	59.7	1,307.3	1,294.6	7.1	5.5	-134.3	2,683.5	216
2024. .	1,216.9	1,109.1	[e]	54.2	53.6	1,379.3	1,366.0	7.4	6.0	-162.4	2,521.1	195
2025. .	1,256.3	1,148.0	[e]	58.7	49.6	1,455.2	1,441.7	7.6	5.9	-199.0	2,322.1	173
2026. .	1,303.4	1,188.6	[e]	70.0	44.8	1,538.9	1,525.1	7.8	6.0	-235.5	2,086.6	151
2027. .	1,342.9	1,222.6	[e]	78.0	42.3	1,625.9	1,611.9	8.0	6.0	-283.0	1,803.6	128
2028. .	1,386.1	1,264.3	[e]	84.3	37.6	1,715.9	1,701.6	8.2	6.0	-329.8	1,473.8	105
2029. .	1,415.3	1,294.2	[e]	90.8	30.3	1,806.0	1,791.4	8.4	6.1	-390.7	1,083.1	82
2030. .	1,446.6	1,326.9	[e]	98.0	21.8	1,896.7	1,881.9	8.6	6.1	-450.1	633.1	57
2031. .	1,476.1	1,358.0	[e]	105.5	12.5	1,989.2	1,974.2	8.9	6.2	-513.2	119.9	32

[a] Includes adjustments for prior years. For example, in June 2021, unusually large negative adjustments to payroll tax contributions in the amount of $35.5 billion were made because payroll tax revenue credited to the trust funds in 2020 was based on estimates that did not anticipate effects of the pandemic and recession.
[b] Includes reimbursements from the General Fund of the Treasury to the OASI and DI Trust Funds for: (1) the cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21; (2) the cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246; and (3) payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.
[c] Revenue from taxation of benefits is the amount that would be assessed on benefit amounts scheduled in law.
[d] The "Trust fund ratio" column represents asset reserves at the beginning of a year (which are identical to reserves at the end of the prior year shown in the "Amount at end of year" column) as a percentage of cost for the year.
[e] Between -$50 million and $50 million.

Note: Components may not sum to totals because of rounding.

D. LONG-RANGE SENSITIVITY ANALYSIS

This appendix presents estimates that illustrate the sensitivity of the long-range actuarial status of the OASDI program to changes in selected individual assumptions. The estimates based on the three alternative sets of assumptions, which were presented earlier in this report, illustrate the effects of varying all of the principal assumptions simultaneously, in order to portray a significantly more optimistic or pessimistic future. For each sensitivity analysis presented in this appendix, the intermediate alternative II projection is the reference point, and one assumption is varied within that alternative. The variation used for each individual assumption is the same as the level used for that assumption in the low-cost alternative I and high-cost alternative III projections.

Each table in this section shows the effects of changing a particular assumption on the OASDI summarized income rates, summarized cost rates, and actuarial balances for 25-year, 50-year, and 75-year valuation periods. Following each table is a discussion of the estimated changes in cost rates. The change in each of the actuarial balances is approximately equal to the change in the corresponding cost rate, but in the opposite direction. This appendix does not discuss income rates following each table because income rates vary only slightly with changes in assumptions that affect revenue from taxation of benefits.

1. Total Fertility Rate

Table VI.D1 shows OASDI income rates, cost rates, and actuarial balances on the basis of alternative II with three different assumptions for the future paths of total fertility rates. Under the Trustees' assumptions, the average annual total fertility rate for the period 2032 through 2096 is 1.69, 1.99, and 2.19 children per woman under alternatives III, II, and I, respectively. The ultimate total fertility rate is reached in 2056 under all three alternatives.

Table VI.D1.—Sensitivity of OASDI Measures to Fertility Assumptions
[As a percentage of taxable payroll]

Valuation period	Average total fertility rate[a] [b] 1.69	1.99	2.19
Summarized income rate:			
25-year: 2022-46	14.38	14.38	14.38
50-year: 2022-71	13.94	13.91	13.89
75-year: 2022-96	13.85	13.78	13.73
Summarized cost rate:			
25-year: 2022-46	16.61	16.62	16.63
50-year: 2022-71	17.26	16.93	16.71
75-year: 2022-96	17.98	17.20	16.69
Actuarial balance:			
25-year: 2022-46	-2.23	-2.24	-2.25
50-year: 2022-71	-3.32	-3.02	-2.82
75-year: 2022-96	-4.13	-3.42	-2.96
Annual balance for 2096	-6.59	-4.25	-2.97
Year of combined trust fund reserve depletion	2035	2035	2035

[a] The total fertility rate for any year is the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, the selected year, and if she were to survive the entire childbearing period. The average total fertility rate shown is for the period 2032 through 2096. The ultimate total fertility rate is reached in 2056 under all three alternatives.
[b] Total fertility rates used for this analysis are consistent with those assumed for the three alternative scenarios; the average total fertility rate for 2032 through 2096 is 1.69 under the alternative III assumptions, 1.99 under the alternative II assumptions, and 2.19 under the alternative I assumptions. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate for the three fertility assumptions varies by only about 0.02 percent of taxable payroll. In contrast, the 75-year cost rate varies over a wide range, decreasing from 17.98 to 16.69 percent, as the average total fertility rate for the period 2032 through 2096 increases from 1.69 for alternative III to 2.19 for alternative I. Similarly, while the 25-year actuarial balance varies by only 0.02 percent of taxable payroll, the 75-year actuarial balance varies over a much wider range, from -4.13 to -2.96 percent.

During the 25-year period, the very slight increases in the working-age population and tax income resulting from higher fertility (than that experienced in an alternative scenario) are more than offset by the effects of decreases in female labor force participation and increases in the number of child beneficiaries. Therefore, program cost as a percent of taxable payroll increases slightly with higher fertility. For the 75-year long-range period, however, changes in fertility have a relatively greater effect on the working-age population than on the beneficiary population. As a result, an increase in fertility significantly reduces the cost rate. Each increase of 0.1 in the average total fertility rate increases the long-range actuarial balance by about 0.24 percent of taxable payroll.

2. Death Rates

Table VI.D2 shows OASDI income rates, cost rates, and actuarial balances on the basis of alternative II with three different assumptions about future reductions in death rates for the period from 2031 to 2096. These assumptions are described in section V.A.2. Under the Trustees' assumptions, the age-sex-adjusted death rates decline at average annual rates of 0.28 percent, 0.74 percent, and 1.25 percent for alternatives I, II, and III, respectively.

Table VI.D2.—Sensitivity of OASDI Measures to Death-Rate Assumptions
[As a percentage of taxable payroll]

Valuation period	Average annual death-rate reduction[a] [b]		
	0.28 percent	0.74 percent	1.25 percent
Summarized income rate:			
25-year: 2022-46	14.38	14.38	14.37
50-year: 2022-71	13.90	13.91	13.93
75-year: 2022-96	13.75	13.78	13.81
Summarized cost rate:			
25-year: 2022-46	16.45	16.62	16.83
50-year: 2022-71	16.49	16.93	17.47
75-year: 2022-96	16.50	17.20	17.99
Actuarial balance:			
25-year: 2022-46	-2.07	-2.24	-2.46
50-year: 2022-71	-2.59	-3.02	-3.54
75-year: 2022-96	-2.75	-3.42	-4.17
Annual balance for 2096	-2.81	-4.25	-5.71
Year of combined trust fund reserve depletion	2035	2035	2034

[a] The average annual death-rate reduction is the average annual geometric rate of decline in the age-sex-adjusted death rate for the period from 2031 to 2096. The overall age-sex-adjusted death rate decreases from 2031 to 2096 by 16 percent, 38 percent, and 56 percent for alternatives I, II, and III, respectively.
[b] The death-rate reductions used for this analysis are consistent with those assumed for the three alternative scenarios; the average annual death-rate reduction from 2031 to 2096 is 0.28 percent from the alternative I assumptions, 0.74 percent from the alternative II assumptions, and 1.25 percent from the alternative III assumptions. All other assumptions used for this analysis are from alternative II.

The variation in cost for the 25-year period is less pronounced than the variation for the 75-year period because decreases in death rates have cumulative effects. The 25-year cost rate increases from 16.45 percent (for an average annual death-rate reduction of 0.28 percent from 2031 to 2096) to 16.83 percent (for an average annual death-rate reduction of 1.25 percent from 2031 to 2096). The 75-year cost rate increases from 16.50 to 17.99 percent. The actuarial balance decreases from -2.07 to -2.46 percent for the 25-year period, and from -2.75 to -4.17 percent for the 75-year period.

Lower death rates raise both the income (through increased taxable payroll) and the cost of the OASDI program. The relative increase in cost, however, exceeds the relative increase in taxable payroll. For any given year, reduc-

tions in the death rates for people who are age 62 and over (ages at which death rates are the highest) increase the number of retired-worker beneficiaries (and, therefore, the amount of retirement benefits paid) without adding significantly to the number of covered workers (and, therefore, to the taxable payroll). Reductions in death rates for people at age 50 to retirement eligibility age result in significant increases to the taxable payroll. However, those increases are not large enough to offset the sum of the additional retirement benefits mentioned above and the disability benefits paid to additional beneficiaries at these pre-retirement ages, which are ages of high disability incidence. At ages under 50, death rates are so low that even substantial reductions in death rates do not result in significant increases in the numbers of covered workers or beneficiaries. Consequently, if death rates decline by about the same relative amount for all ages, the cost increases faster than the rate of growth in payroll, which results in higher cost rates and lower actuarial balances. Each additional 0.1-percentage-point increase in the average annual rate of decline in the death rate decreases the long-range actuarial balance by about 0.15 percent of taxable payroll.

3. Immigration

Table VI.D3 shows OASDI income rates, cost rates, and actuarial balances under alternative II with three different assumptions about the magnitude of total net immigration (sum of net lawful permanent resident (LPR) immigration and net other-than-LPR immigration). See section V.A.3 for more information on immigration assumptions and methods. Under the Trustees' assumptions, total net annual immigration averages 829,000 persons, 1,246,000 persons, and 1,684,000 persons for the period 2032 through 2096 under alternatives III, II, and I, respectively.

Table VI.D3.—Sensitivity of OASDI Measures to Total Net Immigration Assumptions
[As a percentage of taxable payroll]

Valuation period	Average annual total net immigration[a] [b]		
	829,000	1,246,000	1,684,000
Summarized income rate:			
25-year: 2022-46	14.41	14.38	14.34
50-year: 2022-71	13.95	13.91	13.87
75-year: 2022-96	13.83	13.78	13.73
Summarized cost rate:			
25-year: 2022-46	16.85	16.62	16.39
50-year: 2022-71	17.28	16.93	16.59
75-year: 2022-96	17.65	17.20	16.77
Actuarial balance:			
25-year: 2022-46	-2.44	-2.24	-2.05
50-year: 2022-71	-3.33	-3.02	-2.71
75-year: 2022-96	-3.82	-3.42	-3.04
Annual balance for 2096	-5.06	-4.25	-3.57
Year of combined trust fund reserve depletion	2034	2035	2035

[a] Average annual total net immigration is the annual total net immigration to the Social Security area, including both LPR and other-than-LPR immigration, averaged for 2032 through 2096.
[b] The total net immigration assumptions used for this analysis are consistent with those assumed for the three alternative scenarios; average annual total net immigration for 2032 through 2096 is 829,000 from the alternative III assumptions, 1,246,000 from the alternative II assumptions, and 1,684,000 from the alternative I assumptions. All other assumptions used for this analysis are from alternative II.

For all three periods, when total net immigration increases, the cost rate decreases. For the 25-year period, the cost rate decreases from 16.85 percent of taxable payroll (for average annual total net immigration of 829,000 persons for 2032 through 2096) to 16.39 percent (for an average annual total net immigration of 1,684,000 persons for 2032 through 2096). For the 50-year period, it decreases from 17.28 percent to 16.59 percent, and for the 75-year period, it decreases from 17.65 percent to 16.77 percent. The actuarial balance increases from -2.44 to -2.05 percent for the 25-year period, from -3.33 to -2.71 percent for the 50-year period, and from -3.82 to -3.04 percent for the 75-year period.

The cost rate decreases with an increase in total net immigration because immigration occurs at relatively young ages, thereby increasing the numbers of covered workers earlier than the numbers of beneficiaries. Increasing average annual total net immigration by 100,000 persons improves the long-range actuarial balance by about 0.09 percent of taxable payroll.

4. Real Wage Differential

Table VI.D4 shows OASDI income rates, cost rates, and actuarial balances on the basis of alternative II with three different assumptions about the real wage differential. Under the Trustees' assumptions, the average annual real

wage differential for the period 2032 through 2096 is 0.53 percentage point, 1.15 percentage points, and 1.77 percentage points under alternatives III, II, and I, respectively. In each case, the ultimate annual increase in the CPI is 2.40 percent (consistent with alternative II). Therefore, the average annual percentage increase in the average wage in covered employment from 2031 to 2096 is 2.93, 3.55, and 4.17 percent under alternatives III, II, and I, respectively.

For the 25-year period, the cost rate decreases from 17.44 percent (for a real wage differential of 0.53 percentage point) to 15.81 percent (for a differential of 1.77 percentage points). For the 50-year period, it decreases from 18.12 to 15.76 percent, and for the 75-year period it decreases from 18.53 to 15.88 percent. The actuarial balance increases from -2.94 to -1.55 percent for the 25-year period, from -4.05 to -2.00 percent for the 50-year period, and from -4.58 to -2.26 percent for the 75-year period.

Table VI.D4.—Sensitivity of OASDI Measures to Real Wage Assumptions
[As a percentage of taxable payroll]

	Average annual percentage increase in wages-CPI [a b]		
Valuation period	2.93-2.40	3.55-2.40	4.17-2.40
Summarized income rate:			
25-year: 2022-46	14.49	14.38	14.26
50-year: 2022-71	14.06	13.91	13.77
75-year: 2022-96	13.95	13.78	13.62
Summarized cost rate:			
25-year: 2022-46	17.44	16.62	15.81
50-year: 2022-71	18.12	16.93	15.76
75-year: 2022-96	18.53	17.20	15.88
Actuarial balance:			
25-year: 2022-46	-2.94	-2.24	-1.55
50-year: 2022-71	-4.05	-3.02	-2.00
75-year: 2022-96	-4.58	-3.42	-2.26
Annual balance for 2096	-6.24	-4.25	-2.50
Year of combined trust fund reserve depletion	2034	2035	2036

[a] The first value in each pair is the average annual percentage increase in the average wage in covered employment from 2031 to 2096. The second value is the ultimate annual percentage increase in the Consumer Price Index. The difference between the two values is the average annual real wage differential for 2032 through 2096.

[b] The real wage assumptions used for this analysis are consistent with those assumed for the three alternative scenarios; the average annual real wage differential for 2032 through 2096 is 0.53 percentage point from the alternative III assumptions, 1.15 percentage points from the alternative II assumptions, and 1.77 percentage points from the alternative I assumptions. All other assumptions used for this analysis are from alternative II.

The cost rate decreases with increasing real wage differentials. Higher wages increase taxable payroll immediately, but they increase benefit levels only gradually as new beneficiaries become entitled. In addition, cost-of-living adjustments (COLAs) to benefits depend not on changes in wages, but on

changes in prices. Each 0.1-percentage-point increase in the real wage differential increases the long-range actuarial balance by about 0.19 percent of taxable payroll.

5. Consumer Price Index

Table VI.D5 shows OASDI income rates, cost rates, and actuarial balances on the basis of alternative II with three different assumptions about the rate of increase for the Consumer Price Index (CPI). Under the Trustees' assumptions, the annual increase in the CPI is 3.00 percent, 2.40 percent, and 1.80 percent under alternatives I, II, and III, respectively. These ultimate rates of increase are reached by 2026 under all three alternatives. In each case, the average annual real wage differential for 2032 through 2096 is 1.15 percentage points (consistent with alternative II), yielding average annual percentage increases in the average wage in covered employment from 2031 to 2096 of 4.15, 3.55, and 2.95 percent under alternatives I, II, and III, respectively.

Table VI.D5.—Sensitivity of OASDI Measures to CPI-Increase Assumptions
[As a percentage of taxable payroll]

	Average annual percentage increase in wages-CPI[a] [b]		
Valuation period	4.15-3.00	3.55-2.40	2.95-1.80
Summarized income rate:			
25-year: 2022-46	14.36	14.38	14.40
50-year: 2022-71	13.90	13.91	13.93
75-year: 2022-96	13.76	13.78	13.79
Summarized cost rate:			
25-year: 2022-46	16.52	16.62	16.73
50-year: 2022-71	16.80	16.93	17.08
75-year: 2022-96	17.05	17.20	17.36
Actuarial balance:			
25-year: 2022-46	-2.17	-2.24	-2.33
50-year: 2022-71	-2.90	-3.02	-3.15
75-year: 2022-96	-3.29	-3.42	-3.56
Annual balance for 2096	-4.09	-4.25	-4.43
Year of combined trust fund reserve depletion	2035	2035	2034

[a] The first value in each pair is the average annual percentage increase in the average wage in covered employment from 2031 to 2096. The second value is the ultimate annual percentage increase in the Consumer Price Index. The difference between the two values is the average annual real wage differential for 2032 through 2096.

[b] The CPI assumptions used for this analysis are consistent with those assumed for the three alternative scenarios; the ultimate CPI increase is 3.00 percent from the alternative I assumptions, 2.40 percent from the alternative II assumptions, and 1.80 percent from the alternative III assumptions. These ultimate rates of increase are reached by 2026 under all three alternatives. All other assumptions used for this analysis are from alternative II.

For all three periods, the cost rate increases when the assumed rates of increase in the CPI are smaller. For the 25-year period, the cost rate increases from 16.52 (for a CPI increase of 3.00 percent) to 16.73 percent (for a CPI increase of 1.80 percent). For the 50-year period, it increases from 16.80 to 17.08 percent, and for the 75-year period, it increases from 17.05 to 17.36 percent. The actuarial balance decreases from -2.17 to -2.33 percent for the 25-year period, from -2.90 to -3.15 percent for the 50-year period, and from -3.29 to -3.56 percent for the 75-year period.

The time lag between the effects of the CPI changes on taxable payroll and on scheduled benefits explains these patterns. When the rate of increase in the CPI is greater and the real wage differential is constant, then: (1) the effect on taxable payroll due to a greater rate of increase in average wages occurs immediately and (2) the effect on benefits due to a larger COLA occurs with a lag of about 1 year. As a result of these effects, the higher taxable payrolls have a stronger effect than the higher benefits, which results in lower cost rates. Each 0.1-percentage-point decrease in the rate of the change in the CPI decreases the long-range actuarial balance by about 0.02 percent of taxable payroll.

6. Real Interest Rate

Table VI.D6 shows OASDI income rates, cost rates, and actuarial balances under alternative II with three different assumptions about the annual real interest rate (compounded semiannually) for special public-debt obligations issuable to the trust funds. Under the Trustees' assumptions, the ultimate annual real interest rate is 1.8 percent, 2.3 percent, and 2.8 percent under alternatives III, II, and I, respectively. These ultimate rates are reached by 2032 under all three alternatives. In each case, the ultimate annual increase in the CPI is 2.40 percent, which is consistent with alternative II. Therefore, the ultimate annual yields are 4.2, 4.8, and 5.3 percent, respectively.

Table VI.D6.—Sensitivity of OASDI Measures to Real Interest Rate Assumptions
[As a percentage of taxable payroll]

Valuation period	Ultimate annual real interest rate[a] [b]		
	1.8 percent	2.3 percent	2.8 percent
Summarized income rate:			
25-year: 2022-46	14.33	14.38	14.42
50-year: 2022-71	13.86	13.91	13.97
75-year: 2022-96	13.72	13.78	13.84
Summarized cost rate:			
25-year: 2022-46	16.68	16.62	16.56
50-year: 2022-71	17.03	16.93	16.84
75-year: 2022-96	17.33	17.20	17.07
Actuarial balance:			
25-year: 2022-46	-2.35	-2.24	-2.14
50-year: 2022-71	-3.17	-3.02	-2.87
75-year: 2022-96	-3.61	-3.42	-3.23
Annual balance for 2096	-4.25	-4.25	-4.25
Year of combined trust fund reserve depletion	2035	2035	2035

[a] The ultimate real interest rate is the effective annual yield on asset reserves held by the trust funds divided by the annual rate of growth in the CPI.
[b] The real interest rate assumptions used for this analysis are consistent with those assumed for the three alternative scenarios; the ultimate annual real interest rate is 1.8 percent from the alternative III assumptions, 2.3 percent from the alternative II assumptions, and 2.8 percent from the alternative I assumptions. These ultimate rates are reached by 2032 under all three alternatives. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate decreases with increasing real interest rates from 16.68 percent (for an ultimate real interest rate of 1.8 percent) to 16.56 percent (for an ultimate real interest rate of 2.8 percent). For the 50-year period, it decreases from 17.03 to 16.84 percent and, for the 75-year period, it decreases from 17.33 to 17.07 percent. The actuarial balance increases from -2.35 to -2.14 percent for the 25-year period, from -3.17 to -2.87 percent for the 50-year period, and from -3.61 to -3.23 percent for the 75-year period. A relatively higher real interest rate has the effect of discounting more distant future years relatively more. To the extent that annual cost rates and annual deficits are larger in later years, a higher interest rate decreases the summarized rates, and a lower interest rate increases the summarized rates. Each 0.1-percentage-point increase in the real interest rate increases the long-range actuarial balance by about 0.04 percent of taxable payroll.

7. Taxable Ratio

Table VI.D7 shows OASDI income rates, cost rates, and actuarial balances under alternative II with three different assumptions about the ratio of taxable payroll to covered earnings (the taxable ratio). Note that covered earnings are the sum of wages and net self-employment earnings covered by

Social Security, and taxable payroll is essentially the amount of covered earnings subject to the Social Security payroll tax up to the contribution and benefit base ($147,000 for 2022). Under the Trustees' assumptions, the taxable ratio at the end of the short-range period (2031) is 81.0 percent, 82.5 percent, and 84.0 percent under alternatives III, II, and I, respectively.

Table VI.D7.—Sensitivity of OASDI Measures to Taxable Ratio Assumptions
[As a percentage of taxable payroll]

Valuation period	Taxable ratio in 2031[a b]		
	81.0 percent	82.5 percent	84.0 percent
Summarized income rate:			
25-year: 2022-46	14.41	14.38	14.35
50-year: 2022-71	13.93	13.91	13.89
75-year: 2022-96	13.80	13.78	13.76
Summarized cost rate:			
25-year: 2022-46	16.86	16.62	16.39
50-year: 2022-71	17.15	16.93	16.72
75-year: 2022-96	17.40	17.20	17.01
Actuarial balance:			
25-year: 2022-46	-2.45	-2.24	-2.04
50-year: 2022-71	-3.22	-3.02	-2.83
75-year: 2022-96	-3.60	-3.42	-3.25
Annual balance for 2096	-4.37	-4.25	-4.14
Year of combined trust fund reserve depletion	2034	2035	2035

[a] The taxable ratio is the ratio of taxable payroll to covered earnings. These concepts are described in further detail in section V.C.6 of this report.
[b] The taxable ratio assumptions used for this analysis are consistent with those assumed for the three alternative scenarios; the taxable ratio at the end of the short-range period (2031) is 81.0 percent from the alternative III assumptions, 82.5 percent from the alternative II assumptions, and 84.0 percent from the alternative I assumptions. All other assumptions used for this analysis are from alternative II.

Because the combined employee-employer tax rate of 12.4 percent is unchanged across all alternatives, the income rate changes a relatively small amount as the taxable ratio increases, due to changes in taxation of benefits and the initial fund as a percentage of taxable payroll.

For the 25-year period, the cost rate decreases with increasing taxable ratios, from 16.86 percent (for a taxable ratio in 2031 of 81.0 percent) to 16.39 percent (for a taxable ratio in 2031 of 84.0 percent). For the 50-year period, it decreases from 17.15 to 16.72 percent and, for the 75-year period, it decreases from 17.40 to 17.01 percent. The actuarial balance increases from -2.45 to -2.04 percent for the 25-year period, from -3.22 to -2.83 percent for the 50-year period, and from -3.60 to -3.25 for the 75-year period.

The cost rate decreases with an increase in taxable payroll because the increase in taxable payroll occurs immediately. The increase in benefit amounts occurs much more gradually as new beneficiaries become entitled. In addition, the change in the taxable ratio does not affect COLAs or AWIs.

Each 1.0 percentage-point increase in the taxable ratio in 2031 increases (improves) the long-range actuarial balance by about 0.12 percent of taxable payroll.

8. Disability Incidence Rates

Table VI.D8 shows OASDI income rates, cost rates, and actuarial balances on the basis of alternative II with three different assumptions about future disability incidence rates. Under the Trustees' assumptions, the ultimate age-sex-adjusted[1] incidence rate is 3.9, 4.8, and 5.8 awards per thousand exposed for alternatives I, II, and III, respectively. Under the Trustees' assumptions, incidence rates by age and sex for all three alternatives vary during the early years of the projection period before reaching their long-term average values.

Table VI.D8.—Sensitivity of OASDI Measures to Disability Incidence Assumptions
[As a percentage of taxable payroll]

Valuation period	Disability incidence rate[a] 3.9	4.8	5.8
Summarized income rate:			
25-year: 2022-46	14.37	14.38	14.38
50-year: 2022-71	13.91	13.91	13.91
75-year: 2022-96	13.78	13.78	13.78
Summarized cost rate:			
25-year: 2022-46	16.41	16.62	16.84
50-year: 2022-71	16.68	16.93	17.18
75-year: 2022-96	16.95	17.20	17.45
Actuarial balance:			
25-year: 2022-46	-2.03	-2.24	-2.46
50-year: 2022-71	-2.77	-3.02	-3.27
75-year: 2022-96	-3.17	-3.42	-3.67
Annual balance for 2096	-3.99	-4.25	-4.50
Year of combined trust fund reserve depletion	2035	2035	2034

[a] The disability incidence rates used for this analysis are consistent with those assumed for the three alternative scenarios; the ultimate age-sex-adjusted incidence rate is 3.9 awards per thousand exposed for the alternative I assumptions, 4.8 awards per thousand exposed for the alternative II assumptions, and 5.8 awards per thousand exposed for the alternative III assumptions. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate increases with increasing disability incidence rates, from 16.41 percent (for the relatively low rates assumed for alternative I) to 16.84 percent (for the relatively high rates assumed for alternative III). For the 50-year period, it increases from 16.68 to 17.18 percent, and for the 75-year period, it increases from 16.95 to 17.45 percent. The actuarial balance decreases from -2.03 to -2.46 percent for the 25-year

[1] Age-sex-adjusted to the disability-exposed population as of the year 2000.

period, from -2.77 to -3.27 percent for the 50-year period, and from -3.17 to -3.67 percent for the 75-year period.

9. Disability Termination Rates

Table VI.D9 shows OASDI income rates, cost rates, and actuarial balances on the basis of alternative II with three different assumptions about future disability termination rates, including deaths and recoveries.

Under the Trustees' assumptions, death rates for disabled-worker beneficiaries for all three alternatives decline throughout the long-range period. The age-sex-adjusted[1] death rate of 30.0 deaths per thousand disabled-worker beneficiaries in 2021 declines to 21.9, 12.5, and 6.2 deaths per thousand in 2096 for alternatives I, II, and III, respectively. These levels are about 27 percent, 58 percent, and 79 percent lower, respectively, than the level in 2021.

The ultimate age-sex-adjusted[1] recovery rate used for this analysis is 12.5 recoveries per thousand disabled-worker beneficiaries for the alternative I assumptions, 10.4 recoveries per thousand disabled-worker beneficiaries for the alternative II assumptions, and 8.3 recoveries per thousand disabled-worker beneficiaries for the alternative III assumptions.

[1] Age-sex-adjusted to the disabled-worker population as of the year 2000.

Table VI.D9.—Sensitivity of OASDI Measures to Disability Termination Assumptions
[As a percentage of taxable payroll]

Valuation period	Disability termination rates (death; recovery)[a]		
	21.9; 12.5	12.5; 10.4	6.2; 8.3
Summarized income rate:			
25-year: 2022-46	14.38	14.38	14.37
50-year: 2022-71	13.91	13.91	13.91
75-year: 2022-96	13.78	13.78	13.78
Summarized cost rate:			
25-year: 2022-46	16.59	16.62	16.65
50-year: 2022-71	16.90	16.93	16.95
75-year: 2022-96	17.18	17.20	17.20
Actuarial balance:			
25-year: 2022-46	-2.22	-2.24	-2.27
50-year: 2022-71	-2.99	-3.02	-3.04
75-year: 2022-96	-3.40	-3.42	-3.43
Annual balance for 2096	-4.25	-4.25	-4.20
Year of combined trust fund reserve depletion	2035	2035	2035

[a] The disability termination rates used for this analysis are consistent with those assumed for the three alternative scenarios; the age-sex-adjusted death rate for 2096 is 21.9 deaths per thousand disabled-worker beneficiaries for the alternative I assumptions, 12.5 deaths per thousand disabled-worker beneficiaries for the alternative II assumptions, and 6.2 deaths per thousand disabled-worker beneficiaries for the alternative III assumptions; the ultimate age-sex-adjusted recovery rate is 12.5 recoveries per thousand disabled-worker beneficiaries for the alternative I assumptions, 10.4 recoveries per thousand disabled-worker beneficiaries for the alternative II assumptions, and 8.3 recoveries per thousand disabled-worker beneficiaries for the alternative III assumptions. All other assumptions used for this analysis are from alternative II.

For the 25-year period, the cost rate increases with decreasing disability termination rates, from 16.59 percent (for the relatively high termination rates assumed for alternative I) to 16.65 percent (for the relatively low termination rates assumed for alternative III). For the 50-year period, it increases from 16.90 to 16.95 percent, and for the 75-year period, it increases from 17.18 to 17.20 percent. The actuarial balance decreases from -2.22 to -2.27 percent for the 25-year period, from -2.99 to -3.04 percent for the 50-year period, and from -3.40 to -3.43 percent for the 75-year period.

E. STOCHASTIC PROJECTIONS AND UNCERTAINTY

Significant uncertainty surrounds the estimates under the intermediate assumptions, especially for a period as long as 75 years. This appendix presents stochastic projections, a way to illustrate the uncertainty of these estimates. The stochastic projections supplement the traditional methods of examining such uncertainty.

1. Background

The Trustees have traditionally shown estimates using the low-cost and high-cost sets of specified assumptions to illustrate the potential implications of uncertainty. These low-cost and high-cost estimates provide a range of possible outcomes for the projections. However, they do not provide an indication of the probability that actual future experience will be inside or outside this range. This appendix presents the results of a stochastic model that estimates a probability distribution of future outcomes of the financial status of the combined OASI and DI Trust Funds. This model was introduced in the 2003 report and enhanced in the 2021 report to include parameter uncertainty for the expected mean for the key variables described in the next section.

2. Stochastic Methodology

Other sections of this report provide estimates of the financial status of the combined OASI and DI Trust Funds using a scenario-based model. For the scenario-based model, the Trustees use three alternative scenarios (low-cost, intermediate, and high-cost) that use specific assumptions for key variables. In general, the Trustees assume that each of these variables will reach an ultimate value at a specific point during the long-range period, and will maintain that value throughout the remainder of the period. The three alternative scenarios assume separate, specified values for each of these variables. Chapter V contains more details about each of these assumptions.

This appendix presents estimates of the probability that key measures of OASDI solvency will fall in certain ranges, based on 5,000 independent stochastic simulations. Each simulation allows key variables to vary throughout the long-range period. These key variables include total fertility rates, changes in mortality rates, new arrival lawful permanent resident (LPR) and other-than-LPR immigration levels, rates of adjustment of status (from other-than-LPR to LPR), rates of legal emigration (from the population of citizens and LPRs), changes in the Consumer Price Index, changes in average real wages, unemployment rates, trust fund real yield rates, and disability incidence and recovery rates. The fluctuation of each variable over time is simu-

lated using historical data and standard time-series techniques. Generally, each variable is modeled using an equation that: (1) captures a relationship between current and prior years' values of the variable, and (2) introduces random variation based on variation observed in the historical period. For some variables, the equations also reflect relationships with other variables. The equations contain parameters that are estimated using historical data for periods from 20 years to over 110 years, depending on the nature and quality of the available data. Each time-series equation is designed so that, in the absence of random variation over time, the value of the variable for each year equals its value for the intermediate scenario.[1]

For each equation in a given simulation, the stochastic model assigns random variation to (1) year-by-year error term values and (2) simulation-specific mean term levels that provide variation in the central tendency across simulations. Each simulation produces estimates for all key variables and for the overall financial status of the combined OASI and DI Trust Funds. This appendix shows the distribution of results from 5,000 simulations of the model.

Readers should interpret the results from this model with an understanding of the model's limitations. Results are sensitive to equation specifications, degrees of interdependence among variables, and the historical periods used for estimating model coefficients. For some variables, recent historical variation may not provide a realistic representation of the potential variation for the future. Also, results would differ if additional variables (such as labor force participation rates, retirement rates, marriage rates, and divorce rates) were also allowed to vary randomly. Time-series modeling reflects only what occurred in the historical period. Future uncertainty exists not only for the underlying central tendency but also for the frequency and size of occasional longer-term shifts in the central tendency. Many experts predict, and history suggests, that the future will likely bring substantial shifts that are not fully reflected in the historical period used for the current model. As a result, readers should understand that the true range of uncertainty might be larger than indicated in this appendix.

3. Stochastic Results

This section illustrates the results for the stochastic simulations of two fundamental measures of actuarial status: annual cost rates and trust fund ratios.

[1] More detail on this model, and stochastic modeling in general, is available at www.ssa.gov/OACT/stochastic/index.html.

The latter measure is highlighted in section II.D of this report. Section 4 follows with a comparison of stochastic results to results from the alternative scenarios for these and other measures, and an analysis of the differences.

Figure VI.E1 displays the probability distribution of the year-by-year OASDI cost rates (that is, cost as a percentage of taxable payroll). The range of the annual cost rates widens as the projections move further into the future, which reflects increasing uncertainty. Because there is relatively little variation in income rates across the 5,000 stochastic simulations, the figure includes only the income rate for the intermediate scenario. The two outermost cost rate lines in this figure indicate the range within which future annual cost rates are projected to occur 95 percent of the time (i.e., a 95-percent confidence interval). In other words, the current model estimates that there is a 2.5 percent probability that the cost rate for a given year will exceed the upper end of this range and a 2.5 percent probability that it will fall below the lower end of this range. Other lines in the figure delineate additional confidence intervals (80-percent, 60-percent, 40-percent, and 20-percent) around future annual cost rates. The median (50th percentile) cost rate for each year is the rate for which half of the simulated outcomes are higher and half are lower for that year. These lines do not represent the results of individual stochastic simulations. Instead, for each given year, they represent the percentile distribution of annual cost rates based on all stochastic simulations for that year.

Figure VI.E1.—Long-Range OASDI Cost Rates From Stochastic Modeling

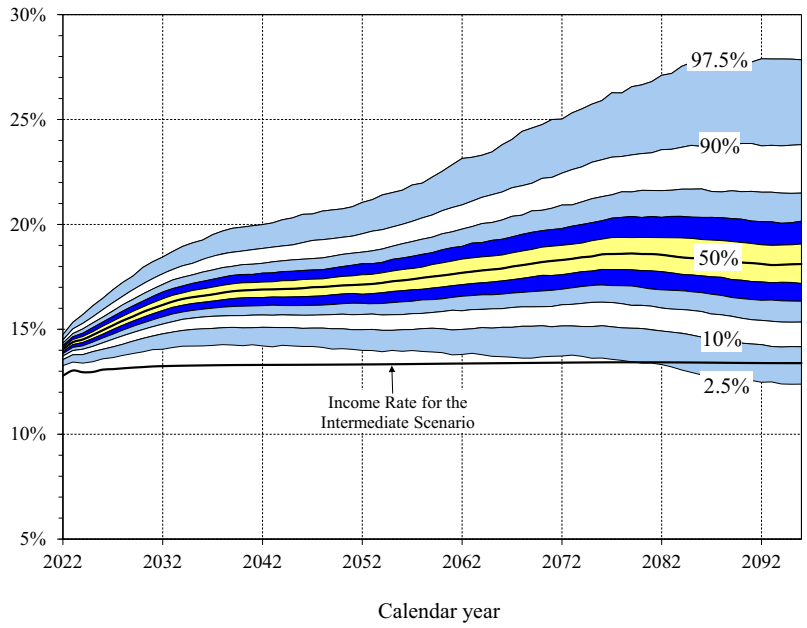
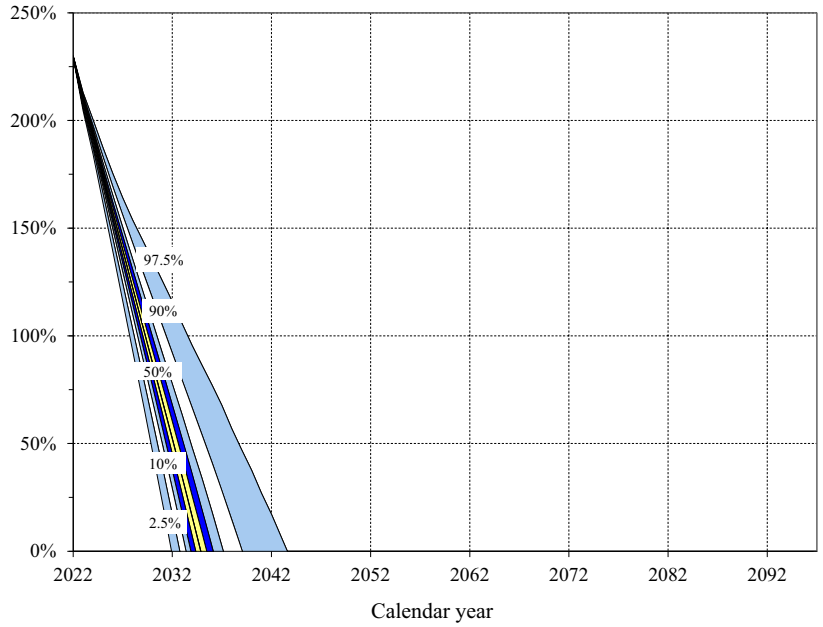


Figure VI.E2 presents the simulated probability distribution of the annual trust fund ratios for the combined OASI and DI Trust Funds. The lines in this figure display the median set (50th percentile) of estimated annual trust fund ratios and delineate the 95-percent, 80-percent, 60-percent, 40-percent, and 20-percent confidence intervals estimated for future annual trust fund ratios. Again, none of these lines represent the path of a single simulation. For each given year, they represent the percentile distribution of trust fund ratios based on all stochastic simulations for that year.

Figure VI.E2 shows that the 95-percent confidence interval for the trust fund reserve depletion year ranges from 2031 to 2043, and that there is a 50-percent probability of trust fund reserve depletion by the end of 2034 (the median reserve depletion year). The median reserve depletion date is late in 2034; the reserve depletion date for the intermediate scenario is early in 2035. The figure also shows confidence intervals for the trust fund ratio in each year.

Figure VI.E2.—Long-Range OASDI Trust Fund Ratios From Stochastic Modeling



4. Comparison of Results: Stochastic to Low-Cost, Intermediate, and High-Cost Alternative Scenarios

This section compares results from two different approaches for illustrating ranges of uncertainty in measures of trust fund actuarial status. One approach uses results from the low-cost, intermediate, and high-cost alternative scenarios. The other approach uses distributions of results from the stochastic simulations. Each of these approaches provides insights into uncertainty. Comparing the results requires an understanding of fundamental differences in the approaches.

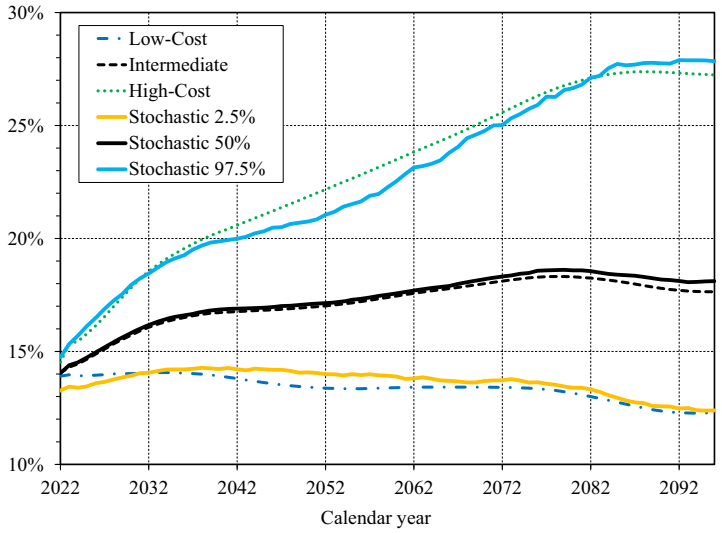
One fundamental difference relates to the presentation of distributional results. Figure VI.E3 shows projected OASDI annual cost rates for the low-cost, intermediate, and high-cost alternative scenarios along with the annual cost rates at the 2.5th percentile, 50th percentile, and 97.5th percentile for the stochastic simulations. While all values on each line for the alternative scenarios are results from a single specified scenario, the values on each stochastic line may be results from different simulations for different years. The one stochastic simulation (from the 5,000 simulations) that yields results

closest to a particular percentile for one projected year may yield results that are distant from that percentile in another projected year.

Because each stochastic simulation shows substantial variability from year to year, the range shown between the 2.5th and 97.5th percentiles is broader than would be seen if simulations followed a smooth trend like in the alternative scenarios. Furthermore, with the introduction of parameter uncertainty for the expected mean for the stochastic simulations in last year's report, the range of the 95-percent confidence interval is generally expanded from the range in prior years' reports.

Both the alternative scenarios and the stochastic results suggest that the range of potential cost rates above the central levels (those for the intermediate scenario and for the stochastic median, respectively) is larger than the range below these central results. The difference between the central results and the higher cost levels (the high-cost alternative scenario and the upper end of the 95-percent confidence range, respectively) is about 1.7 to 1.8 times as large as the difference between the central and lower cost levels for both models by the end of the projection period.

Figure VI.E3.—OASDI Cost Rates: Comparison of Stochastic to Low-Cost, Intermediate, and High-Cost Alternative Scenarios
[As a percentage of taxable payroll]

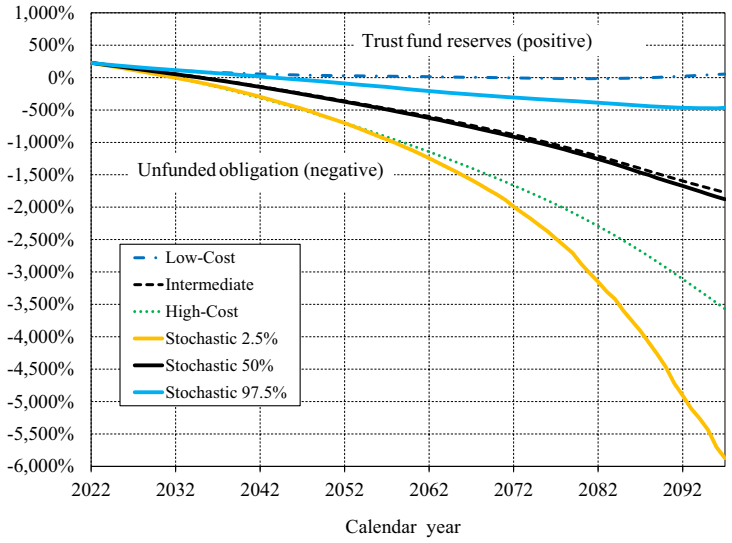


Another fundamental difference between the alternative scenarios and the stochastic simulations is the method of assigning values for assumptions. For the alternative scenarios, specific values are assigned for each of the key demographic, economic, and program-specific variables. The high-cost alternative scenario uses parameter values that increase estimated annual cost as a percent of payroll, while the low-cost alternative scenario uses parameter values that decrease annual cost as a percent of payroll. (One parameter, the interest rate, has no effect on annual cost as a percent of payroll for either the alternative scenarios or the stochastic simulations.) In contrast, the stochastic method independently assigns random variation to each of the key demographic and economic variables for each year in each of the 5,000 stochastic simulations. For each of the stochastic simulations, the assigned values for different variables result in varying and often offsetting effects on projected cost as a percent of payroll, with some tending toward higher cost and some tending toward lower cost. This difference tends to narrow the range of cost as a percent of payroll across the 95-percent confidence interval.

It is important to understand that the stochastic model's 95-percent confidence intervals for any summary measure of trust fund finances would tend to be narrower than the range produced for the low-cost and high-cost alternative scenarios, even if the stochastic model's 95-percent confidence interval for annual cost rates were identical to the range defined by the low-cost and high-cost scenarios. This is true because summary measures of trust fund finances depend on cost rates for many years, and the probability that annual cost rates, on average for individual stochastic simulations, will be at least as low (high) as the 2.5 (97.5) percentile line is significantly lower than 2.5 percent. As a result, the relationship between the ranges presented for annual cost rates and summary measures of trust fund finances is fundamentally different for the stochastic model than it is for the low-cost and high-cost alternative scenarios.

Figure VI.E4 compares the ranges of trust fund (unfunded obligation) ratios for the alternative scenarios to the 95-percent confidence interval of the stochastic simulations. This figure extends figure VI.E2 to show unfunded obligation ratios, expressed as negative values below the zero percent line. An unfunded obligation ratio is the ratio of the unfunded obligation accumulated through the beginning of the year to the cost for that year.

Figure VI.E4.—OASDI Trust Fund (Unfunded Obligation) Ratios: Comparison of Stochastic to Low-Cost, Intermediate, and High-Cost Alternative Scenarios[a]
[Trust fund reserves (unfunded obligation) as a percentage of annual cost]



[a] An unfunded obligation, shown as a negative value in this figure, is equivalent to the amount the trust funds would need to have borrowed to date in order to pay all scheduled benefits (on a timely basis) after trust fund reserves are depleted. Note that current law does not permit the trust funds to borrow.

As mentioned above, a summary measure that accumulates annual values tends to smooth the kind of annual fluctuations that occur in stochastic simulations. Therefore, one might expect the range across the stochastic confidence interval for trust fund (unfunded obligation) ratios to be narrower and fall within the range seen across the high-cost and low-cost alternative scenarios, as it does for the actuarial balance measure. But this is not the case, largely due to the way interest rates are assigned.

For the stochastic model, real interest rates for each simulation are assigned to be essentially independent of other variables, so the rate for compounding of trust fund reserves (unfunded obligations) is essentially uncorrelated with the level of cost as a percent of payroll. On the other hand, real interest rates are assigned to be higher for the low-cost alternative scenario and lower for the high-cost alternative scenario. High interest rates raise the level of the positive trust fund ratio in the low-cost alternative scenario somewhat, but this effect is limited because the magnitude of reserves is small. However, low interest rates substantially reduce the magnitude of the unfunded obligation ratio for the high-cost alternative scenario because the magnitude of

unfunded obligations is relatively large. As a result, the trust fund (unfunded obligation) ratios are shifted, albeit unevenly, higher (or less negative) for both the high-cost and low-cost alternative scenarios relative to those of the stochastic simulations.

This interest rate effect on the alternative scenarios is not as evident for some other summary measures of actuarial status, such as the actuarial balance. Because the actuarial balance reflects the cumulative effects of interest in both its numerator and denominator, the interest rate effect is much less pronounced. In contrast, cumulative interest affects only the numerator of the trust fund (unfunded obligation) ratio. There is also no significant interest rate effect on the trust fund depletion date.

Other factors also contribute, to varying degrees, to the difference in ranges between the results of the alternative scenarios and the stochastic simulations. The contrasts in results and methods do not mean that either approach to illustrating ranges of uncertainty is superior to the other. The ranges are different and explainable.

Table VI.E1 displays long-range actuarial estimates for the combined OASDI program using the two methods of illustrating uncertainty: alternative scenarios and stochastic simulations. The table shows scenario-based estimates for the intermediate, low-cost, and high-cost assumptions. It also shows stochastic estimates for the median (50th percentile) and for the 80-percent and 95-percent confidence intervals. Each individual stochastic estimate in the table is the level at that percentile from the distribution of the 5,000 simulations. For each given percentile, the values in the table for each long-range actuarial measure are generally from different stochastic simulations.

The median stochastic estimates displayed in table VI.E1 are similar to the intermediate scenario-based estimates. The median estimate of the long-range actuarial balance is -3.45 percent of taxable payroll, about 0.03 percentage point lower (more negative) than projected in the intermediate scenario. The median estimate for the open-group unfunded obligation is $20.6 trillion, about $0.2 trillion larger than the $20.4 trillion estimate in the intermediate scenario. The median first projected year for which cost exceeds non-interest income (as it did in 2010 through 2021), and remains in excess of non-interest income throughout the remainder of the long-range period, is 2022. This is the same year as projected in the intermediate scenario. The median projected date at which trust fund reserves first become depleted is late in 2034; the reserve depletion date for the intermediate scenario is early in 2035. The median estimates of the annual cost rate for the 75th year of the projection period are 18.11 percent of taxable payroll and

6.01 percent of gross domestic product (GDP). The comparable estimates in the intermediate scenario are 17.64 percent of payroll and 5.86 percent of GDP.

For three measures in table VI.E1 (the actuarial balance, the first projected year cost exceeds non-interest income and remains in excess through 2096, and the first year trust fund reserves become depleted), the 95-percent stochastic confidence interval falls within the range defined by the low-cost and high-cost scenarios. For the remaining three measures (the open-group unfunded obligation, the annual cost in the 75th year as a percent of taxable payroll, and the annual cost in the 75th year as a percent of GDP), one or both of the bounds of the 95-percent stochastic confidence interval fall outside the range defined by the low-cost and high-cost scenarios.

Table VI.E1.—Long-Range Estimates Relating to the Actuarial Status of the Combined OASDI Program
[Comparison of scenario-based and stochastic results]

	Traditional scenario-based model			Stochastic model				
					80-percent confidence interval		95-percent confidence interval	
	Intermediate	Low-cost	High-cost	Median 50th percentile	10th percentile	90th percentile	2.5th percentile	97.5th percentile
Actuarial balance	-3.42	-0.07	-8.09	-3.45	-5.50	-1.84	-6.88	-1.01
Open-group unfunded obligation (in trillions)	$20.4	-$.6	$38.6	$20.6	$9.1	$40.4	$4.7	$55.2
First projected year cost exceeds non-interest income and remains in excess through 2096	2022	[a]	2022	2022	2022	2042	2022	[a]
First year trust fund reserves become depleted [b]	2035	2069	2031	2034	2032	2039	2031	2043
Annual cost in 75th year (percent of taxable payroll)	17.64	12.29	27.24	18.11	14.17	23.80	12.39	27.85
Annual cost in 75th year (percent of GDP)	5.86	4.43	8.34	6.01	4.74	7.82	4.16	9.11

[a] Cost is projected to exceed non-interest income for a temporary period, before falling below non-interest income by the end of the projection period.
[b] For the low-cost scenario and for some stochastic simulations, the first year in which trust fund reserves become depleted does not indicate a permanent depletion of reserves.

F. INFINITE HORIZON PROJECTIONS

Another measure of trust fund financial status is the infinite horizon unfunded obligation, which takes account of all past and future annual balances, even those after the next 75 years. The extension of the time period past 75 years assumes that the current law for the OASDI program and the demographic and economic trends used for the 75-year projection continue indefinitely.

Table VI.F1 shows that the OASDI open-group unfunded obligation over the infinite horizon is $61.8 trillion in present value, which is $41.3 trillion larger than for the 75-year period. The $41.3 trillion increment reflects a significant financing gap projected for OASDI for years after 2096 into perpetuity. Of course, the degree of uncertainty associated with estimates increases substantially for years further in the future.

The $61.8 trillion infinite horizon open-group unfunded obligation is equal to 4.5 percent of taxable payroll or 1.4 percent of GDP over the same period. These relative measures of the unfunded obligation over the infinite horizon express its magnitude in relation to the resources potentially available to finance the shortfall.

The summarized shortfalls for the 75-year period and through the infinite horizon both reflect annual cash-flow shortfalls for all years after trust fund reserve depletion. The annual shortfalls after trust fund reserve depletion rise slowly and reflect increases in life expectancy. The summarized shortfalls over the infinite horizon, as percentages of taxable payroll and GDP, are larger than the shortfalls for the 75-year period.

To illustrate the magnitude of the projected infinite horizon shortfall, consider that it could be eliminated with additional revenue equivalent to an immediate increase in the combined payroll tax rate from 12.4 percent to about 16.9 percent,[1] or with cost reductions equivalent to an immediate and permanent reduction in benefits for all current and future beneficiaries by about 26.4 percent.

[1] While an increase in the payroll tax rate would cause some behavioral changes in earnings and ensuing changes in benefit levels, such changes are not included in the calculations because they are assumed to have roughly offsetting effects on OASDI actuarial status over the infinite horizon.

Table VI.F1.—Unfunded OASDI Obligations Through the Infinite Horizon and the 75-Year Projection Period, Based on Intermediate Assumptions
[Present values as of January 1, 2022; dollar amounts in trillions]

		Expressed as a percentage of future payroll and GDP	
	Present value	Taxable payroll	GDP
Unfunded obligation through the infinite horizon[a]	$61.8	4.5	1.4
Unfunded obligation through 2096[b]	20.4	3.2	1.1

[a] Present value of future cost less future non-interest income, reduced by the amount of trust fund asset reserves at the beginning of 2022. Expressed as a percentage of payroll and GDP for the period 2022 through the infinite horizon.
[b] Present value of future cost less future non-interest income through 2096, reduced by the amount of trust fund reserves at the beginning of 2022. Expressed as a percentage of payroll and GDP for the period 2022 through 2096.

Notes:
1. The present values of future taxable payroll for 2022-96 and for 2022 through the infinite horizon are $631.6 trillion and $1,382.3 trillion, respectively.
2. The present values of GDP for 2022-96 and for 2022 through the infinite horizon are $1,817.7 trillion and $4,521.4 trillion, respectively. Present values of GDP shown in the Medicare Trustees Report differ slightly due to the use of discount rates that are specific to each program's trust fund holdings.

Last year, the Trustees projected that the infinite horizon unfunded obligation was $59.8 trillion in present value discounted to January 1, 2021. If the assumptions, methods, and starting values had not changed, moving the valuation date forward by 1 year to January 1, 2022 would have discounted future values by 1 year less, thus increasing the measured unfunded obligation by about $1.5 trillion, to $61.3 trillion. The net effects of changes in assumptions, methods, law, and starting values increased the infinite horizon unfunded obligation by an additional $0.5 trillion. The nominal dollar levels of taxable payroll (and GDP), cost, and thus annual cash-flow shortfalls are higher in this year's report than in last year's report. At the same time, the assumed interest rates used for discounting did not increase to the same degree, thus increasing the measured present value of the unfunded obligation in dollars. This increase was partially offset by a reduction in the assumed ultimate disabled worker incidence rate and changes in economic data and assumptions. See section IV.B.6 for details regarding changes in law, data, methods, and assumptions.

Compared to last year's report, the unfunded obligation over the infinite horizon in this year's report decreased by 0.1 percentage point as a share of taxable payroll and remained the same as a share of GDP. The unfunded obligation over the 75-year projection period decreased by 0.2 percentage point as a share of taxable payroll and decreased by 0.1 percentage point as a share of GDP.

a. Unfunded Obligations for Past, Current, and Future Participants

Table VI.F2 separates the components of the infinite horizon unfunded obligation (with the exception of General Fund reimbursements) among past, current, and future participants. The table does not separate past General Fund reimbursements among participants because there is no clear basis for attributing the reimbursements across generations.

Past participants are defined as those no longer alive as of the valuation date. Current participants are those age 15 and older as of 2022. Future participants are those under age 15 or not yet born.

The excess of the present value of cost for past and current participants over the present value of dedicated tax income for past and current participants produces an unfunded obligation for past and current participants of $46.4 trillion. Table VI.F2 also shows an unfunded obligation of $45.7 trillion for past and current participants, including past and future General Fund reimbursements. Future participants are scheduled to pay dedicated taxes of $16.1 trillion less into the system than the cost of their scheduled benefits ($143.0 trillion of dedicated tax income as compared to $159.1 trillion of cost). The unfunded obligation for all participants through the infinite horizon thus equals $61.8 trillion.

Making Social Security solvent over the infinite horizon requires some combination of increased revenue or reduced benefits for current and future participants amounting to $61.8 trillion in present value, 4.5 percent of future taxable payroll, or 1.4 percent of future GDP.

Table VI.F2.—Present Values Through the Infinite Horizon for Various Categories of Program Participants, Based on Intermediate Assumptions
[Present values as of January 1, 2022; dollar amounts in trillions]

		Expressed as a percentage of future payroll and GDP	
	Present value	Taxable payroll	GDP
Present value of past cost	$73.4	5.3	1.6
Less present value of past dedicated tax income	75.6	5.5	1.7
Plus present value of future cost for current participants	91.0	6.6	2.0
Less present value of future dedicated tax income for current participants	42.4	3.1	.9
Equals unfunded obligation for past and current participants excluding General Fund reimbursements	46.4	3.4	1.0
Less present value of past General Fund reimbursements[a]	.7	[b]	[c]
Less present value of future General Fund reimbursements through the infinite horizon[a]	[d]	[b]	[c]
Equals unfunded obligation for past and current participants including General Fund reimbursements	45.7	3.3	1.0
Plus present value of cost for future participants through the infinite horizon	159.1	11.5	3.5
Less present value of dedicated tax income for future participants through the infinite horizon	143.0	10.3	3.2
Equals unfunded obligation for all participants through the infinite horizon	61.8	4.5	1.4

[a] Distribution of General Fund reimbursements among past, current, and future participants cannot be determined.
[b] Less than 0.05 percent of taxable payroll.
[c] Less than 0.05 percent of GDP.
[d] Less than $50 billion.

Notes:
1. The present value of future taxable payroll for 2022 through the infinite horizon is $1,382.3 trillion.
2. The present value of GDP for 2022 through the infinite horizon is $4,521.4 trillion.
3. Components may not sum to totals because of rounding.

G. ESTIMATES FOR OASDI AND HI, SEPARATE AND COMBINED

In this appendix, the Trustees present long-range actuarial estimates for the OASDI and Hospital Insurance (HI) programs both separately and on a combined basis. These estimates facilitate analysis of the adequacy of the income and asset reserves of these programs relative to their cost under current law. This appendix does not include estimates for the Supplementary Medical Insurance (SMI) program because adequate financing is guaranteed in the law and because the SMI program is not financed through a payroll tax. For more information on Medicare estimates, please see the 2022 Medicare Trustees Report.

The information in this appendix on combined operations, while significant, should not obscure the analysis of the financial status of the individual trust funds, which are legally separate and cannot be commingled. In addition, the factors which determine the costs of the OASI, DI, and HI programs differ substantially.

1. Estimates as a Percentage of Taxable Payroll

Comparing cost and income rates for the OASDI and HI programs as percentages of taxable payroll requires a note of caution. The taxable payrolls for the HI program are larger than those for the OASDI program because: (1) a larger maximum taxable amount was established for the HI program in 1991, with the maximum eliminated altogether for the HI program in 1994; (2) larger proportions of Federal, State, and local government employees are covered under the HI program; and (3) the earnings of railroad workers are included directly in the HI taxable payroll but are not included in the OASDI taxable payroll. (Railroad worker contributions for the equivalent of OASDI benefits are accounted for in a net interchange that occurs annually between the OASDI and Railroad Retirement programs.) As a result, the HI taxable payroll is 26 percent larger than the OASDI taxable payroll on average over the long-range period.

As with the OASI and DI Trust Funds, income to the HI Trust Fund comes primarily from contributions paid by employees, employers, and self-employed persons. Table VI.G1 shows the OASDI and HI contribution rates that are authorized in the Federal Insurance Contributions Act.

Table VI.G1.—Payroll Tax Contribution Rates for the OASDI and HI Programs
[In percent]

	Employees and employers, combined[a]		Employees only	Self employed[b]		
Calendar years	OASDI up to base[c]	HI all earnings[d]	HI over limit[e]	OASDI up to base[c]	HI all earnings[d]	HI over limit[e]
1966	7.70	0.70	—	5.80	0.35	—
1967	7.80	1.00	—	5.90	.50	—
1968	7.60	1.20	—	5.80	.60	—
1969-70	8.40	1.20	—	6.30	.60	—
1971-72	9.20	1.20	—	6.90	.60	—
1973	9.70	2.00	—	7.00	1.00	—
1974-77	9.90	1.80	—	7.00	.90	—
1978	10.10	2.00	—	7.10	1.00	—
1979-80	10.16	2.10	—	7.05	1.05	—
1981	10.70	2.60	—	8.00	1.30	—
1982-83	10.80	2.60	—	8.05	1.30	—
1984[f]	11.40	2.60	—	11.40	2.60	—
1985[f]	11.40	2.70	—	11.40	2.70	—
1986-87[f]	11.40	2.90	—	11.40	2.90	—
1988-89[f]	12.12	2.90	—	12.12	2.90	—
1990-2010[g]	12.40	2.90	—	12.40	2.90	—
2011-2012[h]	10.40	2.90	—	10.40	2.90	—
2013 and later	12.40	2.90	0.90	12.40	2.90	0.90

[a] Except as noted below, the combined employee/employer rate is divided equally between employees and employers.

[b] Beginning in 1990, self-employed persons receive a deduction, for purposes of computing their net earnings, equal to half of the combined OASDI and HI contributions that would be payable without regard to the contribution and benefit base. The OASDI contribution rate then applies to net earnings after this deduction, but subject to the OASDI base.

[c] The payroll tax on earnings for the OASDI program applies to annual earnings up to a contribution and benefit base indexed to the average wage level. The base is $147,000 for 2022.

[d] Prior to 1994, the payroll tax on earnings for the HI program applied to annual earnings up to a contribution base. The HI contribution base was eliminated beginning in 1994.

[e] Starting with Federal personal income tax returns for tax year 2013, earned income exceeding $200,000 for individual filers and $250,000 for married couples filing jointly is subject to an additional HI tax of 0.9 percent. These income limits are not indexed after 2013.

[f] In 1984 only, employees received an immediate credit of 0.3 percent of taxable wages against their OASDI payroll tax contributions. The self-employed received similar credits of 2.7 percent, 2.3 percent, and 2.0 percent against their combined OASDI and Hospital Insurance (HI) contributions on net earnings from self-employment in 1984, 1985, and 1986-89, respectively. The General Fund of the Treasury reimbursed the trust funds for these credits.

[g] Public Law 111-147 exempted most employers from paying the employer share of OASDI payroll tax on wages paid during the period March 19, 2010 through December 31, 2010 to certain qualified individuals hired after February 3, 2010. The General Fund of the Treasury reimbursed the trust funds for the payroll tax revenue forgone under this law.

[h] Public Law 111-312, Public Law 112-78, and Public Law 112-96 reduced the OASDI payroll tax rate for 2011 and 2012 by 2 percentage points for employees and for self-employed workers. The General Fund of the Treasury reimbursed the trust funds for the payroll tax revenue forgone under these laws.

Table VI.G2 shows the Trustees' estimates of annual income rates and cost rates for the OASDI program and the HI program under the intermediate, low-cost, and high-cost sets of assumptions described earlier in this report. The income rates reflect the payroll tax rates shown in table VI.G1, revenue from taxation of scheduled OASDI benefits for both the OASDI and HI

Trust Funds, and any reimbursements from the General Fund of the Treasury. For the HI program, the income rates also reflect: (1) the additional 0.9-percent tax on employees for relatively high earnings and the portion of total payroll to which the 0.9-percent rate applies, (2) premium revenues, and (3) monies from fraud and abuse control activities. Annual income and cost rates indicate the cash-flow operation of the programs. Therefore, income rates exclude interest earned on trust fund asset reserves. Table VI.G2 also shows annual balances, which are the differences between annual income rates and cost rates.

The Trustees project that the OASDI and HI cost rates will rise generally above current levels under the intermediate and high-cost sets of assumptions. The greatest increase occurs from 2022 to about 2038 under the intermediate and high-cost assumptions for OASDI and the intermediate assumptions for HI, and from 2022 to 2046 under the high-cost assumptions for HI. Under the intermediate assumptions, the OASDI cost rate increases by 26 percent from its current level by 2096, while under the high-cost assumptions, the cost rate increases by 87 percent by 2096. For HI, cost rates increase by 39 percent and 188 percent from 2022 to 2096 under the intermediate and high-cost assumptions, respectively. Under the low-cost assumptions, the OASDI and HI cost rates decrease from 2022 to 2096 by 12 percent and 33 percent, respectively.

The Trustees project annual deficits for every year of the projection period under the intermediate and high-cost assumptions for both the OASDI and HI programs. Under the low-cost assumptions, OASDI annual balances are negative through 2080, and are positive and mostly increasing thereafter, reaching 0.79 percent of payroll for 2096. HI annual balances as a percent of payroll are positive and mostly increasing throughout the projection period under the low-cost assumptions, reaching 2.12 percent of HI taxable payroll by 2096.

Table VI.G2.—OASDI and HI Annual Income Rates, Cost Rates, and Balances, Calendar Years 2022-2100

[As a percentage of taxable payroll[a]]

	OASDI			HI		
Calendar year	Income rate	Cost rate[b]	Balance[b]	Income rate	Cost rate	Balance
Intermediate:						
2022	12.79	14.05	-1.26	3.40	3.44	-0.04
2023	13.04	14.31	-1.27	3.42	3.50	-.08
2024	12.95	14.45	-1.49	3.44	3.59	-.15
2025	12.97	14.66	-1.69	3.46	3.68	-.22
2026	13.08	14.88	-1.80	3.54	3.79	-.25
2027	13.10	15.10	-2.00	3.56	3.88	-.32
2028	13.14	15.33	-2.19	3.59	3.97	-.38
2029	13.17	15.53	-2.35	3.61	4.05	-.44
2030	13.20	15.72	-2.52	3.64	4.11	-.47
2031	13.23	15.91	-2.67	3.67	4.17	-.50
2035	13.27	16.42	-3.15	3.75	4.55	-.80
2040	13.30	16.72	-3.42	3.83	4.78	-.95
2045	13.31	16.82	-3.51	3.89	4.88	-.99
2050	13.32	16.95	-3.63	3.95	4.89	-.94
2055	13.34	17.15	-3.81	4.02	4.87	-.85
2060	13.36	17.45	-4.09	4.10	4.87	-.77
2065	13.38	17.73	-4.35	4.17	4.90	-.73
2070	13.40	18.00	-4.60	4.24	4.95	-.71
2075	13.42	18.25	-4.83	4.30	4.99	-.69
2080	13.43	18.30	-4.87	4.35	4.99	-.63
2085	13.42	18.11	-4.69	4.39	4.95	-.56
2090	13.40	17.79	-4.39	4.41	4.89	-.47
2095	13.39	17.64	-4.25	4.44	4.81	-.37
2100	13.39	17.73	-4.33	4.48	4.73	-.25
Low-cost:						
2022	12.75	13.91	-1.16	3.40	3.35	.05
2023	13.04	13.96	-.92	3.41	3.29	.13
2024	12.93	13.92	-.99	3.43	3.30	.13
2025	12.93	13.93	-1.00	3.45	3.33	.12
2026	13.03	13.95	-.92	3.51	3.36	.15
2027	13.04	13.97	-.93	3.53	3.37	.16
2028	13.07	14.00	-.93	3.56	3.38	.17
2029	13.09	14.01	-.92	3.58	3.39	.19
2030	13.11	14.02	-.91	3.60	3.36	.24
2031	13.13	14.02	-.89	3.62	3.35	.28
2035	13.15	14.06	-.91	3.70	3.38	.33
2040	13.15	13.91	-.76	3.78	3.21	.57
2045	13.14	13.62	-.49	3.85	2.98	.87
2050	13.13	13.42	-.29	3.92	2.72	1.20
2055	13.13	13.35	-.22	3.99	2.51	1.48
2060	13.14	13.40	-.26	4.07	2.37	1.69
2065	13.14	13.42	-.28	4.13	2.31	1.82
2070	13.14	13.42	-.27	4.19	2.31	1.88
2075	13.14	13.37	-.23	4.24	2.32	1.92
2080	13.13	13.15	-.02	4.27	2.32	1.95
2085	13.11	12.75	.36	4.29	2.30	1.99
2090	13.08	12.36	.72	4.31	2.27	2.04
2095	13.08	12.27	.80	4.34	2.24	2.10
2100	13.09	12.43	.66	4.38	1.92	2.46

Table VI.G2.—OASDI and HI Annual Income Rates, Cost Rates, and Balances, Calendar Years 2022-2100 (Cont.)
[As a percentage of taxable payroll[a]]

	OASDI			HI		
Calendar year	Income rate	Cost rate[b]	Balance[b]	Income rate	Cost rate	Balance
High-cost:						
2022	12.90	14.53	-1.63	3.41	3.62	-0.21
2023	13.02	15.34	-2.31	3.44	3.83	-.39
2024	12.99	15.45	-2.46	3.46	3.96	-.49
2025	13.02	15.78	-2.76	3.48	4.14	-.66
2026	13.14	16.14	-3.00	3.56	4.34	-.77
2027	13.17	16.54	-3.37	3.60	4.53	-.94
2028	13.22	16.98	-3.76	3.63	4.73	-1.10
2029	13.27	17.40	-4.13	3.66	4.91	-1.25
2030	13.31	17.82	-4.50	3.69	5.08	-1.38
2031	13.36	18.22	-4.87	3.73	5.25	-1.52
2035	13.43	19.34	-5.91	3.82	6.18	-2.36
2040	13.48	20.28	-6.80	3.91	7.15	-3.25
2045	13.53	21.06	-7.53	3.98	8.08	-4.10
2050	13.58	21.85	-8.27	4.05	8.92	-4.87
2055	13.63	22.65	-9.02	4.13	9.57	-5.44
2060	13.69	23.49	-9.80	4.21	10.11	-5.90
2065	13.74	24.32	-10.57	4.29	10.53	-6.24
2070	13.80	25.21	-11.40	4.37	10.78	-6.41
2075	13.87	26.13	-12.27	4.45	10.86	-6.41
2080	13.92	26.89	-12.97	4.52	10.85	-6.33
2085	13.95	27.31	-13.36	4.58	10.77	-6.18
2090	13.96	27.36	-13.41	4.62	10.64	-6.01
2095	13.95	27.26	-13.31	4.65	10.47	-5.82
2100	13.95	27.25	-13.30	4.71	11.90	-7.19

[a] The taxable payroll for HI is significantly larger than the taxable payroll for OASDI because the HI taxable maximum amount was eliminated beginning in 1994, and because HI covers all Federal civilian employees, all State and local government employees hired after April 1, 1986, and railroad employees.

[b] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Notes:
1. The income rate excludes interest income.

2. The Trustees show income and cost estimates generally on a cash basis for the OASDI program and on an incurred basis for the HI program.

3. Components may not sum to totals because of rounding.

Table VI.G3 shows summarized values over the 25-year, 50-year, and 75-year valuation periods. For each of those periods, the summarized income rates include beginning trust fund asset reserves, and the summarized cost rates include the cost of accumulating an ending fund reserve equal to 100 percent of annual cost at the end of the period.

Table VI.G3.—Summarized OASDI and HI Income Rates and Cost Rates for Valuation Periods,[a] Calendar Years 2022-2096
[As a percentage of taxable payroll[b]]

Valuation period	OASDI			HI		
	Income rate	Cost rate[c]	Actuarial balance	Income rate	Cost rate	Actuarial balance
Intermediate:						
25-year:						
2022-46	14.38	16.62	-2.24	3.75	4.51	-0.76
50-year:						
2022-71	13.91	16.93	-3.02	3.90	4.67	-.77
75-year:						
2022-96	13.78	17.20	-3.42	4.03	4.73	-.70
Low-cost:						
25-year:						
2022-46	14.14	14.48	-.34	3.72	3.39	.33
50-year:						
2022-71	13.66	13.93	-.27	3.88	2.93	.95
75-year:						
2022-96	13.50	13.56	-.07	4.00	2.73	1.27
High-cost:						
25-year:						
2022-46	14.69	19.29	-4.61	3.82	6.16	-2.34
50-year:						
2022-71	14.25	20.93	-6.68	3.97	7.72	-3.75
75-year:						
2022-96	14.18	22.27	-8.09	4.11	8.41	-4.30

[a] Income rates include beginning trust fund asset reserves and cost rates include the cost of reaching an ending target trust fund equal to 100 percent of annual cost at the end of the period.
[b] The taxable payroll for HI is significantly larger than the taxable payroll for OASDI because the HI taxable maximum amount was eliminated beginning 1994, and because HI covers all Federal civilian employees, all State and local government employees hired after April 1, 1986, and railroad employees.
[c] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

The Trustees project that the OASDI and HI programs will each experience large actuarial deficits for the 25-year, 50-year, and 75-year valuation periods under the high-cost assumptions. Actuarial deficits under the intermediate assumptions are smaller than those for the high-cost assumptions for all three valuation periods. Under the low-cost assumptions, the OASDI program has relatively small actuarial deficits for all three valuation periods, while the HI program has positive actuarial balances for all three valuation periods.

2. Estimates as a Percentage of Gross Domestic Product

This section presents long-range projections of the operations of the combined Old-Age and Survivors Insurance and Disability Insurance (OASI and DI) Trust Funds and of the Hospital Insurance (HI) Trust Fund, expressed as a percentage of gross domestic product (GDP). While expressing fund operations as a percentage of taxable payroll is a very useful approach for assessing the financial status of the programs (see section IV.B.1), expressing them as a percentage of the total value of goods and services produced in the United States provides an additional perspective.

Table VI.G4 shows non-interest income, total cost, and the resulting balance of the combined OASI and DI Trust Funds, of the HI Trust Fund, and of the combined OASI, DI, and HI Trust Funds, expressed as percentages of GDP on the basis of each of the three alternative sets of assumptions. Table VI.G4 also contains estimates of GDP. For OASDI, non-interest income consists of payroll tax contributions, proceeds from taxation of scheduled OASDI benefits, and any reimbursements from the General Fund of the Treasury. Cost consists of scheduled benefits, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. For HI, non-interest income consists of payroll tax contributions (including contributions from railroad employment), up to an additional 0.9 percent tax on earned income for relatively high earners, proceeds from taxation of scheduled OASDI benefits, premium revenues, monies from fraud and abuse control activities, and any reimbursements from the General Fund of the Treasury. Cost consists of outlays (benefits and administrative expenses) for beneficiaries. The Trustees show income and cost estimates generally on a cash basis for the OASDI program[1] and on an incurred basis for the HI program.

The Trustees project the OASDI annual balance (non-interest income less cost) as a percentage of GDP to be negative throughout the projection period under the intermediate and high-cost assumptions. Under the low-cost assumptions, the OASDI annual deficit as a percentage of GDP decreases from 2022 to 2023, increases through 2025, and then slightly decreases in 2026, in part because of a permanent level shift upward in taxation of benefits income due to the expiration of the personal income tax provisions in Public Law 115-97, the Tax Cuts and Jobs Act. After 2026, deficits fluctuate

[1] OASDI benefits paid for entitlement for a particular month are generally paid in the succeeding month. There are two primary exceptions to this general rule. First, payments can occur with a greater delay when a benefit award is made after the month of initial benefit entitlement. At the time of benefit award, benefits owed for months of prior entitlement are then also paid to the beneficiary. For the projections in this report, such retroactive payments are included in the period where they are paid (at time of award). Second, when benefit payments scheduled for January 3 are paid on the prior December 31, because January 3 falls on a Sunday, such payments are shown in this report for the period they were scheduled to be paid.

through 2033 and then decrease through 2055. After 2055, the annual deficits slightly increase through 2063 and then decrease through 2080 before becoming positive for 2081 and later. Under the intermediate assumptions, the OASDI annual deficits as a percentage of GDP increase from 2022 through 2078, and decrease thereafter. Under the high-cost assumptions, annual deficits increase relatively rapidly through 2086, and then slightly decrease through the end of the projection period.

The Trustees project that the HI annual balance as a percentage of GDP will be positive and mostly increasing throughout the projection period, under the low-cost assumptions. Under the intermediate and the high-cost assumptions, the HI annual balance is negative for all years of the projection period. Under the intermediate assumptions, annual deficits increase through 2044, and then decline thereafter. Under the high-cost assumptions, annual deficits reach a peak in 2070 and decline thereafter.

The combined OASDI and HI annual balance as a percentage of GDP is negative throughout the projection period under both the intermediate and high-cost assumptions. Under the low-cost assumptions, the combined OASDI and HI annual balance is negative through 2040, and then positive and rising thereafter. Under the intermediate assumptions, the combined OASDI and HI annual deficits increase through 2077 and then decline thereafter, reaching 1.56 percent of GDP by 2096. Under the high-cost assumptions, combined annual deficits rise to a peak of 6.68 percent in 2082 and decrease thereafter.

By 2096, the combined OASDI and HI annual balances as percentages of GDP range from a positive annual balance of 1.22 percent for the low-cost assumptions to an annual deficit of 6.34 percent for the high-cost assumptions. Annual balances differ by a much smaller amount for the tenth projection year, 2031, ranging from an annual deficit of 0.20 percent for the low-cost assumptions to an annual deficit of 2.41 percent for the high-cost assumptions.

The summarized long-range (75-year) actuarial balance as a percentage of GDP for the combined OASDI and HI programs varies among the three alternatives by a relatively large amount, from a positive actuarial balance of 0.54 percent under the low-cost assumptions to an actuarial deficit of 4.56 percent under the high-cost assumptions. The 25-year summarized actuarial balance varies by a smaller amount, from a positive actuarial balance of 0.02 percent of GDP to an actuarial deficit of 2.67 percent. Summarized rates are calculated on a present-value basis. They include the trust fund reserve balances on January 1, 2022 and the cost of reaching a target trust fund level equal to 100 percent of the following year's annual cost at the end of the period. (See section IV.B.4 for further explanation.)

Table VI.G4.—OASDI and HI Annual and Summarized Income, Cost, and Balance as a Percentage of GDP, Calendar Years 2022-2100

	Percentage of GDP									GDP in dollars
	OASDI			HI			Combined			
Calendar year	Income[a]	Cost[b]	Balance[b]	Income[a]	Cost	Balance	Income[a]	Cost[b]	Balance[b]	(billions)
Intermediate:										
2022	4.53	4.98	-0.45	1.55	1.57	-0.02	6.08	6.55	-0.46	$24,951
2023	4.63	5.09	-.45	1.56	1.60	-.04	6.19	6.68	-.49	26,194
2024	4.63	5.17	-.53	1.57	1.63	-.07	6.20	6.80	-.60	27,365
2025	4.66	5.26	-.61	1.58	1.68	-.10	6.23	6.94	-.71	28,538
2026	4.71	5.36	-.65	1.61	1.73	-.12	6.32	7.09	-.77	29,720
2027	4.73	5.45	-.72	1.62	1.77	-.15	6.35	7.22	-.87	30,944
2028	4.75	5.54	-.79	1.64	1.81	-.18	6.39	7.35	-.97	32,212
2029	4.77	5.62	-.85	1.65	1.85	-.20	6.42	7.47	-1.05	33,546
2030	4.78	5.69	-.91	1.66	1.87	-.21	6.44	7.56	-1.13	34,924
2031	4.79	5.76	-.97	1.67	1.89	-.23	6.46	7.65	-1.19	36,355
2035	4.77	5.90	-1.13	1.69	2.05	-.36	6.46	7.96	-1.49	42,674
2040	4.73	5.95	-1.22	1.71	2.13	-.42	6.44	8.08	-1.64	51,968
2045	4.69	5.93	-1.24	1.72	2.16	-.44	6.41	8.08	-1.68	63,220
2050	4.65	5.92	-1.27	1.73	2.14	-.41	6.38	8.06	-1.68	77,080
2055	4.62	5.95	-1.32	1.75	2.12	-.37	6.37	8.06	-1.69	94,163
2060	4.60	6.01	-1.41	1.77	2.10	-.33	6.38	8.12	-1.74	115,104
2065	4.58	6.07	-1.49	1.79	2.11	-.31	6.38	8.18	-1.80	140,533
2070	4.57	6.13	-1.57	1.81	2.12	-.30	6.38	8.25	-1.87	171,276
2075	4.55	6.18	-1.64	1.83	2.12	-.29	6.38	8.31	-1.93	208,657
2080	4.52	6.17	-1.64	1.84	2.11	-.27	6.37	8.28	-1.91	254,750
2085	4.50	6.07	-1.57	1.85	2.08	-.23	6.34	8.15	-1.81	312,022
2090	4.47	5.93	-1.47	1.85	2.05	-.20	6.32	7.98	-1.66	382,873
2095	4.45	5.86	-1.41	1.85	2.01	-.15	6.30	7.87	-1.57	469,505
2100	4.44	5.87	-1.44	1.86	1.97	-.10	6.30	7.84	-1.54	574,472
Summarized rates: [c]										
25-year:										
2022-46 . .	5.15	5.95	-.80	1.69	2.03	-.35	6.83	7.98	-1.15	
50-year:										
2022-71 . .	4.90	5.96	-1.06	1.72	2.07	-.34	6.62	8.03	-1.41	
75-year:										
2022-96 . .	4.79	5.98	-1.19	1.76	2.07	-.31	6.55	8.04	-1.50	
Low-cost:										
2022	4.51	4.92	-.41	1.54	1.52	.02	6.05	6.44	-.39	25,233
2023	4.62	4.95	-.33	1.55	1.49	.06	6.17	6.44	-.27	27,035
2024	4.62	4.97	-.35	1.56	1.50	.06	6.18	6.48	-.30	28,626
2025	4.66	5.02	-.36	1.57	1.52	.05	6.23	6.53	-.31	30,230
2026	4.72	5.06	-.33	1.60	1.53	.07	6.32	6.59	-.26	31,899
2027	4.75	5.09	-.34	1.61	1.54	.07	6.36	6.63	-.27	33,650
2028	4.78	5.12	-.34	1.62	1.54	.08	6.40	6.67	-.26	35,487
2029	4.81	5.15	-.34	1.63	1.54	.09	6.44	6.69	-.25	37,432
2030	4.83	5.17	-.34	1.64	1.53	.11	6.47	6.70	-.23	39,469
2031	4.85	5.18	-.33	1.65	1.52	.13	6.50	6.71	-.20	41,603
2035	4.84	5.17	-.33	1.68	1.53	.15	6.51	6.70	-.19	51,340
2040	4.80	5.08	-.28	1.70	1.44	.26	6.50	6.52	-.02	66,552
2045	4.76	4.94	-.18	1.72	1.33	.39	6.48	6.27	.21	86,469
2050	4.74	4.84	-.10	1.74	1.21	.53	6.48	6.05	.43	112,884
2055	4.72	4.80	-.08	1.77	1.11	.66	6.49	5.91	.58	147,707
2060	4.72	4.81	-.09	1.80	1.05	.75	6.52	5.86	.66	193,224
2065	4.72	4.82	-.10	1.83	1.02	.80	6.54	5.84	.70	252,250
2070	4.72	4.81	-.10	1.85	1.02	.83	6.56	5.83	.73	328,790
2075	4.72	4.80	-.08	1.87	1.03	.85	6.59	5.82	.76	428,864
2080	4.71	4.72	-.01	1.89	1.03	.86	6.60	5.75	.86	561,361

Table VI.G4.—OASDI and HI Annual and Summarized Income, Cost, and Balance as a Percentage of GDP, Calendar Years 2022-2100 (Cont.)

	Percentage of GDP									GDP in dollars
	OASDI			HI			Combined			
Calendar year	Income[a]	Cost[b]	Balance[b]	Income[a]	Cost	Balance	Income[a]	Cost[b]	Balance[b]	(billions)
Low-cost (Cont.):										
2085	4.71	4.58	0.13	1.90	1.02	0.88	6.60	5.60	1.01	$737,780
2090	4.70	4.45	.26	1.91	1.01	.90	6.61	5.45	1.16	970,403
2095	4.71	4.42	.29	1.92	.99	.93	6.64	5.42	1.22	1,272,813
2100	4.73	4.49	.24	1.95	.85	1.09	6.67	5.34	1.33	1,663,845
Summarized rates: [c]										
25-year:										
2022-46 . .	5.16	5.28	-.12	1.68	1.53	.15	6.83	6.81	.02	
50-year:										
2022-71 . .	4.95	5.05	-.10	1.73	1.31	.42	6.68	6.36	.32	
75-year:										
2022-96 . .	4.88	4.90	-.02	1.78	1.22	.57	6.66	6.12	.54	
High-cost:										
2022	4.60	5.19	-.58	1.56	1.65	-.09	6.16	6.84	-.68	24,002
2023	4.63	5.46	-.82	1.56	1.73	-.17	6.19	7.19	-1.00	24,349
2024	4.64	5.52	-.88	1.57	1.79	-.22	6.21	7.31	-1.10	25,296
2025	4.64	5.63	-.99	1.58	1.88	-.30	6.23	7.51	-1.28	26,204
2026	4.69	5.76	-1.07	1.62	1.97	-.35	6.32	7.74	-1.42	27,076
2027	4.71	5.91	-1.20	1.64	2.07	-.43	6.35	7.98	-1.63	27,880
2028	4.72	6.07	-1.34	1.65	2.15	-.50	6.38	8.22	-1.84	28,655
2029	4.73	6.21	-1.47	1.66	2.24	-.57	6.40	8.44	-2.04	29,466
2030	4.73	6.34	-1.60	1.68	2.30	-.63	6.41	8.64	-2.23	30,293
2031	4.74	6.46	-1.73	1.69	2.38	-.69	6.43	8.84	-2.41	31,140
2035	4.72	6.79	-2.08	1.71	2.77	-1.06	6.43	9.57	-3.14	34,779
2040	4.68	7.03	-2.36	1.73	3.17	-1.44	6.41	10.20	-3.80	39,776
2045	4.63	7.21	-2.58	1.74	3.53	-1.79	6.37	10.74	-4.37	45,209
2050	4.59	7.39	-2.80	1.75	3.86	-2.11	6.34	11.25	-4.90	51,266
2055	4.56	7.57	-3.02	1.76	4.09	-2.33	6.32	11.67	-5.34	58,144
2060	4.53	7.77	-3.24	1.78	4.28	-2.50	6.31	12.05	-5.74	66,006
2065	4.50	7.96	-3.46	1.79	4.41	-2.61	6.29	12.37	-6.07	74,832
2070	4.47	8.16	-3.69	1.81	4.47	-2.66	6.28	12.63	-6.35	84,615
2075	4.44	8.37	-3.93	1.82	4.45	-2.63	6.27	12.82	-6.56	95,432
2080	4.41	8.52	-4.11	1.83	4.40	-2.57	6.24	12.92	-6.68	107,594
2085	4.37	8.55	-4.18	1.84	4.32	-2.48	6.21	12.87	-6.66	121,494
2090	4.32	8.47	-4.15	1.83	4.22	-2.39	6.16	12.70	-6.54	137,507
2095	4.28	8.36	-4.08	1.83	4.12	-2.29	6.11	12.48	-6.37	155,792
2100	4.24	8.28	-4.04	1.84	4.64	-2.80	6.08	12.92	-6.85	176,484
Summarized rates: [c]										
25-year:										
2022-46 . .	5.16	6.78	-1.62	1.71	2.76	-1.05	6.87	9.54	-2.67	
50-year:										
2022-71 . .	4.89	7.18	-2.29	1.74	3.38	-1.64	6.62	10.56	-3.93	
75-year:										
2022-96 . .	4.76	7.47	-2.72	1.76	3.61	-1.85	6.52	11.08	-4.56	

[a] Income for individual years excludes interest on the trust funds. Interest is implicit in all summarized values.

[b] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[c] Summarized rates are calculated on a present-value basis. They include the value of the trust funds on January 1, 2022 and the cost of reaching a target trust fund level equal to 100 percent of annual cost at the end of the period.

Notes:
1. The Trustees show income and cost estimates generally on a cash basis for the OASDI program and on an incurred basis for the HI program.

2. Components may not sum to totals because of rounding.

Table VI.G5 displays annual ratios of OASDI taxable payroll to GDP. These ratios facilitate comparisons of trust fund operations expressed as percentages of taxable payroll and those expressed as percentages of GDP. HI taxable payroll is 26 percent larger than the OASDI taxable payroll on average over the long-range period; see section 1 of this appendix for a detailed description of the difference. For each year, the cost as a percentage of GDP is equal to the cost as a percentage of taxable payroll multiplied by the ratio of taxable payroll to GDP.

Table VI.G5.—Ratio of OASDI Taxable Payroll to GDP, Calendar Years 2022-2100

Calendar year	Intermediate	Low-cost	High-cost
2022	0.354	0.354	0.357
2023	.355	.354	.356
2024	.358	.357	.357
2025	.359	.360	.357
2026	.360	.362	.357
2027	.361	.364	.357
2028	.362	.366	.357
2029	.362	.367	.357
2030	.362	.368	.356
2031	.362	.370	.355
2035	.360	.368	.351
2040	.356	.365	.347
2045	.352	.363	.342
2050	.349	.361	.338
2055	.347	.360	.334
2060	.345	.359	.331
2065	.343	.359	.327
2070	.341	.359	.324
2075	.339	.359	.320
2080	.337	.359	.317
2085	.335	.359	.313
2090	.334	.360	.310
2095	.332	.360	.307
2100	.331	.361	.304

Projections of GDP reflect projected increases in U.S. employment, labor productivity, average hours worked, and the GDP price index (GDP deflator). Projections of taxable payroll reflect the components of growth in GDP along with assumed changes in the ratio of total labor compensation to GDP, the ratio of earnings to total labor compensation, the ratio of OASDI covered earnings to total earnings, and the ratio of taxable to total covered earnings.

Over the long-range period, the ratio of OASDI taxable payroll to GDP is projected to decline mostly due to a projected decline in the ratio of wages and salaries to employee compensation. Over the last six complete economic cycles, the ratio of wages and salaries to employee compensation declined at an average annual rate of 0.17 percent. Over the 65-year period ending in 2096, the ratio of wages and salaries to employee compensation is projected to decline at an average annual rate of 0.02, 0.12, and 0.22 percent for the low-cost, intermediate, and high-cost assumptions, respectively.

3. Estimates in Dollars

This section presents long-range projections, in dollars, of the operations of the combined OASI and DI Trust Funds and in some cases the HI Trust Fund. Comparing current dollar values over long periods of time is difficult because of the effect of inflation. In order to compare dollar values in a meaningful way, table VI.G6 provides several economic series or indices which can be used to adjust current dollars for changes in prices, wages, or other aspects of economic growth during the projection period. Any series of values can be adjusted by dividing the value for each year by the corresponding index value for the year.

One of the most common forms of standardization is price indexing, which uses some measure of change in the prices of consumer goods. The Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W, hereafter referred to as CPI), published by the Bureau of Labor Statistics, Department of Labor, is one such price index. Consistent with the law, the Social Security Administration (SSA) uses this index to determine the annual cost-of-living increases for OASDI monthly benefits. The ultimate annual rate of increase in the CPI is assumed to be 3.0, 2.4, and 1.8 percent for the low-cost, intermediate, and high-cost sets of assumptions, respectively. Table VI.G7 provides CPI-indexed dollar values (those adjusted using the CPI in table VI.G6), which indicate the relative purchasing power of the values over time.

Wage indexing is another type of standardization. It combines the effects of price inflation and real wage growth. The wage index presented here is the national average wage index, as defined in section 209(k)(1) of the Social Security Act. SSA uses this index to annually adjust the contribution and benefit base and other earnings-related program amounts. The average wage is assumed to grow by an average rate of 4.8, 3.6, and 2.3 percent under the low-cost, intermediate, and high-cost assumptions, respectively, between 2031 and 2096. Wage-indexed values indicate the level of a series of values relative to the changing standard of living of workers over time.

The taxable payroll series is used as an index to adjust for the effects of changes in the number of workers and changes in the proportion of earnings that are taxable, as well as for the effects of price inflation and real wage growth. The OASDI taxable payroll consists of all earnings subject to OASDI taxation, with an adjustment for the lower effective tax rate on multiple-employer excess wages. A series of values, divided by the taxable payroll, indicates the percentage of payroll that each value represents, and thus

the extent to which the series of values increases or decreases as a percent of payroll over time.

The GDP series is used as an index to adjust for the growth in the aggregate amount of goods and services produced in the United States. Values adjusted by GDP (see section 2 of this appendix) indicate their relative share of the total output of the economy. No direct assumption is made about growth in taxable payroll or GDP. These series reflect the basic demographic and economic assumptions, as discussed in sections V.A and V.B, respectively.

Discounting at the rate of interest is another way of standardizing current dollars. The compound new-issue interest factor shown in table VI.G6 increases each year by the assumed effective annual nominal yield for special public-debt obligations issuable to the trust funds in the 12 months of the prior year. The compound effective trust-fund interest factor shown in table VI.G6 uses the effective annual yield on all currently-held securities in the combined OASI and DI Trust Funds. The reciprocal of the compound effective trust-fund interest factor approximates the cumulative discount factor used to convert nominal dollar values to present values as of the start of the valuation period in order to create summarized values for this report.

Table VI.G6.—Selected Economic Variables, Calendar Years 2021-2100
[GDP and taxable payroll in billions]

Calendar year	Adjusted CPI[a]	Average wage index	Taxable payroll[b]	Gross domestic product	Compound new-issue interest factor[c]	Compound effective trust-fund interest factor[d]
Intermediate:						
2021	95.66	$58,743.07	$8,223	$22,989	0.9862	0.9879
2022	100.00	62,583.15	8,842	24,951	1.0000	1.0115
2023	102.33	65,571.72	9,310	26,194	1.0184	1.0340
2024	104.78	68,371.79	9,787	27,365	1.0417	1.0563
2025	107.30	71,147.65	10,244	28,538	1.0717	1.0792
2026	109.87	73,980.60	10,698	29,720	1.1078	1.1037
2027	112.51	76,857.74	11,171	30,944	1.1493	1.1306
2028	115.21	79,761.29	11,650	32,212	1.1964	1.1603
2029	117.98	82,702.63	12,145	33,546	1.2485	1.1931
2030	120.81	85,713.03	12,647	34,924	1.3055	1.2295
2031	123.71	88,836.46	13,169	36,355	1.3665	1.2703
2035	136.02	102,530.83	15,347	42,674	1.6454	1.4887
2040	153.14	122,417.01	18,495	51,968	2.0756	1.8737
2045	172.42	145,582.26	22,277	63,220	2.6184	2.3633
2050	194.13	172,887.64	26,928	77,080	3.3030	2.9813
2055	218.57	205,634.94	32,655	94,163	4.1666	3.7608
2060	246.09	244,870.78	39,669	115,104	5.2561	4.7442
2065	277.07	291,767.28	48,142	140,533	6.6304	5.9846
2070	311.95	347,552.77	58,341	171,276	8.3641	7.5495
2075	351.23	413,851.91	70,697	208,657	10.5511	9.5234
2080	395.45	492,391.60	85,839	254,750	13.3099	12.0136
2085	445.24	585,488.00	104,553	312,022	16.7901	15.1548
2090	501.29	696,610.41	127,694	382,873	21.1803	19.1174
2095	564.40	829,710.10	156,054	469,505	26.7183	24.1160
2100	635.46	988,243.75	190,275	574,472	33.7044	30.4217
Low-cost:						
2021	95.12	58,757.18	8,225	22,995	0.9862	0.9879
2022	100.00	62,852.52	8,923	25,233	1.0000	1.0116
2023	103.00	67,130.25	9,581	27,035	1.0245	1.0348
2024	106.09	70,999.01	10,229	28,626	1.0602	1.0589
2025	109.28	74,558.14	10,889	30,230	1.1020	1.0847
2026	112.55	78,330.86	11,563	31,899	1.1508	1.1131
2027	115.93	82,316.43	12,260	33,650	1.2065	1.1451
2028	119.41	86,451.88	12,984	35,487	1.2693	1.1812
2029	122.99	90,722.28	13,747	37,432	1.3387	1.2221
2030	126.68	95,162.12	14,541	39,469	1.4146	1.2682
2031	130.48	99,831.80	15,379	41,603	1.4970	1.3203
2035	146.86	120,904.37	18,881	51,340	1.8817	1.5948
2040	170.25	153,141.65	24,290	66,552	2.5043	2.1043
2045	197.36	192,907.89	31,351	86,469	3.3331	2.7984
2050	228.80	242,825.70	40,738	112,884	4.4360	3.7245
2055	265.24	306,381.76	53,146	147,707	5.9040	4.9570
2060	307.49	387,161.85	69,415	193,224	7.8578	6.5973
2065	356.46	489,443.85	90,524	252,250	10.4580	8.7805
2070	413.24	618,371.03	117,944	328,790	13.9188	11.6862
2075	479.05	780,679.71	153,886	428,864	18.5248	15.5534
2080	555.35	984,656.78	201,498	561,361	24.6550	20.7003
2085	643.81	1,241,352.70	264,935	737,780	32.8139	27.5504
2090	746.35	1,565,910.51	348,909	970,403	43.6726	36.6673
2095	865.22	1,977,646.95	458,723	1,272,813	58.1247	48.8013
2100	1,003.03	2,497,177.10	600,836	1,663,845	77.3593	64.9505

Table VI.G6.—Selected Economic Variables, Calendar Years 2021-2100 (Cont.)
[GDP and taxable payroll in billions]

Calendar year	Adjusted CPI[a]	Average wage index	Taxable payroll[b]	Gross domestic product	Compound new-issue interest factor[c]	Compound effective trust-fund interest factor[d]
High-cost:						
2021	96.23	$58,728.91	$8,221	$22,983	0.9862	0.9879
2022	100.00	61,441.05	8,565	24,002	1.0000	1.0114
2023	101.02	62,461.55	8,666	24,349	1.0112	1.0334
2024	102.56	64,422.99	9,035	25,296	1.0231	1.0546
2025	104.40	66,330.90	9,348	26,204	1.0453	1.0757
2026	106.28	68,361.44	9,669	27,076	1.0731	1.0974
2027	108.19	70,254.36	9,963	27,880	1.1049	1.1203
2028	110.14	72,021.11	10,236	28,655	1.1397	1.1446
2029	112.12	73,775.14	10,509	29,466	1.1769	1.1700
2030	114.14	75,544.17	10,773	30,293	1.2176	1.1969
2031	116.19	77,352.07	11,043	31,140	1.2619	1.2260
2035	124.79	85,056.13	12,219	34,779	1.4555	1.4061
2040	136.43	95,717.67	13,794	39,776	1.7398	1.6808
2045	149.16	107,504.03	15,476	45,209	2.0795	2.0090
2050	163.08	120,453.15	17,338	51,266	2.4857	2.4014
2055	178.29	135,019.52	19,441	58,144	2.9711	2.8704
2060	194.93	151,435.04	21,836	66,006	3.5514	3.4310
2065	213.11	169,953.30	24,492	74,832	4.2450	4.1010
2070	233.00	190,743.00	27,398	84,615	5.0741	4.9020
2075	254.73	214,087.58	30,570	95,432	6.0651	5.8594
2080	278.50	240,146.72	34,077	107,594	7.2496	7.0037
2085	304.48	269,209.78	38,036	121,494	8.6654	8.3715
2090	332.89	302,052.35	42,586	137,507	10.3578	10.0065
2095	363.95	339,224.29	47,795	155,792	12.3807	11.9608
2100	397.91	380,998.63	53,643	176,484	14.7987	14.2968

[a] CPI-W indexed to calendar year 2022.
[b] Total earnings subject to OASDI contribution rates, adjusted to reflect the lower effective contribution rates (compared to the combined employee-employer rate) that apply to multiple-employer "excess wages."
[c] For each alternative, incorporates the average of the assumed annual yield for special public-debt obligations issuable to the trust funds in the 12 months of the prior year.
[d] For each alternative, incorporates the annual effective yield for all outstanding special public-debt obligations held by the trust fund, with a half-year's interest effect in each row. The effective yield for a period equals total interest earned during the period divided by the total exposure to interest on asset reserves and all income and cost items during the period. The reciprocals of the factors approximate the discounting/accumulation factors that are used to calculate summarized rates and balances in this report.

Table VI.G7 shows the operations of the combined OASI and DI Trust Funds in CPI-indexed 2022 dollars—that is, adjusted by the CPI indexing series as discussed above. The following items are presented in the table: (1) non-interest income, (2) interest income, (3) total income, (4) cost, and (5) asset reserves at the end of the year. Non-interest income consists of payroll tax contributions, income from taxation of scheduled OASDI benefits, and any reimbursements from the General Fund of the Treasury. Cost consists of scheduled benefits, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. Table VI.G7 shows trust fund operations under the intermediate, low-cost, and high-cost sets of assumptions.

Table VI.G7.—Operations of the Combined OASI and DI Trust Funds, in CPI-indexed 2022 Dollars,[a] Calendar Years 2022-2100
[In billions]

Calendar year	Non-interest income	Interest income	Total income	Cost[b]	Asset reserves at end of year[b]
Intermediate:					
2022	$1,131.2	$64.6	$1,195.8	$1,242.7	$2,805.2
2023	1,186.1	58.9	1,245.0	1,301.8	2,684.5
2024	1,210.1	55.2	1,265.3	1,349.4	2,537.5
2025	1,238.1	53.3	1,291.4	1,399.3	2,370.1
2026	1,273.5	52.8	1,326.3	1,449.3	2,191.6
2027	1,300.8	52.5	1,353.3	1,499.5	1,994.0
2028	1,328.8	51.0	1,379.8	1,549.9	1,777.1
2029	1,356.2	48.3	1,404.5	1,598.5	1,541.5
2030	1,381.9	44.7	1,426.6	1,645.8	1,286.1
2031[c]	1,408.5	39.8	1,448.3	1,693.2	1,011.1
Low-cost:					
2022	1,137.7	65.4	1,203.2	1,241.0	2,814.2
2023	1,213.2	62.0	1,275.2	1,299.0	2,708.4
2024	1,246.8	61.7	1,308.5	1,342.1	2,596.0
2025	1,288.5	62.7	1,351.2	1,387.8	2,483.8
2026	1,338.5	65.4	1,404.0	1,432.9	2,382.5
2027	1,379.3	69.2	1,448.4	1,477.6	2,283.9
2028	1,421.3	72.7	1,494.0	1,522.6	2,188.8
2029	1,463.6	76.1	1,539.7	1,566.2	2,098.6
2030	1,504.8	79.7	1,584.4	1,609.3	2,012.6
2031	1,547.3	82.9	1,630.3	1,652.8	1,931.5
2035	1,690.5	86.7	1,777.2	1,807.1	1,609.8
2040	1,876.3	73.7	1,950.0	1,984.5	1,233.1
2045	2,086.9	57.3	2,144.2	2,164.0	938.3
2050	2,337.7	47.3	2,385.0	2,389.2	765.2
2055	2,630.6	41.3	2,672.0	2,674.2	653.8
2060	2,965.7	33.4	2,999.1	3,024.2	494.7
2065	3,337.5	19.6	3,357.1	3,408.1	230.3
2070	[d]	[d]	[d]	[d]	[d]
2075	[d]	[d]	[d]	[d]	[d]
2080	[d]	[d]	[d]	[d]	[d]
2085	[d]	[d]	[d]	[d]	[d]
2090	6,115.5	52.7	6,168.2	5,779.7	960.0
2095	6,932.7	183.0	7,115.7	6,507.2	3,328.6
2100	7,839.1	341.6	8,180.7	7,443.3	6,144.9

Table VI.G7.—Operations of the Combined OASI and DI Trust Funds, in CPI-indexed 2022 Dollars,[a] Calendar Years 2022-2100 (Cont.)
[In billions]

Calendar year	Non-interest income	Interest income	Total income	Cost[b]	Asset reserves at end of year[b]
High-cost:					
2022	$1,104.8	$63.8	$1,168.6	$1,244.6	$2,776.0
2023	1,117.1	55.8	1,172.9	1,315.6	2,605.2
2024	1,144.5	49.9	1,194.5	1,361.4	2,399.1
2025	1,165.9	45.0	1,210.8	1,413.3	2,154.4
2026	1,195.5	41.0	1,236.5	1,468.2	1,884.7
2027	1,213.2	36.9	1,250.1	1,523.5	1,577.9
2028	1,229.1	31.0	1,260.0	1,578.2	1,231.8
2029	1,243.8	23.5	1,267.3	1,630.8	846.6
2030[c]	1,256.3	15.4	1,271.8	1,681.5	421.9

[a] CPI-indexed 2022 dollars equal current dollars adjusted by the CPI indexing series in table VI.G6.
[b] Benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.
[c] The combined OASI and DI Trust Funds become depleted in 2035 under the intermediate assumptions and in 2031 under the high-cost assumptions, so estimates for later years are not shown.
[d] The combined OASI and DI Trust Funds become depleted in 2069 under the low-cost assumptions, but combined asset reserves become positive again by the beginning of 2089 and remain positive through the remainder of the projection period. Estimates are not shown for years in which asset reserves are negative.

Note: Components may not sum to totals because of rounding.

Figure VI.G1 compares annual cost with annual total income and annual non-interest income. The figure shows only the OASDI program under intermediate assumptions, and presents values in CPI-indexed 2022 dollars, consistent with table VI.G7. The difference between the income values for each year is equal to the trust fund interest earnings. The figure illustrates that, under intermediate assumptions, annual cost exceeds both total income and non-interest income for 2022 until trust fund reserves are depleted in 2035. Estimates after reserve depletion are not shown. For 2022 through 2034 (the year preceding the year of trust fund reserve depletion), annual cost is covered by drawing down combined trust fund reserves.

Figure VI.G1.—Estimated OASDI Income and Cost in CPI-indexed 2022 Dollars, Based on Intermediate Assumptions
[In billions]

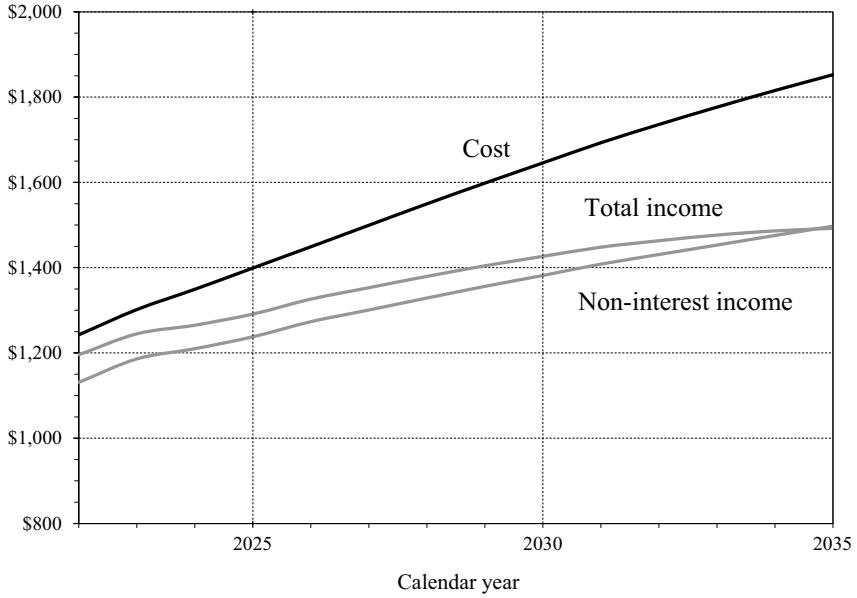


Table VI.G8 presents the operations of the combined OASI and DI Trust Funds in current, or nominal, dollars—that is, in dollars unadjusted for inflation. The following items are presented in the table: (1) non-interest income, (2) interest income, (3) total income, (4) cost, and (5) asset reserves at the end of the year. These estimates are presented using the intermediate, low-cost, and high-cost sets of demographic and economic assumptions to facilitate independent analysis.

Table VI.G8.—Operations of the Combined OASI and DI Trust Funds, in Current Dollars, Calendar Years 2022-2100
[In billions]

Calendar year	Non-interest income	Interest income	Total income	Cost[a]	Asset reserves at end of year[a]
Intermediate:					
2022	$1,131.2	$64.6	$1,195.8	$1,242.7	$2,805.2
2023	1,213.7	60.2	1,273.9	1,332.1	2,747.0
2024	1,267.9	57.9	1,325.8	1,413.9	2,658.9
2025	1,328.5	57.2	1,385.7	1,501.5	2,543.1
2026	1,399.3	58.0	1,457.3	1,592.4	2,408.0
2027	1,463.6	59.0	1,522.6	1,687.1	2,243.4
2028	1,530.9	58.7	1,589.6	1,785.6	2,047.4
2029	1,600.0	56.9	1,656.9	1,885.8	1,818.6
2030	1,669.4	54.0	1,723.4	1,988.3	1,553.7
2031[b]	1,742.4	49.3	1,791.7	2,094.7	1,250.8

Table VI.G8.—Operations of the Combined OASI and DI Trust Funds, in Current Dollars, Calendar Years 2022-2100 (Cont.)
[In billions]

Calendar year	Non-interest income	Interest income	Total income	Cost[a]	Asset reserves at end of year[a]
Low-cost:					
2022	$1,137.7	$65.4	$1,203.2	$1,241.0	$2,814.2
2023	1,249.6	63.9	1,313.5	1,338.0	2,789.7
2024	1,322.8	65.5	1,388.3	1,423.8	2,754.2
2025	1,408.0	68.5	1,476.5	1,516.5	2,714.1
2026	1,506.6	73.6	1,580.2	1,612.8	2,681.5
2027	1,599.0	80.2	1,679.2	1,713.0	2,647.7
2028	1,697.2	86.9	1,784.0	1,818.1	2,613.7
2029	1,800.1	93.6	1,893.7	1,926.3	2,581.1
2030	1,906.2	100.9	2,007.2	2,038.6	2,549.6
2031	2,019.0	108.2	2,127.2	2,156.5	2,520.2
2035	2,482.6	127.3	2,609.9	2,653.8	2,364.1
2040	3,194.3	125.5	3,319.8	3,378.6	2,099.3
2045	4,118.8	113.1	4,231.9	4,271.0	1,851.9
2050	5,348.6	108.3	5,456.9	5,466.4	1,750.9
2055	6,977.5	109.6	7,087.2	7,093.2	1,734.0
2060	9,119.0	102.7	9,221.8	9,298.9	1,521.1
2065	11,896.8	69.9	11,966.7	12,148.5	820.8
2070	[c]	[c]	[c]	[c]	[c]
2075	[c]	[c]	[c]	[c]	[c]
2080	[c]	[c]	[c]	[c]	[c]
2085	[c]	[c]	[c]	[c]	[c]
2090	45,643.4	393.3	46,036.6	43,136.5	7,164.9
2095	59,983.7	1,582.9	61,566.6	56,301.5	28,800.1
2100	78,628.5	3,426.5	82,055.0	74,658.8	61,635.4
High-cost:					
2022	1,104.8	63.8	1,168.6	1,244.6	2,776.0
2023	1,128.5	56.4	1,184.9	1,329.1	2,631.8
2024	1,173.9	51.2	1,225.0	1,396.3	2,460.6
2025	1,217.2	46.9	1,264.1	1,475.5	2,249.2
2026	1,270.6	43.6	1,314.2	1,560.4	2,003.0
2027	1,312.6	40.0	1,352.5	1,648.3	1,707.2
2028	1,353.7	34.1	1,387.8	1,738.3	1,356.7
2029	1,394.6	26.3	1,420.9	1,828.5	949.2
2030[b]	1,434.0	17.6	1,451.6	1,919.2	481.5

[a] Benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

[b] The combined OASI and DI Trust Funds become depleted in 2035 under the intermediate assumptions and in 2031 under the high-cost assumptions, so estimates for later years are not shown.

[c] The combined OASI and DI Trust Funds become depleted in 2069 under the low-cost assumptions, but combined asset reserves become positive again by the beginning of 2089 and remain positive through the remainder of the projection period. Estimates are not shown for years in which asset reserves are negative.

Note: Components may not sum to totals because of rounding.

Table VI.G9 presents values in CPI-indexed 2022 dollars—that is, adjusted by the CPI indexing series discussed at the beginning of this section. This table contains the annual non-interest income and cost of the combined OASI and DI Trust Funds, of the HI Trust Fund, and of the combined OASI, DI, and HI Trust Funds, based on the intermediate, low-cost, and high-cost sets of assumptions. For OASDI, non-interest income consists of payroll tax contributions, proceeds from taxation of scheduled OASDI benefits, and any

reimbursements from the General Fund of the Treasury. Cost consists of scheduled benefits, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries. For HI, non-interest income consists of payroll tax contributions (including contributions from railroad employment), up to an additional 0.9 percent tax on earned income for relatively high earners, proceeds from the taxation of scheduled OASDI benefits, premium revenues, monies from fraud and abuse control activities, and any reimbursements from the General Fund of the Treasury. Total cost consists of scheduled benefits and administrative expenses. The Trustees show income and cost estimates generally on a cash basis for the OASDI program[1] and on an incurred basis for the HI program. Table VI.G9 also shows the annual balance, which equals the difference between non-interest income and cost.

Table VI.G9.—OASDI and HI Annual Non-interest Income, Cost, and Balance in CPI-Indexed 2022 Dollars,[a] Calendar Years 2022-2100
[In billions]

	OASDI			HI			Combined		
Calendar year	Non-interest income	Cost[b]	Balance[b]	Non-interest income	Cost	Balance	Non-interest income	Cost[b]	Balance[b]
Intermediate:									
2022	$1,131	$1,243	-$111	$387	$391	-$4	$1,518	$1,633	-$116
2023	1,186	1,302	-116	399	408	-10	1,585	1,710	-125
2024	1,210	1,349	-139	409	427	-17	1,619	1,776	-157
2025	1,238	1,399	-161	420	447	-27	1,658	1,846	-188
2026	1,274	1,449	-176	436	467	-31	1,710	1,917	-207
2027	1,301	1,500	-199	447	487	-40	1,748	1,987	-239
2028	1,329	1,550	-221	457	506	-49	1,786	2,056	-270
2029	1,356	1,598	-242	468	525	-57	1,824	2,123	-299
2030	1,382	1,646	-264	479	540	-61	1,861	2,186	-325
2031	1,408	1,693	-285	490	556	-66	1,898	2,249	-351
2035	1,498	1,853	-355	530	644	-113	2,028	2,496	-468
2040	1,606	2,019	-413	579	723	-144	2,185	2,742	-557
2045	1,719	2,173	-454	630	790	-161	2,349	2,964	-615
2050	1,848	2,351	-503	688	850	-163	2,535	3,201	-666
2055	1,992	2,562	-570	754	912	-158	2,746	3,474	-728
2060	2,154	2,813	-659	829	984	-156	2,982	3,797	-815
2065	2,325	3,081	-755	909	1,068	-159	3,234	4,149	-915
2070	2,507	3,367	-860	995	1,162	-167	3,501	4,529	-1,028
2075	2,702	3,674	-972	1,087	1,260	-173	3,789	4,934	-1,146
2080	2,915	3,972	-1,058	1,186	1,359	-172	4,101	5,331	-1,230

[1] OASDI benefits paid for entitlement for a particular month are generally paid in the succeeding month. There are two primary exceptions to this general rule. First, payments can occur with a greater delay when a benefit award is made after the month of initial benefit entitlement. At the time of benefit award, benefits owed for months of prior entitlement are then also paid to the beneficiary. For the projections in this report, such retroactive payments are included in the period where they are paid (at time of award). Second, when benefit payments scheduled for January 3 are paid on the prior December 31, because January 3 falls on a Sunday, such payments are shown in this report for the period they were scheduled to be paid.

Table VI.G9.—OASDI and HI Annual Non-interest Income, Cost, and Balance in CPI-Indexed 2022 Dollars,[a] Calendar Years 2022-2100 (Cont.)
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[b]	Balance[b]	Non-interest income	Cost	Balance	Non-interest income	Cost[b]	Balance[b]
Intermediate (Cont.):									
2085	$3,151	$4,252	-$1,101	$1,294	$1,458	-$164	$4,445	$5,710	-$1,265
2090	3,413	4,532	-1,119	1,411	1,563	-152	4,824	6,095	-1,271
2095	3,702	4,878	-1,176	1,542	1,671	-129	5,244	6,548	-1,305
2100	4,011	5,308	-1,297	1,683	1,778	-95	5,694	7,086	-1,392
Low-cost:									
2022	1,138	1,241	-103	389	384	6	1,527	1,625	-98
2023	1,213	1,299	-86	407	392	15	1,620	1,691	-71
2024	1,247	1,342	-95	421	406	16	1,668	1,748	-80
2025	1,288	1,388	-99	434	420	15	1,723	1,807	-85
2026	1,339	1,433	-94	454	434	20	1,792	1,867	-74
2027	1,379	1,478	-98	468	447	21	1,847	1,924	-77
2028	1,421	1,523	-101	482	458	23	1,903	1,981	-78
2029	1,464	1,566	-103	496	469	27	1,960	2,036	-76
2030	1,505	1,609	-105	511	477	34	2,015	2,086	-71
2031	1,547	1,653	-105	525	485	40	2,073	2,138	-65
2035	1,690	1,807	-117	586	534	52	2,276	2,341	-65
2040	1,876	1,985	-108	664	564	100	2,541	2,549	-8
2045	2,087	2,164	-77	753	582	171	2,840	2,746	94
2050	2,338	2,389	-51	859	596	263	3,197	2,985	212
2055	2,631	2,674	-44	985	619	366	3,615	3,293	322
2060	2,966	3,024	-58	1,130	660	470	4,096	3,684	412
2065	3,337	3,408	-71	1,292	722	569	4,629	4,130	499
2070	3,752	3,830	-78	1,472	810	662	5,223	4,639	584
2075	4,222	4,296	-74	1,675	918	757	5,898	5,214	683
2080	4,764	4,771	-7	1,907	1,036	871	6,672	5,807	864
2085	5,394	5,247	147	2,174	1,166	1,008	7,567	6,412	1,155
2090	6,116	5,780	336	2,480	1,308	1,171	8,595	7,088	1,507
2095	6,933	6,507	426	2,832	1,461	1,371	9,764	7,968	1,796
2100	7,839	7,443	396	3,227	1,413	1,815	11,067	8,856	2,211
High-cost:									
2022	1,105	1,245	-140	374	396	-23	1,478	1,641	-163
2023	1,117	1,316	-199	375	417	-42	1,492	1,733	-241
2024	1,145	1,361	-217	387	442	-55	1,531	1,804	-272
2025	1,166	1,413	-247	397	472	-75	1,563	1,886	-323
2026	1,196	1,468	-273	413	503	-90	1,609	1,971	-362
2027	1,213	1,524	-310	422	532	-110	1,635	2,056	-420
2028	1,229	1,578	-349	430	560	-130	1,659	2,138	-479
2029	1,244	1,631	-387	437	587	-150	1,681	2,218	-537
2030	1,256	1,681	-425	445	612	-167	1,701	2,293	-592
2031	1,269	1,732	-463	453	637	-184	1,722	2,369	-647

Table VI.G9.—OASDI and HI Annual Non-interest Income, Cost, and Balance in CPI-Indexed 2022 Dollars,[a] Calendar Years 2022-2100 (Cont.)
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[b]	Balance[b]	Non-interest income	Cost	Balance	Non-interest income	Cost[b]	Balance[b]
High-cost (Cont.):									
2035	$1,315	$1,893	-$579	$478	$773	-$295	$1,792	$2,666	-$874
2040	1,363	2,050	-687	505	924	-420	1,868	2,975	-1,107
2045	1,404	2,185	-781	528	1,071	-543	1,932	3,256	-1,324
2050	1,444	2,323	-879	551	1,213	-662	1,995	3,536	-1,541
2055	1,486	2,470	-984	575	1,334	-759	2,062	3,805	-1,743
2060	1,533	2,632	-1,098	603	1,448	-846	2,136	4,080	-1,944
2065	1,579	2,795	-1,215	630	1,548	-918	2,210	4,343	-2,133
2070	1,623	2,964	-1,341	657	1,622	-965	2,280	4,586	-2,306
2075	1,664	3,136	-1,472	684	1,668	-985	2,348	4,805	-2,457
2080	1,703	3,290	-1,587	709	1,701	-992	2,412	4,991	-2,579
2085	1,743	3,412	-1,669	733	1,723	-990	2,476	5,135	-2,659
2090	1,785	3,500	-1,715	758	1,744	-986	2,543	5,244	-2,701
2095	1,832	3,580	-1,748	784	1,764	-980	2,615	5,343	-2,728
2100	1,881	3,674	-1,794	814	2,057	-1,243	2,695	5,732	-3,037

[a] CPI-indexed 2022 dollars equal current dollars adjusted by the CPI indexing series in table VI.G6.
[b] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

Table VI.G10 shows values in current, or nominal, dollars—that is, in dollars unadjusted for inflation. This table presents the annual non-interest income, cost, and balance of the combined OASI and DI Trust Funds, of the HI Trust Fund, and of the combined OASI, DI, and HI Trust Funds, based on the intermediate, low-cost, and high-cost sets of assumptions.

Table VI.G10.—OASDI and HI Annual Non-interest Income, Cost, and Balance in Current Dollars, Calendar Years 2022-2100
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[a]	Balance[a]	Non-interest income	Cost	Balance	Non-interest income	Cost[a]	Balance[a]
Intermediate:									
2022	$1,131	$1,243	-$111	$387	$391	-$4	$1,518	$1,633	-$116
2023	1,214	1,332	-118	408	418	-10	1,622	1,750	-128
2024	1,268	1,414	-146	429	447	-18	1,697	1,861	-164
2025	1,328	1,501	-173	450	479	-29	1,779	1,981	-202
2026	1,399	1,592	-193	479	513	-34	1,878	2,106	-227
2027	1,464	1,687	-224	503	548	-45	1,966	2,235	-269
2028	1,531	1,786	-255	527	583	-56	2,058	2,369	-311
2029	1,600	1,886	-286	552	619	-67	2,152	2,505	-353
2030	1,669	1,988	-319	578	652	-74	2,248	2,641	-393
2031	1,742	2,095	-352	606	688	-82	2,348	2,782	-434
2035	2,037	2,520	-483	721	875	-154	2,758	3,395	-637
2040	2,460	3,092	-633	887	1,107	-220	3,347	4,200	-853
2045	2,965	3,747	-783	1,086	1,363	-277	4,051	5,110	-1,060
2050	3,587	4,564	-977	1,335	1,651	-316	4,921	6,215	-1,293
2055	4,355	5,600	-1,245	1,647	1,993	-346	6,002	7,593	-1,591
2060	5,300	6,923	-1,623	2,039	2,422	-383	7,339	9,344	-2,006
2065	6,443	8,536	-2,093	2,519	2,960	-441	8,961	11,495	-2,534
2070	7,819	10,503	-2,683	3,103	3,626	-522	10,923	14,128	-3,206
2075	9,489	12,905	-3,415	3,818	4,426	-608	13,307	17,331	-4,024
2080	11,527	15,709	-4,182	4,691	5,372	-681	16,218	21,081	-4,864
2085	14,029	18,931	-4,902	5,760	6,492	-732	19,789	25,423	-5,633
2090	17,108	22,720	-5,611	7,075	7,835	-760	24,183	30,554	-6,371
2095	20,893	27,531	-6,638	8,702	9,429	-727	29,595	36,960	-7,365
2100	25,486	33,730	-8,244	10,696	11,297	-601	36,183	45,027	-8,845
Low-cost:									
2022	1,138	1,241	-103	389	384	6	1,527	1,625	-98
2023	1,250	1,338	-88	419	404	15	1,669	1,742	-73
2024	1,323	1,424	-101	447	430	16	1,770	1,854	-85
2025	1,408	1,516	-108	475	459	16	1,883	1,975	-93
2026	1,507	1,613	-106	511	488	22	2,017	2,101	-84
2027	1,599	1,713	-114	542	518	25	2,141	2,231	-89
2028	1,697	1,818	-121	575	547	28	2,272	2,365	-93
2029	1,800	1,926	-126	610	577	33	2,410	2,504	-93
2030	1,906	2,039	-132	647	604	42	2,553	2,643	-90
2031	2,019	2,157	-138	686	633	53	2,705	2,790	-85
2035	2,483	2,654	-171	860	784	76	3,343	3,438	-95
2040	3,194	3,379	-184	1,131	961	170	4,325	4,339	-14
2045	4,119	4,271	-152	1,486	1,149	337	5,605	5,420	185
2050	5,349	5,466	-118	1,966	1,363	603	7,314	6,829	485
2055	6,978	7,093	-116	2,612	1,641	971	9,590	8,735	855
2060	9,119	9,299	-180	3,475	2,028	1,446	12,594	11,327	1,266
2065	11,897	12,148	-252	4,604	2,574	2,030	16,501	14,723	1,778
2070	15,503	15,825	-322	6,081	3,346	2,735	21,584	19,171	2,413
2075	20,227	20,582	-355	8,026	4,397	3,628	28,253	24,979	3,274
2080	26,460	26,497	-37	10,592	5,754	4,838	37,052	32,251	4,801
2085	34,725	33,778	946	13,995	7,505	6,490	48,720	41,283	7,437
2090	45,643	43,136	2,507	18,507	9,764	8,743	64,150	52,901	11,249
2095	59,984	56,302	3,682	24,499	12,639	11,860	84,483	68,941	15,542
2100	78,628	74,659	3,970	32,372	14,170	18,203	111,001	88,828	22,172

Table VI.G10.—OASDI and HI Annual Non-interest Income, Cost, and Balance in Current Dollars, Calendar Years 2022-2100 (Cont.)
[In billions]

Calendar year	OASDI			HI			Combined		
	Non-interest income	Cost[a]	Balance[a]	Non-interest income	Cost	Balance	Non-interest income	Cost[a]	Balance[a]
High-cost:									
2022	$1,105	$1,245	-$140	$374	$396	-$23	$1,478	$1,641	-$163
2023	1,128	1,329	-201	379	421	-42	1,507	1,750	-243
2024	1,174	1,396	-222	397	454	-57	1,571	1,850	-279
2025	1,217	1,476	-258	415	493	-78	1,632	1,969	-337
2026	1,271	1,560	-290	439	535	-95	1,710	2,095	-385
2027	1,313	1,648	-336	457	576	-119	1,769	2,224	-455
2028	1,354	1,738	-385	473	617	-143	1,827	2,355	-528
2029	1,395	1,828	-434	490	659	-168	1,885	2,487	-602
2030	1,434	1,919	-485	508	698	-190	1,942	2,617	-675
2031	1,475	2,013	-538	526	740	-214	2,001	2,753	-752
2035	1,640	2,363	-722	596	964	-368	2,236	3,327	-1,090
2040	1,860	2,797	-937	688	1,261	-572	2,548	4,058	-1,510
2045	2,094	3,259	-1,165	787	1,598	-811	2,881	4,856	-1,975
2050	2,354	3,788	-1,434	898	1,978	-1,080	3,253	5,766	-2,513
2055	2,650	4,404	-1,754	1,026	2,379	-1,353	3,676	6,783	-3,107
2060	2,989	5,129	-2,141	1,175	2,823	-1,648	4,164	7,953	-3,789
2065	3,366	5,956	-2,589	1,343	3,299	-1,956	4,709	9,255	-4,546
2070	3,782	6,906	-3,124	1,531	3,780	-2,249	5,313	10,686	-5,373
2075	4,239	7,989	-3,750	1,741	4,250	-2,509	5,980	12,239	-6,259
2080	4,743	9,162	-4,419	1,974	4,737	-2,763	6,717	13,899	-7,182
2085	5,306	10,388	-5,082	2,233	5,247	-3,014	7,539	15,635	-8,096
2090	5,943	11,652	-5,709	2,523	5,806	-3,283	8,466	17,458	-8,992
2095	6,667	13,028	-6,361	2,852	6,418	-3,567	9,519	19,446	-9,927
2100	7,483	14,620	-7,137	3,239	8,186	-4,947	10,722	22,806	-12,084

[a] OASDI benefit payments which were scheduled to be paid on January 3 for some past and future years were actually paid on December 31 as required by the statutory provision for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. For comparability with the values for historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment each year.

Note: Components may not sum to totals because of rounding.

H. ANALYSIS OF BENEFIT PAYMENTS FROM THE OASI TRUST FUND WITH RESPECT TO DISABLED BENEFICIARIES

(Required by section 201(c) of the Social Security Act)

Effective January 1957, the OASI Trust Fund pays monthly benefits to disabled children aged 18 and over of retired and deceased workers if the disability began before age 18. The age by which disability must have begun was later changed to age 22. Effective February 1968, the OASI Trust Fund pays reduced monthly benefits to disabled widows and widowers at ages 50 and over. Effective January 1991, the requirements for the disability of the widow or widower were made less restrictive.

At the end of 2021, the OASI Trust Fund was providing monthly benefit payments to about 1,136,000 people because of their disabilities or the disabilities of children. This total includes approximately 22,000 mothers and fathers (wives or husbands under normal retirement age of retired-worker beneficiaries and widows or widowers of deceased insured workers) who met all other qualifying requirements and were receiving unreduced benefits solely because they had disabled-child beneficiaries (or disabled children aged 16 or 17) in their care. In calendar year 2021, the OASI Trust Fund paid a total of $12,453 million to the people described above. Table VI.H1 shows OASI scheduled benefits for disability for selected calendar years during 1960 through 2021 and estimates for 2022 through 2031 based on the intermediate set of assumptions.

Table VI.H1.—Scheduled Benefit Payments From the OASI Trust Fund With Respect to Disabled Beneficiaries

[Beneficiaries in thousands; scheduled benefits in millions]

Calendar year	Disabled beneficiaries, end of year			Amount of scheduled benefits[a] [b]		
	Total	Children[c]	Widows-widowers[d]	Total	Children[c]	Widows-widowers[e]
Historical data:						
1960	117	117	—	$59	$59	—
1965	214	214	—	134	134	—
1970	316	281	36	301	260	$41
1975	435	376	58	664	560	104
1980	519	460	59	1,223	1,097	126
1985	594	547	47	2,072	1,885	187
1990	662	613	49	2,882	2,649	233
1995	772	681	91	4,202	3,672	531
2000	811	707	104	5,203	4,523	680
2005	836	728	108	6,449	5,556	834
2010	996	879	117	8,671	7,662	1,008
2011	1,020	899	121	8,937	7,885	1,050
2012	1,045	920	125	9,513	8,410	1,102
2013	1,065	939	126	9,815	8,703	1,109
2014	1,079	954	125	10,242	9,133	1,108
2015	1,096	972	124	10,640	9,528	1,109
2016	1,109	988	121	10,909	9,818	1,087
2017	1,124	1,006	117	11,222	10,156	1,061
2018	1,139	1,027	112	11,767	10,729	1,031
2019	1,144	1,041	103	12,148	11,152	983
2020	1,147	1,051	95	12,351	11,403	934
2021	1,136	1,050	86	12,453	11,578	861
Estimates under the intermediate assumptions:						
2022	1,144	1,064	80	13,307	12,447	847
2023	1,156	1,080	76	14,036	13,198	829
2024	1,170	1,097	73	14,674	13,842	822
2025	1,188	1,116	72	15,383	14,546	827
2026	1,206	1,135	72	16,150	15,288	852
2027	1,225	1,153	72	16,964	16,071	883
2028	1,245	1,171	74	17,813	16,874	928
2029	1,262	1,188	74	18,690	17,709	971
2030	1,278	1,205	73	19,572	18,571	989
2031	1,295	1,222	73	20,491	19,460	1,020

[a] Beginning in 1966, includes payments for vocational rehabilitation services.

[b] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[c] Also includes certain mothers and fathers (see text).

[d] In 1984 and later years, includes only disabled widows and widowers aged 50-59, because disabled widows and widowers age 60 and older are eligible for the same benefit as a nondisabled aged widow or widower. Therefore, they are not receiving benefits solely because of a disability.

[e] In 1983 and prior years, includes the offsetting effect of lower benefits payable to disabled widows and widowers who continued to receive benefits after attaining age 60 (62, for disabled widowers prior to 1973), compared to the higher nondisabled widow's and widower's benefits that would otherwise be payable. In 1984 and later years, includes only scheduled benefits to disabled widows and widowers aged 50-59 (see footnote d).

Note: Components may not sum to totals because of rounding.

Under the intermediate assumptions, estimated total scheduled benefits paid from the OASI Trust Fund with respect to disabled beneficiaries will increase from $13,307 million in calendar year 2022 to $20,491 million in calendar year 2031.

In calendar year 2021, benefit payments (including payments for vocational rehabilitation services) with respect to disabled persons from the OASI Trust Fund and from the DI Trust Fund (including payments from the DI fund to all children and spouses of disabled-worker beneficiaries) totaled $152,538 million. Of this amount, $12,453 million, or 8.2 percent, represented payments from the OASI Trust Fund. Table VI.H2 contains these and similar figures for selected calendar years during 1960 through 2021 and estimates for calendar years 2022 through 2031.

Table VI.H2.—Scheduled Benefit Payments[a] Under the OASDI Program With Respect to Disabled Beneficiaries
[Amounts in millions]

Calendar year	Total[b]	DI Trust Fund[c]	OASI Trust Fund	
			Amount[d]	Percentage of total
Historical data:				
1960	$627	$568	$59	9.4
1965	1,707	1,573	134	7.9
1970	3,386	3,085	301	8.9
1975	9,169	8,505	664	7.2
1980	16,738	15,515	1,223	7.3
1985	20,908	18,836	2,072	9.9
1990	27,717	24,835	2,882	10.4
1995	45,140	40,937	4,202	9.3
2000	60,204	55,001	5,203	8.6
2005	91,835	85,386	6,449	7.0
2010	132,916	124,245	8,671	6.5
2011	137,916	128,979	8,937	6.5
2012	146,438	136,925	9,513	6.5
2013	149,970	140,155	9,815	6.5
2014	151,947	141,705	10,242	6.7
2015	154,028	143,388	10,640	6.9
2016	153,709	142,800	10,909	7.1
2017	154,048	142,826	11,222	7.3
2018	155,526	143,760	11,767	7.6
2019	157,289	145,141	12,148	7.7
2020	155,933	143,582	12,351	7.9
2021	152,538	140,085	12,453	8.2
Estimates under the intermediate assumptions:				
2022	156,760	143,452	13,307	8.5
2023	163,693	149,657	14,036	8.6
2024	170,548	155,875	14,674	8.6
2025	180,524	165,141	15,383	8.5
2026	190,260	174,111	16,150	8.5
2027	200,609	183,645	16,964	8.5
2028	208,398	190,585	17,813	8.5
2029	215,136	196,445	18,690	8.7
2030	221,564	201,993	19,572	8.8
2031	229,589	209,098	20,491	8.9

[a] Amounts for 2020 and 2021 are adjusted to include in 2021 operations those benefit payments regularly scheduled in the law to be paid on January 3, 2021, which were actually paid on December 31, 2020 as required by the statutory provision for early benefit payments when the normal delivery date is on a weekend or holiday. Such shifts in payments across calendar years have occurred in the past, including in 2016, and will occur periodically in the future whenever January 3rd falls on a Sunday. In order to provide a consistent perspective on trust fund operations over time, all trust fund operations in each year reflect the 12 months of benefits that are regularly scheduled for payment in that year.

[b] Beginning in 1966, includes payments for vocational rehabilitation services.

[c] Scheduled benefits for disabled workers and their children and spouses.

[d] Scheduled benefits for disabled children aged 18 and over, for certain mothers and fathers (see text), and for disabled widows and widowers (see footnote e, table VI.H1).

Note: Components may not sum to totals because of rounding.

I. GLOSSARY

Actuarial balance. The difference between the summarized income rate and the summarized cost rate as a percentage of taxable payroll over a given valuation period.

Actuarial deficit. A negative actuarial balance.

Administrative expenses. Expenses incurred by the Social Security Administration and the Department of the Treasury in administering the OASDI program and the provisions of the Internal Revenue Code relating to the collection of contributions. Such administrative expenses are paid from the OASI and DI Trust Funds.

Advance tax transfers. Amounts representing the estimated total OASDI tax contributions for a given month. From May 1983 through November 1990, such amounts were credited to the OASI and DI Trust Funds at the beginning of each month. The trust funds reimbursed the General Fund of the Treasury for the associated loss of interest. Advance tax transfers are no longer made unless needed in order to pay benefits.

Alternatives I, II, or III. See "Assumptions."

Annual balance. The difference between the income rate and the cost rate for a given year.

Asset reserves. See "Trust fund reserves".

Assumptions. Values related to future trends in key factors that affect the trust funds. Demographic assumptions include fertility, mortality, net immigration, marriage, and divorce. Economic assumptions include unemployment rates, average earnings, inflation, interest rates, and productivity. Program-specific assumptions include retirement patterns, and disability incidence and termination rates. This report presents three sets of demographic, economic, and program-specific assumptions:

- Alternative II is the intermediate set of assumptions, and represents the Trustees' best estimates of likely future demographic, economic, and program-specific conditions.
- Alternative I is a low-cost set of assumptions—it assumes relatively rapid economic growth, high inflation, and favorable (from the standpoint of program financing) demographic and program-specific conditions.
- Alternative III is a high-cost set of assumptions—it assumes relatively slow economic growth, low inflation, and unfavorable (from the standpoint of program financing) demographic and program-specific conditions.

See tables V.A2, V.B1, and V.B2.

Automatic cost-of-living benefit increase. The annual increase in benefits, effective for December, reflecting the increase, if any, in the cost of living. A

benefit increase is applicable only after a beneficiary becomes eligible for benefits. In general, the benefit increase equals the percentage increase in the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W) measured from the third quarter of the previous year to the third quarter of the current year. If there is no increase in the CPI-W, there is no cost-of-living benefit increase. See table V.C1.

Auxiliary benefits. Monthly benefits payable to a spouse or child of a retired or disabled worker, or to a survivor of a deceased worker.

Average indexed monthly earnings—AIME. The measure of lifetime earnings used in determining the primary insurance amount (PIA) for most workers who attain age 62, become disabled, or die after 1978. A worker's actual past earnings are adjusted by changes in the average wage index, in order to bring them up to their approximately equivalent value at the time of retirement or other eligibility for benefits.

Average wage index—AWI. A series that generally increases with the average amount of total wages for each year after 1950, including wages in noncovered employment and wages in covered employment in excess of the OASDI contribution and benefit base. (See Title 20, Chapter III, section 404.211(c) of the Code of Federal Regulations for a more precise definition.) These average wage amounts are used to index the taxable earnings of most workers first becoming eligible for benefits in 1979 or later, and for automatic adjustments in the contribution and benefit base, bend points, earnings test exempt amounts, and other wage-indexed amounts. See tables V.C1 and VI.G6.

Award. An administrative determination that an individual is entitled to receive a specified type of OASDI benefit. Awards can represent not only new entrants to the benefit rolls but also persons already on the rolls who become entitled to a different type of benefit. Awards usually result in the immediate payment of benefits, although payments may be deferred or withheld depending on the individual's particular circumstances.

Baby boom. The period from the end of World War II (1946) through 1965 marked by unusually high birth rates.

Bend points. The dollar amounts defining the AIME or PIA brackets in the benefit formulas. For the bend points for years 1979 and later, see table V.C2.

Beneficiary. A person who has been awarded benefits on the basis of his or her own or another's earnings record. The benefits may be either in current-payment status or withheld.

Benefit award. See "Award."

Benefit conversion. See "Disability conversion."

Benefit payments. The amounts disbursed for OASI and DI benefits by the Department of the Treasury.

Benefit termination. See "Termination."

Best estimate assumptions. See "Assumptions."

Board. See "Board of Trustees."

Board of Trustees. A Board established by the Social Security Act to oversee the financial operations of the Federal Old-Age and Survivors Insurance Trust Fund and the Federal Disability Insurance Trust Fund. The Board is composed of six members. Four members serve by virtue of their positions in the Federal Government: the Secretary of the Treasury, who is the Managing Trustee; the Secretary of Labor; the Secretary of Health and Human Services; and the Commissioner of Social Security. The President appoints and the Senate confirms the other two members to serve as public representatives. Also referred to as the "Board" or the "Trustees."

Cash flow. Actual or projected revenue and costs reflecting the levels of payroll tax contribution rates and benefits scheduled in the law. Net cash flow is the difference between non-interest income and cost.

Consumer Price Index—CPI. An official measure of inflation in consumer prices. In this report, CPI refers to the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W). The Bureau of Labor Statistics, Department of Labor, publishes historical values for the CPI-W.

Contribution and benefit base. Annual dollar amount above which earnings in employment covered under the OASDI program are neither taxable nor creditable for benefit-computation purposes. (Also referred to as maximum contribution and benefit base, annual creditable maximum, taxable maximum, and maximum taxable.) See tables V.C1 and V.C6. See "Hospital Insurance (HI) contribution base."

Contributions. See "Payroll tax contributions."

Conversion. See "Disability conversion."

Cost. The cost shown for a year includes benefits scheduled for payment in the year, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries.

Cost-of-living adjustment. See "Automatic cost-of-living benefit increase."

Cost rate. The cost rate for a year is the ratio of the cost of the program to the taxable payroll for the year.

Covered earnings. Wages or earnings from self-employment covered by the OASDI program.

Covered employment. All employment for which earnings are creditable for Social Security purposes. The program covers almost all employment. Some exceptions are:

- State and local government employees whose employer has not elected to be covered under Social Security and who are participating in an employer-provided pension plan.
- Current Federal civilian workers hired before 1984 who have not elected to be covered.
- Self-employed workers earning less than $400 in a calendar year.

Covered worker. A person who has earnings creditable for Social Security purposes based on services for wages in covered employment or income from covered self-employment.

CPI-indexed dollars. Amounts adjusted by the CPI to the value of the dollar in a particular year.

Creditable earnings. Wages or self-employment earnings posted to a worker's earnings record. Such earnings determine eligibility for benefits and the amount of benefits on that worker's record. The contribution and benefit base is the maximum amount of creditable earnings for each worker in a calendar year.

Current-cost financing. See "Pay-as-you-go financing."

Current dollars. Amounts expressed in nominal dollars with no adjustment for inflation.

Currently insured status. A worker is currently insured when he or she has accumulated six quarters of coverage during the 13-quarter period ending with the current quarter.

Current-payment status. Status of a beneficiary to whom a benefit is being paid for a given month (with or without deductions, provided the deductions add to less than a full month's benefit).

Deemed filing. Under certain circumstances, a person applying for or receiving either an aged-spouse benefit or a retired-worker benefit is required to also file for the other of these two types of benefits. For those first eligible for benefits before 2016, this requirement applies to any person under normal retirement age who is eligible for the other benefit as of the starting month for the first benefit. For those first eligible for benefits in 2016 and later, this requirement applies whenever the person is eligible for the other benefit. This can occur at any age, and in months after the starting month of the first benefit.

Deemed wage credit. See "Military service wage credits."

Delayed retirement credits. Increases in the benefit amount for certain individuals who did not receive benefits for months after attaining normal retirement age but before age 70. Delayed retirement credits apply to benefits for

January of the year following the year they are earned or for the month of attainment of age 70, whichever comes first. See table V.C3.

Demographic assumptions. See "Assumptions."

Disability. For Social Security purposes, the inability to engage in any substantial gainful activity (see "Substantial gainful activity—SGA") by reason of any medically determinable physical or mental impairment that can be expected to result in death or to last for a continuous period of not less than 12 months. Special rules apply for workers at ages 55 and over whose disability is based on blindness.

The law generally requires that a person be disabled continuously for 5 months before he or she can qualify for a disabled-worker benefit.

Disability conversion ratio. For a given year, the ratio of the number of disability conversions to the average number of disabled-worker beneficiaries at all ages during the year.

Disability conversion. Upon attainment of normal retirement age, a disabled-worker beneficiary is automatically converted to retired-worker status.

Disability incidence rate. The proportion of workers in a given year, insured for but not receiving disability benefits, who apply for and are awarded disability benefits.

Disability Insurance (DI) Trust Fund. See "Trust fund."

Disability insured status. A worker is disability insured if he or she is: (1) a fully insured worker who has accumulated 20 quarters of coverage during the 40-quarter period ending with the current quarter, (2) a fully insured worker aged 24-30 who has accumulated quarters of coverage during one-half of the quarters elapsed after the quarter of attainment of age 21 and up to and including the current quarter, or (3) a fully insured worker under age 24 who has accumulated six quarters of coverage during the 12-quarter period ending with the current quarter.

Disability prevalence rate. The proportion of persons insured for disability benefits who are disabled-worker beneficiaries in current-payment status.

Disability termination rate. The proportion of disabled-worker beneficiaries in a given year whose disability benefits terminate as a result of their recovery or death.

Disabled-worker benefit. A monthly benefit payable to a disabled worker under normal retirement age and insured for disability. Before November 1960, disability benefits were limited to disabled workers aged 50-64.

Dual entitlement. A person may be entitled to more than one benefit at the same time. For example, a person may be entitled as a retired worker on his or her own record and as a spouse on another record. However, a person's benefit amount can never exceed the highest single benefit to which that per-

son is entitled. Some benefits are calculated independently with the larger benefit being paid or the smaller benefit being paid plus the excess amount of the larger one.

Earnings. Unless otherwise qualified, all wages from employment and net earnings from self-employment, whether or not they are taxable or covered.

Earnings test. The provision requiring the withholding of benefits if beneficiaries under normal retirement age have earnings in excess of certain exempt amounts. See table V.C1.

Economic assumptions. See "Assumptions."

Effective interest rate. See "Interest rate."

Excess wages. Wages in excess of the contribution and benefit base on which a worker initially makes payroll tax contributions, usually as a result of working for more than one employer during a year. Employee payroll taxes on excess wages are refundable to affected employees, while the employer taxes are not refundable.

Expenditures. Actual payments made or expected to be made under current law, including benefits paid or payable, administrative expenses, financial interchange with the Railroad Retirement program, and payments for vocational rehabilitation services for disabled beneficiaries.

Exposed population. For any event (such as being awarded a benefit, or dying), the group that is exposed to the possibility of experiencing the event. For example, the exposed population for disabled worker awards (incidence) is the disability insured population less those already receiving benefits.

Federal Insurance Contributions Act—FICA. Provision authorizing payroll taxes on the wages of employed persons to provide for Old-Age, Survivors, and Disability Insurance, and for Hospital Insurance. Workers and their employers generally pay the tax in equal amounts.

Financial interchange. Provisions of the Railroad Retirement Act providing for transfers between the trust funds and the Social Security Equivalent Benefit Account of the Railroad Retirement program in order to place each trust fund in the same financial position it would have been had railroad employment always been covered under Social Security.

Fiscal year. The accounting year of the United States Government. Starting in 1976, a fiscal year is the 12-month period ending September 30. For example, fiscal year 2022 began October 1, 2021, and will end September 30, 2022.

Full advance funding. A financing method in which contributions are established to match the full cost of future benefits as these costs are incurred through current service. Such financing methods also provide for amortization over a fixed period of any financial obligation that is incurred at the

beginning of the program (or subsequent modification) as a result of granting credit for past service.

Fully insured status. A worker is fully insured when his or her total number of quarters of coverage is greater than or equal to the number of years elapsed after the year of attainment of age 21 (but not less than six). Once a worker has accumulated 40 quarters of coverage, he or she remains permanently fully insured.

General Fund of the Treasury. Funds held by the Treasury of the United States, other than income collected for a specific purpose (such as Social Security), and maintained in a separate account for that purpose.

General Fund reimbursements. Payments from the General Fund of the Treasury to the trust funds for specific purposes defined in the law, including:

- The cost of noncontributory wage credits for military service before 1957, and periodic adjustments of previous determinations.
- The cost in 1971-82 of deemed wage credits for military service performed after 1956.
- The cost of benefits to certain uninsured persons who attained age 72 before 1968.
- The cost of payroll tax credits provided to employees in 1984 and self-employed persons in 1984-89 by Public Law 98-21.
- The cost in 2009-17 of excluding certain self-employment earnings from SECA taxes under Public Law 110-246.
- Payroll tax revenue forgone under the provisions of Public Laws 111-147, 111-312, 112-78, and 112-96.

The General Fund also reimburses the trust funds for various other items, including interest on checks which are not negotiated 6 months after the month of issue and costs incurred in performing certain legislatively mandated activities not directly related to administering the OASI and DI programs.

Gross domestic product—GDP. The total dollar value of all goods and services produced by labor and property located in the United States, regardless of who supplies the labor or property.

Hospital Insurance (HI) contribution base. Annual dollar amount above which earnings in employment covered under the HI program are not taxable. (Also referred to as maximum contribution base, taxable maximum, and maximum taxable.) Beginning in 1994, the HI contribution base was eliminated.

High-cost assumptions. See "Assumptions."

Hospital Insurance (HI) Trust Fund. See "Trust fund."

Immigration. See "Lawful permanent resident (LPR) immigration" and "Other-than-LPR immigration."

Income. Income for a given year is the sum of tax revenue on a cash basis (payroll tax contributions and income from the taxation of scheduled benefits), reimbursements from the General Fund of the Treasury, if any, and interest credited to the trust funds.

Income rate. Ratio of non-interest income to the OASDI taxable payroll for the year.

Infinite horizon. The period extending indefinitely into the future.

Inflation. An increase in the general price level of goods and services.

Insured status. The state or condition of having sufficient quarters of coverage to meet the eligibility requirements for retired-worker or disabled-worker benefits, or to permit the worker's spouse and children or survivors to establish eligibility for benefits in the event of his or her disability, retirement, or death. See "Quarter of coverage."

Interest. A payment in exchange for the use of money during a specified period.

Interest rate. Interest rates on new public-debt obligations issuable to Federal trust funds (see "Special public-debt obligation") are determined monthly. Such rates are equal to the average market yield on all outstanding marketable U.S. securities not due or callable until after 4 years from the date the rate is determined. See table V.B2 for historical and assumed future interest rates on new special-issue securities. The effective interest rate for a trust fund is the ratio of the interest earned by the fund over a given period of time to the average level of asset reserves held by the fund during the period. The effective rate of interest thus represents a measure of the overall average interest earnings on the fund's portfolio of investments. See table VI.G6 for projected compound new-issue interest factors and compound effective trust-fund interest factors.

Interfund borrowing. The borrowing of asset reserves by a trust fund (OASI, DI, or HI) from another trust fund when the first fund is in danger of depletion. The Social Security Act permitted interfund borrowing only during 1982 through 1987, and required all amounts borrowed to be repaid prior to the end of 1989. The only exercise of this authority occurred in 1982, when the OASI Trust Fund borrowed from the DI and HI Trust Funds. The final repayment of borrowed amounts occurred in 1986.

Intermediate assumptions. See "Assumptions."

Lawful permanent resident (LPR) immigration. Persons who enter the Social Security area population and are granted LPR status, or who are already in the Social Security area population and adjust their status to become LPRs. Persons who enter the country with legal visas but without LPR status, such as temporary foreign workers and students, are not included in the "LPR immigration" category.

Legal emigration. Lawful permanent residents and citizens who leave the Social Security area population.

Life expectancy. Average remaining number of years expected prior to death. Period life expectancy is calculated for a given year using the actual or expected death rates at each age for that year. Cohort life expectancy, sometimes referred to as generational life expectancy, is calculated for individuals at a specific age in a given year using actual or expected death rates from the years in which the individuals would actually reach each succeeding age if they survive.

Long-range. The first 75 projection years. The Trustees make long-range actuarial estimates for this period because it covers approximately the maximum remaining lifetime for virtually all current Social Security participants.

Low-cost assumptions. See "Assumptions."

Lump-sum death payment. A lump sum, generally $255, payable on the death of a fully or currently insured worker. The lump sum is payable to the surviving spouse of the worker, under most circumstances, or to the worker's children.

Maximum family benefit. The maximum monthly amount that can be paid on a worker's earnings record. Whenever the total of the individual monthly benefits payable to all the beneficiaries entitled on one earnings record exceeds the maximum, each dependent's or survivor's benefit is proportionately reduced. Benefits payable to divorced spouses or surviving divorced spouses are not reduced under the family maximum provision.

Medicare. A nationwide, Federally administered health insurance program authorized in 1965 under Title XVIII of the Social Security Act to cover the cost of hospitalization, medical care, and some related services for most persons age 65 and over. In 1972, lawmakers extended coverage to persons receiving Social Security Disability Insurance payments for 2 years and persons with End-Stage Renal Disease. (For beneficiaries whose primary or secondary diagnosis is Amyotrophic Lateral Sclerosis, the 2-year waiting period is waived.) In 2010, persons exposed to environmental health hazards within areas under a corresponding emergency declaration became Medicare-eligible. In 2006, prescription drug coverage was added as well. Medicare consists of two separate but coordinated trust funds—Hospital Insurance (HI, Part A) and Supplementary Medical Insurance (SMI). The SMI Trust Fund is composed of two separate accounts—the Part B account and the Part D account. Almost all persons who are aged 65 and over or disabled and who are entitled to HI are eligible to enroll in Part B and Part D on a voluntary basis by paying monthly premiums.

Military service wage credits. Credits toward OASDI earnings records for benefit computation purposes, recognizing that military personnel receive non-wage compensation (such as food and shelter) in addition to their basic

pay and other cash payments. Military personnel do not pay payroll taxes on these credits. Noncontributory wage credits of $160 were provided for each month of active military service from September 16, 1940, through December 31, 1956. For years after 1956, the basic pay of military personnel is covered under the Social Security program on a contributory basis. In addition to the contributory credits for basic pay, noncontributory wage credits of $300 were granted for each calendar quarter, from January 1957 through December 1977, in which a person received pay for military service. Noncontributory wage credits of $100 were granted for each $300 of military wages, up to a maximum credit of $1,200 per calendar year, from January 1978 through December 2001.

National average wage index—AWI. See "Average wage index—AWI."

Non-interest income. Non-interest income for a given year is the sum of tax revenue on a cash basis (payroll tax contributions and income from the taxation of scheduled benefits) and reimbursements from the General Fund of the Treasury, if any.

Nonresident alien beneficiary. An OASDI beneficiary who is not a U.S. citizen and who is living abroad while receiving benefits.

Normal retirement age—NRA. The age at which a person may first become entitled to retirement benefits without reduction based on age. For persons reaching age 62 before 2000, the normal retirement age is 65. It increases gradually to 67 for persons reaching age 62 in 2022 or later, beginning with an increase to 65 years and 2 months for persons reaching age 62 in 2000. See table V.C3.

Old-Age and Survivors Insurance (OASI) Trust Fund. See "Trust fund."

Old-law base. Amount the contribution and benefit base would have been if the 1977 amendments had not provided for ad hoc increases. The Social Security Amendments of 1972 provided for automatic annual indexing of the contribution and benefit base. The Social Security Amendments of 1977 specified ad hoc bases for 1978-81, with subsequent bases updated in accordance with the normal indexing procedure. See table V.C2.

Open-group unfunded obligation. See "Unfunded obligation."

Other-than-LPR emigration. Other-than-LPR immigrants who leave the Social Security area population or who adjust their status to become LPRs.

Other-than-LPR immigration. Persons who enter the Social Security area population and stay to the end of the year without being granted LPR status, such as undocumented immigrants, and foreign workers and students entering with temporary visas.

Par value. The value printed on the face of a bond. For both public and special issues held by the trust funds, par value is also the redemption value at maturity.

Partial advance funding. A financing method in which contributions are established to provide a substantial accumulation of trust fund asset reserves, thereby generating additional interest income to the trust funds and reducing the need for payroll tax increases in periods when costs are relatively high. Higher general contributions or additional borrowing may be required, however, to support the payment of such interest. While substantial, the trust fund buildup under partial advance funding is much smaller than it would be with full advance funding.

Pay-as-you-go financing. A financing method in which contributions are established to produce just as much income as required to pay current benefits, with trust fund asset reserves built up only to the extent needed to prevent depletion of the fund by random economic fluctuations.

Payroll tax contributions. The amount based on a percent of earnings, up to an annual maximum, that must be paid by:

- employers and employees on wages from employment under the Federal Insurance Contributions Act,
- the self-employed on net earnings from self-employment under the Self-Employment Contributions Act, and
- States on the wages paid in 1986 and earlier to State and local government employees covered under the Social Security Act through voluntary agreements under section 218 of the act.

Also referred to as payroll taxes.

Population in the Social Security area. See "Social Security area population."

Present value. The equivalent value, at the present time, of a stream of values (either income or cost, past or future). Present values are used widely in calculations involving financial transactions over long periods of time to account for the time value of money, by discounting or accumulating these transactions at the rate of interest. Present-value calculations for this report use the effective yield on trust fund asset reserves.

Primary insurance amount—PIA. The monthly amount payable to a retired worker who begins to receive benefits at normal retirement age or, generally, to a disabled worker. This amount, which is typically related to the worker's average monthly wage or average indexed monthly earnings, is also used as a base for computing all types of benefits payable on an individual's earnings record.

Primary-insurance-amount formula. The mathematical formula relating the PIA to the AIME for workers who attain age 62, become disabled, or die after 1978. The PIA is equal to the sum of 90 percent of AIME up to the first bend point, plus 32 percent of AIME above the first bend point up to the second bend point, plus 15 percent of AIME in excess of the second bend point.

Automatic benefit increases are applied beginning with the year of eligibility. See table V.C2 for historical and assumed future bend points and table V.C1 for historical and assumed future benefit increases.

Quarter of coverage. Basic unit of measurement for determining insured status. For 1978, a worker earned one quarter of coverage, up to four, for each $250 of that worker's annual covered earnings. After 1978, the $250 amount increases automatically with increases in the national average wage index. See table V.C2.

Railroad Retirement. A Federal insurance program, similar to Social Security, designed for workers in the railroad industry. The provisions of the Railroad Retirement Act provide for a system of coordination and financial interchange between the Railroad Retirement program and the Social Security program.

Reallocation of payroll tax rates. An increase in the payroll tax rate for either the OASI or DI Trust Fund, with a corresponding reduction in the rate for the other fund, so that the total OASDI payroll tax rate is not changed.

Real wage differential. The difference between the percentage increases in: (1) the average annual wage in covered employment and (2) the average annual Consumer Price Index. See table V.B1.

Recession. A period of adverse economic conditions, generally defined as two or more successive calendar quarters of negative real growth in gross domestic product.

Reserves. See "Trust fund reserves."

Retired-worker benefit. A monthly benefit payable to a fully insured retired worker aged 62 or older or to a person entitled under the transitionally insured status provision in the law.

Retirement earnings test. See "Earnings test."

Retirement eligibility age. The age, currently age 62, at which a fully insured individual first becomes eligible to receive retired-worker benefits.

Scheduled benefits. The level of benefits specified under current law.

Scenario-based model. A model with specified assumptions for and relationships among variables. Under such a model, any specified set of assumptions determines a single outcome directly reflecting the specifications.

Self-employment. Operation of a trade or business by an individual or by a partnership in which an individual is a member.

Self-Employment Contributions Act–SECA. Provision authorizing Social Security payroll taxes on the net earnings of most self-employed persons.

Short-range. The first 10 projection years. The Social Security Act requires estimates for 5 years; the Trustees prepare estimates for an additional 5 years

to help clarify trends that are only starting to develop in the mandated first 5-year period.

Social Security Act. Provisions of the law governing most operations of the Social Security program. The original Social Security Act is Public Law 74-271, enacted August 14, 1935. With subsequent amendments, the Social Security Act consists of 21 titles, of which three have been repealed. Title II of the Social Security Act authorizes the Old-Age, Survivors, and Disability Insurance program.

Social Security area population. The population composed of: (1) residents of the 50 States and the District of Columbia (adjusted for net census undercount); (2) civilian residents of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Northern Mariana Islands; (3) Federal civilian employees and persons in the U.S. Armed Forces abroad and their dependents; (4) non-citizens living abroad who are insured for Social Security benefits; and (5) all other U.S. citizens abroad.

Solvency. A program is solvent at a point in time if it is able to pay scheduled benefits when due with scheduled financing. For example, the OASDI program is solvent over any period for which the trust funds maintain a positive level of asset reserves.

Special public-debt obligation. Securities of the United States Government issued exclusively to the OASI, DI, HI, and SMI Trust Funds and other Federal trust funds. Section 201(d) of the Social Security Act provides that the public-debt obligations issued for purchase by the OASI and DI Trust Funds shall have maturities fixed with due regard for the needs of the funds. The usual practice has been to spread the holdings of special issues, as of each June 30, so that the amounts maturing in each of the next 15 years are approximately equal. Special public-debt obligations are redeemable at par value at any time and carry interest rates determined by law (see "Interest rate"). See tables VI.A4 and VI.A5 for a listing of the obligations held by the OASI and DI Trust Funds, respectively.

Stochastic model. A model used for projecting a probability distribution of potential outcomes. Such models allow for random variation in one or more variables through time. The random variation is generally based on fluctuations observed in historical data for a selected period. A large number of simulations, each of which reflects random variation in the variable(s), produce a distribution of potential outcomes.

Substantial gainful activity—SGA. The level of work activity used to establish disability. A finding of disability requires that a person be unable to engage in substantial gainful activity. A person who earns more than a certain monthly amount (net of impairment-related work expenses) is ordinarily considered to be engaging in SGA. The amount of monthly earnings considered as SGA depends on the nature of a person's disability. The Social Security Act specifies a higher SGA amount for statutorily blind individuals;

Federal regulations specify a lower SGA amount for non-blind individuals. Both SGA amounts increase with increases in the national average wage index.

Summarized balance. The difference between the summarized income rate and the summarized cost rate, expressed as a percentage of GDP. The difference between the summarized income rate and cost rate as a percentage of taxable payroll is referred to as the actuarial balance.

Summarized cost rate. The ratio of the present value of cost to the present value of the taxable payroll (or GDP) for the years in a given period, expressed as a percentage. To evaluate the financial adequacy of the program, the summarized cost rate is adjusted to include the cost of reaching and maintaining a target trust fund level. A trust fund level of about 1 year's cost is considered to be an adequate reserve for unforeseen contingencies; therefore, the targeted trust fund ratio is 100 percent of annual cost. Accordingly, the adjusted summarized cost rate is equal to the ratio of: (1) the sum of the present value of the cost during the period plus the present value of the targeted ending trust fund level to (2) the present value of the taxable payroll (or GDP) during the projection period.

Summarized income rate. The ratio of the present value of scheduled noninterest income to the present value of taxable payroll (or GDP) for the years in a given period, expressed as a percentage. To evaluate the financial adequacy of the program, the summarized income rate is adjusted to include asset reserves on hand at the beginning of the period. Accordingly, the adjusted summarized income rate equals the ratio of: (1) the sum of the trust fund reserve at the beginning of the period plus the present value of noninterest income during the period to (2) the present value of the taxable payroll (or GDP) for the years in the period.

Supplemental Security Income—SSI. A Federally administered program (often with State supplementation) of cash assistance for needy aged, blind, or disabled persons. The General Fund of the Treasury funds Federal expenditures for the SSI program. The Social Security Administration administers it.

Supplementary Medical Insurance (SMI) Trust Fund. See "Trust fund."

Survivor benefit. Benefit payable to a survivor of a deceased worker.

Sustainable solvency. Sustainable solvency for the financing of the program under a specified set of assumptions is achieved when the projected trust fund ratio is positive throughout the 75-year projection period and is either stable or rising at the end of the period.

Taxable earnings. Wages or self-employment income, in employment covered by the OASDI or HI programs, that is under the applicable annual maxi-

mum taxable limit. For 1994 and later, no maximum taxable limit applies to the HI program.

Taxable payroll. A weighted sum of taxable wages and taxable self-employment income. When multiplied by the combined employee-employer payroll tax rate, taxable payroll yields the total amount of payroll taxes incurred by employees, employers, and the self-employed for work during the period.

Taxable self-employment income. The maximum amount of net earnings from self-employment by an earner which, when added to any taxable wages, does not exceed the contribution and benefit base. For HI beginning in 1994, all net earnings from self-employment.

Taxable wages. See "Taxable earnings."

Taxation of benefits. Beginning in 1984, Federal law subjected up to 50 percent of an individual's or a couple's OASDI benefits to Federal income taxation under certain circumstances. Treasury allocates the revenue derived from this provision to the OASI and DI Trust Funds on the basis of the income taxes paid on the benefits from each fund. Beginning in 1994, the law increased the maximum percentage from 50 percent to 85 percent. The HI Trust Fund receives the additional tax revenue resulting from the increase to 85 percent.

Taxes. See "Payroll tax contributions" and "Taxation of benefits."

Termination. Cessation of payment because the beneficiary is no longer entitled to receive a specific type of benefit. For example, benefits might terminate as a result of the death of the beneficiary, the recovery of a disabled beneficiary, or the attainment of age 18 by a child beneficiary. In some cases, an individual may cease one benefit and this is not a termination because they become immediately entitled to another type of benefit, such as the conversion of a disabled-worker beneficiary at normal retirement age to a retired-worker beneficiary.

Test of long-range close actuarial balance. The conditions required to meet this test are:

- The trust fund satisfies the test of short-range financial adequacy; and
- The trust fund ratio stays above zero throughout the 75-year projection period, such that benefits would be payable in a timely manner throughout the period.

The Trustees apply the test to OASI, DI, and the combined OASDI program based on the intermediate set of assumptions.

Test of short-range financial adequacy. The conditions required to meet this test are:

- If the trust fund ratio is at least 100 percent at the beginning of the 10-year projection period, then it must remain at or above 100 percent throughout the entire projection period;

- If the ratio is initially less than 100 percent, then it must reach at least 100 percent within 5 years (without reserve depletion at any time during this period) and then remain at or above 100 percent throughout the remainder of the 10-year period.

The Trustees apply the test to OASI, DI, and the combined OASDI program based on the intermediate set of assumptions.

Total-economy productivity. The ratio of real GDP to hours worked by all workers. Also referred to as "labor productivity."

Total fertility rate. The sum of the single-year-of-age birth rates for girls and women aged 14 through 49, where the rate for age 14 includes births to girls aged 14 and under, and the rate for age 49 includes births to women aged 49 and over. The total fertility rate may be interpreted as the average number of children that would be born to a woman if she were to experience, at each age of her life, the birth rate observed in, or assumed for, a specified year, and if she were to survive the entire childbearing period.

Trust fund. Separate accounts in the United States Treasury which hold the payroll taxes received under the Federal Insurance Contributions Act and the Self-Employment Contributions Act; payroll taxes resulting from coverage of State and local government employees; any sums received under the financial interchange with the railroad retirement account; voluntary hospital and medical insurance premiums; and reimbursements or payments from the General Fund of the Treasury. As required by law, the Department of the Treasury invests funds not required to meet current expenditures in interest-bearing securities backed by the full faith and credit of the U.S. Government. The interest earned is also deposited in the trust funds.

- **Old-Age and Survivors Insurance (OASI).** The trust fund used for paying monthly benefits to retired-worker (old-age) beneficiaries, their spouses and children, and to survivors of deceased insured workers.
- **Disability Insurance (DI).** The trust fund used for paying monthly benefits to disabled-worker beneficiaries, their spouses and children, and for providing rehabilitation services to the disabled.
- **Hospital Insurance (HI).** The Medicare trust fund that covers specified inpatient hospital services, posthospital skilled nursing care, home health services, and hospice care for aged and disabled individuals who meet the eligibility requirements. Also known as Medicare Part A.
- **Supplementary Medical Insurance (SMI).** The Medicare trust fund composed of the Part B Account, the Part D Account, and the Transitional Assistance Account. The Part B Account pays for a portion of the costs of physicians' services, outpatient hospital services, and other related medical and health services for voluntarily enrolled aged and disabled individuals. The Part D Account pays private plans to provide

prescription drug coverage, beginning in 2006. The Transitional Assistance Account paid for transitional assistance under the prescription drug card program in 2004 and 2005.

The trust funds are distinct legal entities which operate independently. Fund operations are sometimes combined on a hypothetical basis.

Trust fund ratio. A measure of trust fund adequacy. The asset reserves at the beginning of a year (equal to the reserves at the end of the prior year), which do not include advance tax transfers, expressed as a percentage of the cost for the year. The trust fund ratio represents the proportion of a year's cost which could be paid solely with the reserves at the beginning of the year.

Trust fund reserve depletion. The point at which reserves in a trust fund are insufficient to pay scheduled benefits in full and on time.

Trust fund reserves. The cumulative excess of trust fund income over trust fund cost over all years to date. These reserves are held by the trust funds in the form of Treasury notes and bonds, other securities guaranteed by the Federal Government, certain Federally sponsored agency obligations, and cash.

Trustees. See "Board of Trustees."

Undisbursed balances. In general, refers to the cumulative differences between the actual cash payments for a month compared to security redemptions from the trust fund reserves made on a preliminary basis to cover such cash payments during the same month. On a monthly basis, the Social Security Administration (SSA) pays benefits and makes payments for other programmatic expenses associated with the trust funds. During each month, SSA draws cash from the trust funds on a preliminary basis, which results in Treasury redeeming invested securities to cover such payments. This monthly difference can be either positive or negative depending on net monthly activity, and is added to the balance at the end of the prior month.

A net positive undisbursed balance represents a situation where cumulative redemptions from the trust fund's securities are more than was needed to cover actual program cash payments through the end of the month. A net negative balance represents a situation where cumulative program cash payments exceeded the amount redeemed from the invested securities. A negative value requires future redemption of additional invested securities.

In addition, about every seven years, when January 3 falls on a Sunday, benefit payments scheduled to be paid on January 3rd are actually paid on December 31 of the preceding year, as required by the statutory provision included in the 1977 Social Security Amendments for early delivery of benefit payments when the normal payment delivery date is a Saturday, Sunday, or legal public holiday. Consistent with practice in prior reports and for comparability with other historical years and the projections in this report, all trust fund operations and asset reserves reflect the 12 months of benefits scheduled for payment in each year. Therefore, such advance payments are

included as positive values in the undisbursed balance at the end of the calendar years in which the advance payments are made.

Unfunded obligation. A measure of the shortfall of trust fund income to fully cover program cost through a specified date after depletion of trust fund asset reserves. This measure can be expressed in present value dollars, discounted to the beginning of the valuation period, by computing the excess of the present value of the projected cost of the program through a specified date over the sum of: (1) the value of trust fund reserves at the beginning of the valuation period; and (2) the present value of the projected non-interest income of the program through a specified date, assuming scheduled tax rates and benefit levels. This measure can apply for all participants through a specified date, i.e., the open group, or be limited to a specified subgroup of participants.

Unfunded obligation ratio. The unfunded obligation accumulated through the beginning of a year expressed as a percentage of the cost for the year.

Unnegotiated check. A check which has not been cashed 6 months after the end of the month in which the check was issued. When a check has been outstanding for a year, the Department of the Treasury administratively cancels the check and reimburses the issuing trust fund separately for the amount of the check and interest for the period the check was outstanding. The appropriate trust fund also receives an interest adjustment for the time the check was outstanding if it is cashed 6 to 12 months after the month of issue. If a check is presented for payment after it has been administratively canceled, a replacement check is issued.

Valuation period. A period of years which is considered as a unit for purposes of calculating the financial status of a trust fund.

Vocational rehabilitation (VR). Services provided to disabled persons to help them to return to gainful employment. VR services are designed to provide an individual with the training or other services that are needed to return to work, to begin working, or to enter a new line of work. The trust funds, and the General Fund in the case of individuals also receiving Supplemental Security Income disability benefits, reimburse the providers of such services only in those cases where the services contributed to the successful rehabilitation of the beneficiaries.

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STATEMENT OF ACTUARIAL OPINION

It is my opinion that: (1) the techniques and methodology used herein to evaluate the actuarial status of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds are based upon sound principles of actuarial practice and are generally accepted within the actuarial profession; and (2) the assumptions used and the resulting actuarial estimates are, individually and in the aggregate, reasonable for the purpose of evaluating the actuarial status of the trust funds, taking into consideration the past experience and future expectations for the population, the economy, and the program. I am a member of the American Academy of Actuaries and I meet the Qualification Standards of the American Academy of Actuaries to render this actuarial opinion.

Stephen C. Goss

Associate, Society of Actuaries
Member, American Academy of Actuaries
Chief Actuary, Social Security Administration

Oregon Office of Economic Analysis

Oregon Economic News, Analysis and Outlook

Oregon's Growing Hispanic and Latino Population

Posted by: **Josh Lehner** | June 21, 2023

Migration, and overall population growth are key drivers of our office's long-run economic and revenue outlook. And while we focus primarily on those impacts, it is also important to note the big demographic changes that are happening within the state. The two biggest ones are the generational shifts happening — Baby Boomers retiring, Millennials becoming the economic drivers, the relatively smaller Gen Z, etc — and the increasing racial and ethnic diversity of Oregonians.

While Oregon will continue to be a more diverse place in the years ahead, the state still ranks below average. Looking at the 2020 Census data, Oregon ranks 30th among all states when it comes to overall racial and ethnic diversity. However, if we focus specifically on the Hispanic and Latino population, Oregon ranks 14th highest across states. Now, at 14% of the state's population, Oregon's Hispanic and Latino population is still a smaller share locally than it is nationally (19%) but the national numbers are driven by increased diversity among large states like California, Arizona, Texas, Florida and the like.

The first chart shows the strong growth and big increase in the state's Hispanic and Latino population. Back in the 1980 Census, about 2% of Oregonians identified as Hispanic or Latino. Fast forward to the most recent 2020 Census and 14% of us did so. Our Hispanic and Latino neighbors make up the fastest growing demographic in our state.

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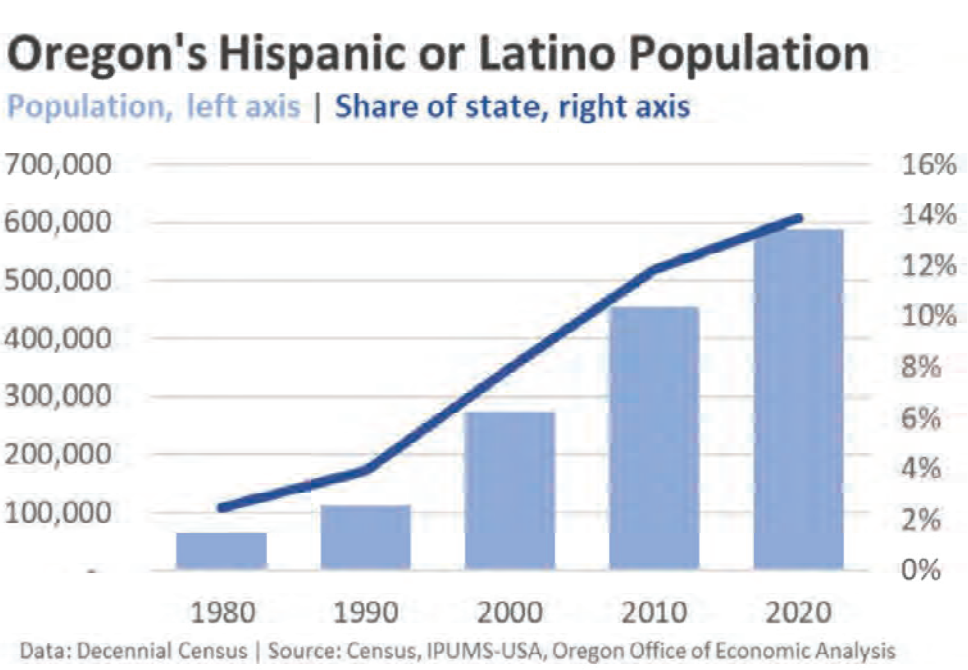
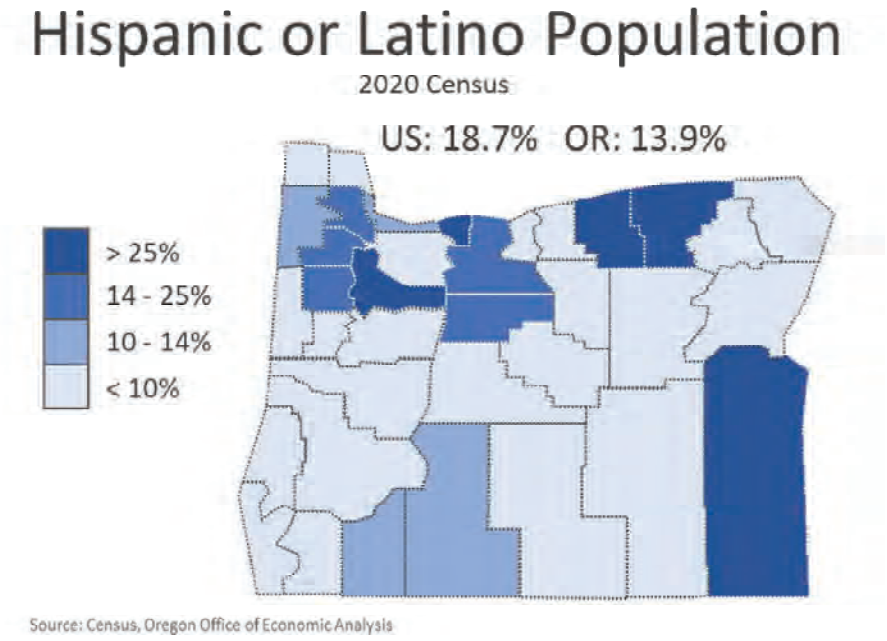


While this growth is largely seen statewide, different regions of the state are more diverse than others. When it comes to Oregon's Hispanic and Latino population we see larger concentrations and more diversity in the Willamette Valley, the Gorge, portions of Eastern Oregon, particularly around Boardman Hermiston, and Ontario, and then in Southern Oregon in both Jackson and Klamath counties.



An important demographic point is that Hispanic and Latino Oregonians have a younger age profile, and younger generations are more diverse overall. For example, about 5% of Baby Boomers in Oregon identify as Hispanic or Latino, while 16% of Millennials do, and 23% of Gen Z does.

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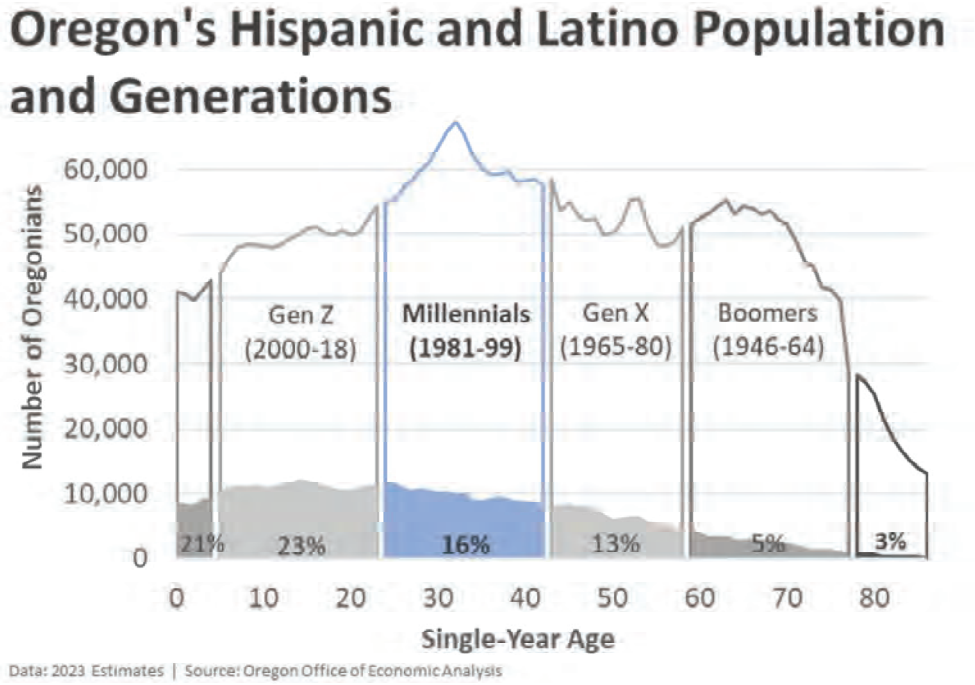
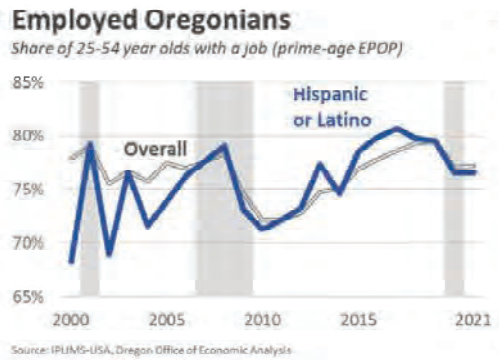
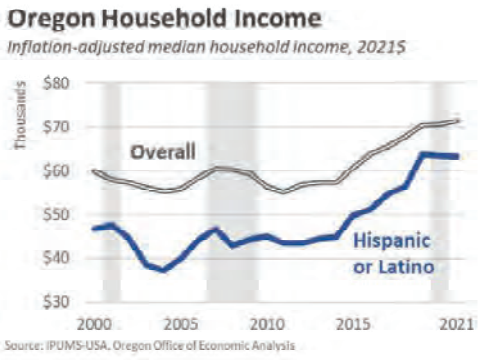


This increased diversity by age has a few important implications moving forward. First, Oregon will continue to become more diverse in the decades ahead. Second, part of that increased diversity is due to somewhat higher birthrates among Hispanic and Latino households, but also just that if households in their 20s, 30s, and 40s are more diverse, the children will be as well. Third, more diverse counties have better demographics and more balanced births and deaths. This goes for rural counties just as much as for urban ones. And fourth, given there is a lot of truth to the demography is destiny saying, there will be big economic implications in the decades ahead as the workforce and households become more diverse. This why somewhere like Salem has great forward-looking demographics.

Speaking of economics, Hispanic and Latino Oregonians are employed at average or slightly above average rates in recent decades when compared with Oregon as a whole. Higher employment rates are seen among low- and middle-wage occupations like agriculture, building maintenance, production, construction, food prep, and transportation and material moving.

As such, the composition of the types of jobs worked does have an impact on overall household income to some degree. As noted before, Oregon, like the nation, has large historical disparities. Looking back a decade or two, median household income for Hispanic and Latino households in the state was 20-30% lower than the overall statewide figures. Economic growth in the past handful of years has been a bit more equitable. Today, the median household income gap is more like 10-15% based on the latest available data. We get 2022 ACS data in September.





Finally, we know wealth inequality in America is even greater than income inequality.

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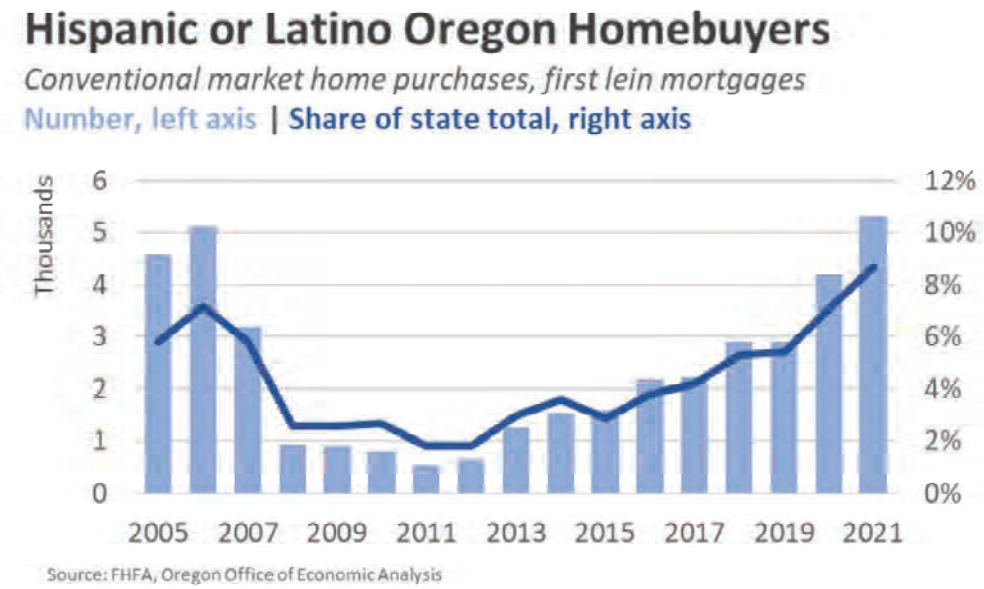
Here, too, we see big historical disparities that may be starting to lessen in recent years. For example, Oregon's overall homeownership rate stood at 64% in 2021. Homeownership among Hispanic and Latino households in the state was 48%. That's a big gap, and while some of it is impacted by the age composition — younger households tend to be renters, older tend to own — we do see lower rates of homeownership for Hispanic and Latino Oregonians at every age group.

If we look at mortgage origination data from the FHFA, we are seeing an increase in new, first lein mortgages going to Hispanic and Latino Oregonians. A decade ago only a couple percent of new mortgages went to our Hispanic and Latino neighbors, but in the most recently available data it was 9%. That is still a smaller percentage than the share of all households that identify as Hispanic or Latino, but starting to move in the more equitable direction. Moving forward, given demographics and the structurally tight labor market, I would expect to see Hispanic and Latino households make up an increasing share of new mortgages.



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Oregon State

Select State using map/list below

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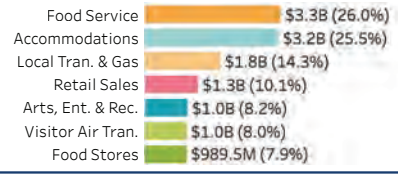
2024 Subcategory Breakout



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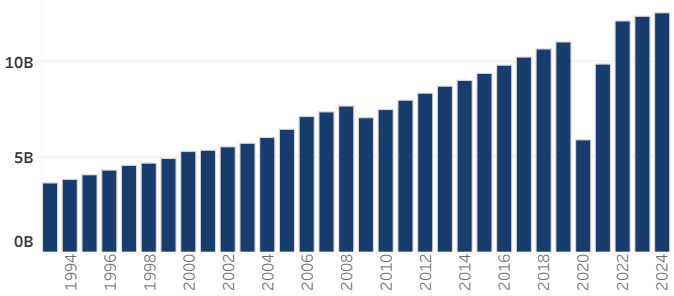
Years: (All)

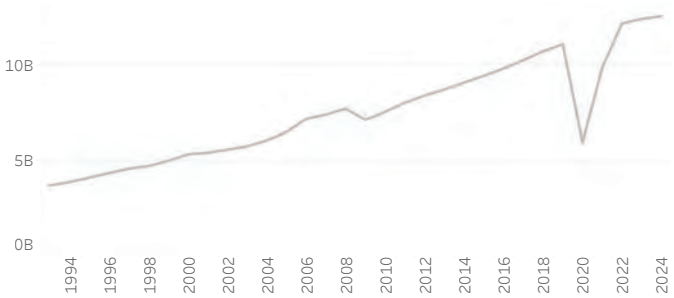
Oregon State

Visitor Spending by Commodity Purchased

All



State Breakout



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